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Steps toward excellence in neurosurgery

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ABSTRACT
The Romanian Society of Neurosurgery (RSN) was founded in 1982 under the leadership of Prof. Dr. Constantin Arsene, with Dr. Ion Oprescu as the society's secretary. This established the first foundational elements for developing organized neurosurgery nationally. Subsequently, especially following the regime change in 1990, SRN experienced significant growth, leading to the 49th Congress. According to the society's statutes, the Congress is held in different locations to involve the entire neurosurgical community in advancing neurosurgery nationwide. The 49th Congress occurred in a remarkable location, Sinaia, known as the "Pearl of the Carpathians" and famed for the splendid Peleș Castle, built by Romania's Royal Family – Carol I of Hohenzollern. The entire Congress was held at the Hotel International, with significant participation from Romania and a notable presence of neurosurgeons worldwide, raising the scientific level of the event. Various neurosurgical topics were structured into substantial sections, including the Young Neurosurgical Corner, dedicated to young neurosurgeons. In conclusion, the 49th Congress, held in English, fully achieved its objective, marking another step forward in the development of this speciality in Romania.

Keywords
congress, Romanian Society of Neurosurgery (RSN), neurosurgical community

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Between September 11th and 14th, 2024, the 49th Congress of the Romanian Society of Neurosurgery (RSN) took place, a landmark event in the field of neurosurgery, held at the Hotel International in Sinaia, in the heart of the Bucegi Mountains (Photo 1).

Founded in 1982 under the leadership of Prof. Dr. Constantin Arsene, this society now includes 409 neurosurgeons, 84 of whom are residents. Sinaia, known as the "Pearl of the Carpathians," provided an ideal setting for this academic event, with its rich history and reputation as a preferred location for international conferences. The relaxing atmosphere and mountain scenery certainly contributed to a memorable experience for all attendees.

The Congress took place in two modern rooms, Magnum and Auditorium, and gathered 219 participants, including specialists from

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around the world, representing almost every continent. This diversity fostered a precious exchange of ideas and experiences (Photo 2).

Photo 1. Official Opening of the 49th RSN Congress.

Photo 2. Auditorium of the 49th RSN Congress.

The congress opening was marked by the 28th edition of the French Neurosurgery Course, organized with the support of the scientific committee chaired by Ph.D. Bogdan Costăchescu and Prof. Olivier Klein.

Throughout the congress, all significant neurosurgical topics were addressed, broken down into pathology categories. Essential aspects related to vascular pathology were discussed, including techniques in open microsurgery and endovascular procedures, which are crucial for treating arteriovenous malformations and cerebral aneurysms. A detailed review of tumor pathology was also presented, covering major lesions from low-grade gliomas to high-grade glioblastomas and highlighting the surgical and adjuvant strategies necessary to optimize therapeutic outcomes. Topics related to spinal pathology were discussed, including modern techniques for spinal surgeries and innovations in treating degenerative conditions. The congress also featured sessions on pediatric and functional neurosurgery, addressing the specific challenges faced in treating young patients and intervention strategies for alleviating severe neurological symptoms.

The congress showcased outstanding research in Neuro-oncology, with exceptional contributions from renowned specialists. Prof. Fady Charbel (SUA), Thomas Santarius (United Kingdom), Henry Schroeder (Germany), Andre Grotenhuis (Olanda), Adrian Bălașa (România), Ioan Ștefan Florian (România) and Grigore Zapuhlîh (Republica Moldova) presented innovative research that captivated the audience.

In the session dedicated to Cerebrovascular Neurosurgery, Waleed Abbas (Egypt), Eduardo Vieira de Carvalho Junior (Brazil), and Ștefan Florian (Romania) made significant contributions, discussing advanced techniques and essential therapeutic strategies for managing cerebrovascular diseases.

Unique aspects of Pituitary Tumor Pathology were presented by Thomas Santarius (United Kingdom), Ligia Gabriela Tătăranu (Romania), Rareș Chinezu (Romania) and Daniel Rotariu (Romania), who explored new perspectives on diagnosing and treating these complex conditions. In Spinal Pathology, presentations by Lukas Rasulic (Serbia), Marcel Ivanov (United Kingdom) Mohamed M. Ali (Saudi Arabia), Mihael Spyrou (Cyprus) and Cezar Popescu (Romania) were remarkable, highlighting innovative surgical techniques and promising results.

A separate section was dedicated to contributions in Stereotactic Radiosurgery, represented by Fery Stoica and Radu-Daniel Pelin (Romania), who discussed recent advances in the use of radiotherapy for neurosurgical treatments.

Olivier Klein and Carmine Mottolesse from France dominated the scene at the French Neurosurgery Course, contributing valuable insights through their extensive expertise.

The Euroacademia Multidisciplinary Neurotraumatic Session (EMN) opened with the presence of former president, Prof. Dr. Wolf-Ingo Steudel. This session delved deeply into various current aspects of European neurotraumatology (Photo 3).

Photo 3. Prof. Dr. Alexandru-Vlad Ciurea and Prof. Dr. Wolf-Ingo Steudel as chairmen.

Photo 4. Prof. Dr. Ștefan Florian.

Covering all critical aspects of neurosurgery, the congress succeeded in attracting the attention of numerous participants, highlighting the interest and commitment of the medical community to this essential field. At the Young Neurosurgical Corner, all Romanian centers contributed valuable papers, culminating in the awarding of three prizes for outstanding contributions.

The congress president and local coordinator, Prof. Dr. Daniel-Mihai Teleanu, skillfully combined neurosurgical and organizational activities, with the support of the advertising company ASPRO, which ensured a flawless execution of the event.

The 50th Congress of the Romanian Society of Neurosurgery, an exceptional jubilee event, will be held in the splendid city of Cluj-Napoca in September 2025 (Photo 4).

This significant gathering will not only celebrate past achievements but also demonstrate the continued commitment of the neurosurgical community to excellence and innovation. In a festive atmosphere, all neurosurgery centres in the country will enthusiastically participate, contributing to a valuable exchange of knowledge and experience.

We look forward to gathering in Cluj-Napoca, a city with a rich academic tradition and a vibrant atmosphere, providing an ideal backdrop for this celebration of neurosurgical excellence.

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Stent assisted coil embolization for post-surgical ruptured recurrence of anterior communicating aneurysm

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ABSTRACT

Cerebral aneurysm recurrences after previous surgical clipping are associated with an important risk of growth and rupture. These lesions can be difficult to manage by either a classical microsurgical approach or endosaccular coiling. The advanced endovascular technique can be considered as a treatment option for these recurred aneurysms. Aneurysm coil occlusion and endoluminal parent vessel reconstruction with intracranial stent may be an ideal method for treating these recurrences by avoiding reoperative surgery or intraprocedural aneurysm rupture with aneurysm access. Stent-assisted coil embolization can be a safe and efficacious treatment approach for recurrent ACom region aneurysms after previously surgical clipping.

Keywords
post-surgical aneurysm recurrence, stent assisted coiling technique

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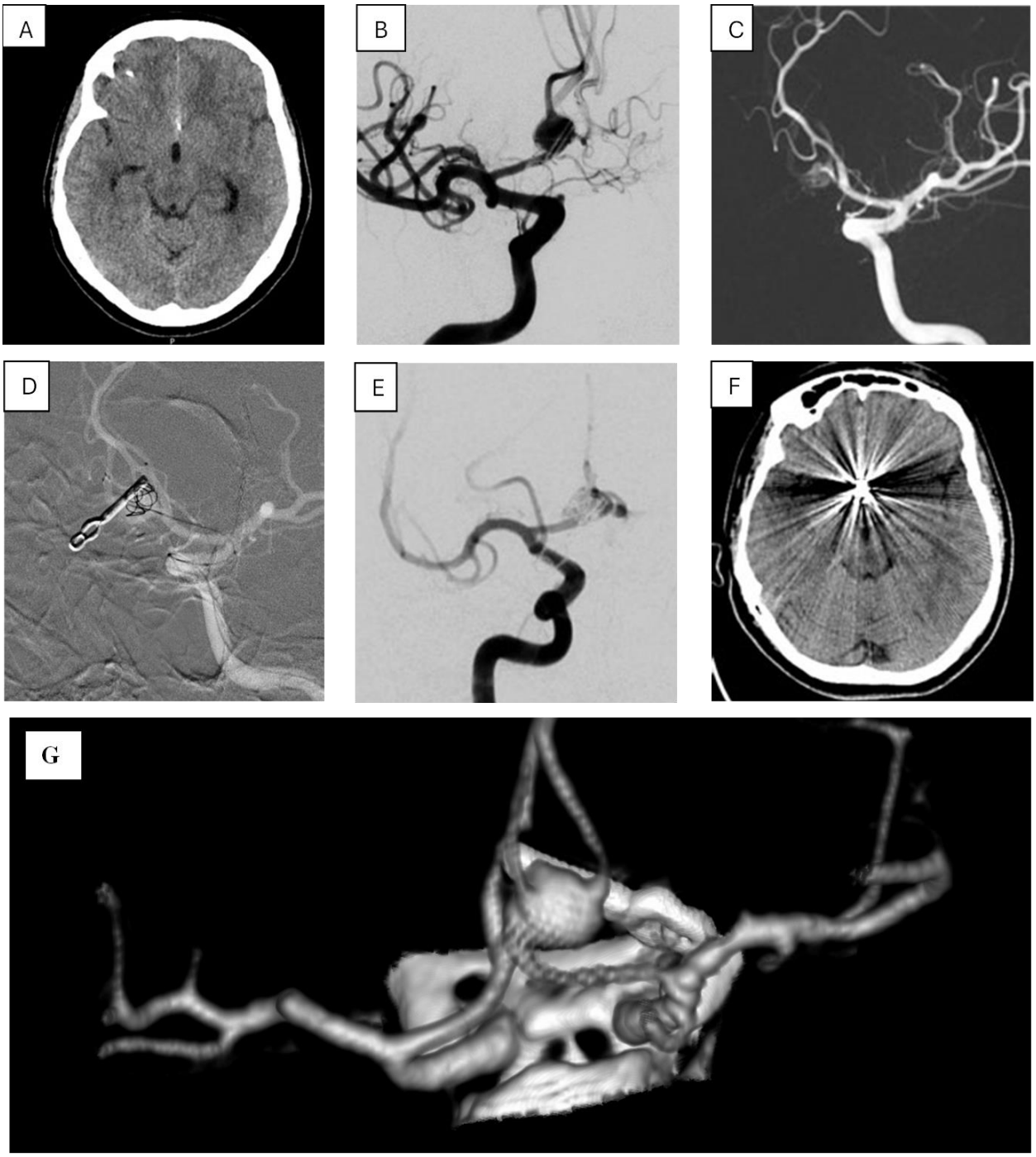
INTRODUCTION

The anterior communicating complex is the most prevalent site for aneurysm formation, comprising up to 25-40% [2,5,7] of all intracranial aneurysms. Due to the arterial anatomy and hemodynamic flow patterns, the anterior communicating artery (ACoA) aneurysms display a higher rate of rupture in comparison to other sites, thus being responsible for debilitating conditions and increased mortality. Even though surgical clipping aims to achieve complete obliteration of the aneurysm sac and neck, aneurysm remnant or recurrence have been reported in literature. To prevent severe neurological deficits and potentially fatal consequences of a new bleeding episode, neuroimaging follow-ups and prompt re-treatment are crucial. Endovascular therapies have proved to be an efficacious method of choice in such cases considering the scar adhesions after surgical clipping and the important structures surrounding the anterior communicating complex [1.3.4].

In this paper, we present a clinical situation of a ruptured recurrence of ACoA aneurysm which required embolization after initially surgically clipped. Post-surgical aneurysms evolution associated with morphological complications, evaluation and management of residual and recurrent intracranial aneurysms are discussed.

CASE REPORT

A 37-year-old woman was admitted to our hospital due to frontoparietal headache, nausea, diplopia, generalized tonico-clonic seizures and right hemiparesis. The patient had a history of microsurgical clipping for an ACoA aneurysm 13 years before, arterial hypertension with regular treatment and depressive syndrome.



Figures. A – Diagnostic CT scan showing a mild subarachnoid hemorrhage; **B** – Right ICA DSA that exposes an ACoA aneurysm, a clip on the top of the aneurysm dome and a triplicate A2 segments; **C** – Left ICA negative DSA which highlights the anatomical separation of the left A1 and A2 segments fromthe aneurysm; **D** –Intraprocedural left ICA negative DSA with right A1-A2 stent, microcatheter in the middle A2 segment originating from the aneurysm and a microcatheter in the aneurysm sac for coil insertin; **E** – Right ICA DSA showing the complete angiographic occlusion of the aneurysm; **F** – Post interventional CT scan. **G** – 3D Angio-CT showing the relation of the aneurysm and trefurcatian A2.

Native cerebral CT showed a mild subarachnoid hemorrhage in the interhemispheric fissure and basal cisterns. Computed tomographic (CT) angiography with three-dimensional reconstruction depicted a recurrent, dysplastic ACoA aneurysm associated with A2 segment trifurcation and metallic clip at the distal end of the dome from the previous surgery. The three arterial branches arose from the aneurysmal neck which had a large diameter of 6 mm. No magnetic resonance imaging (MRI) was performed, because its compatibility with the surgical clip was unknown.

Subtraction catheter cerebral angiography confirmed the diagnosis: ruptured ACoA aneurysm associated with triplicate A2 segments. Due to the ACA anatomical variant and the complex aneurysm morphology which involved bilateral A2 segments and the possible complications of a new craniotomy, endovascular treatment under general anesthesia was decided.

Prior to induction of general anesthesia with orotracheal intubation, the patient was administered a antiplatelet therapy with Aspenter 150mg. The approach was performed through the right femoral access route with a 6F introduction sheath. 5000 IU heparin was injected intravenously immediately after sheath placement. A 6F Envoy guiding catheter (Codman - Johnson & Johnson) was first placed in the right internal carotid artery and multiple digital subtraction angiography (DSA) series were obtained in different degrees of obliquity for the clear exposure of the aneurysm neck and dome. After the three-dimensional reconstruction of the DSA data, the best projection degree showed the aneurysm sac and its neck. Under road-mapping guidance, a Prowler Select Plus Microcatheter (Codman) was advanced over a 0.014 Transend micro-guidewire (Stryker Neurovascular) into the right A2 segment. The first Enterprise 2 (Cerenovus, J&J) stent was deployed at the proper position between the right distal A1 segment and the proximal right A2 segment. Subsequently, the guiding catheter was rerouted in the left internal carotid artery. Two straight Excelsior SL-10 microcatheter were navigated concurrently into the left A2 segment and the aneurysm sac. First, three 0.012" GALAXY G3™ XSFT coils (Cerenovus, J&J) were detached into the aneurysm sac with complete angiographic occlusion. This was immediately followed by a detachment of a Neuroform Atlas stent (Striker) between proximal left A2 segment and distal left A1 segment. Serial DSAs were performed to monitor the occlusion of the aneurysm and to verify the patency of the arterial branches. The microcatheters were gently removed, followed by the guiding catheter and the femoral sheath. Homeostasis of the femoral artery was obtained via prolonged compression. The patient was awakened from general anesthesia and admitted to the neuro-intensive care unit. The next day, the CT control revealed successful endovascular treatment without any other pathological aspects.

Postoperatively, the patient was prescribed dual antiplatelet therapy for 6 months, followed by mono antiplatelet therapy.

Discussions

Exclusion from cerebral circulation by microsurgical clipping of intracranial aneurysms was and may still be considered the standard of care for these vascular lesions. However, residual, recurrent or de-novo aneurysms after this therapeutic technique have been reported in literature series from 1.5 to 8% of patients by postoperative cerebral angiography at various time intervals. The main mechanisms mentioned in the literature for residual or recurrent aneurysms after micro surgical clipping intervention were represented by incomplete clipping due to technical or anatomical difficulties in clip positioning, postoperative aneurysm clips slippage and aneurysm regrowth from residual parts of the lesion[5,8.9].

Even if International subarachnoid aneurysm trials (ISAT) reported zero risks of rebleeding at one year and 2.2% at ten years interval after aneurysm clipping, the percentages are different in the case of incomplete clipping where the risk of rebleeding is estimated to be in the range of 0.8 to 1.8% per year[3,7]. Also, a history of multiple aneurysms was associated with de-novo aneurysm formation on the same arterial segment with the initial clipped aneurysm.

Therapeutic management of recurrent or remnant aneurysms can be especially challenging from both a microsurgical and endovascular perspective. Even if microsurgical clipping re-intervention of aneurysms was considered a viable solution for these clinical situations, technical difficulties represented by scar and adhesions to the implant or to the area of aneurysmal repermeabilization may preclude the positioning of

a new clip by the initial one. Today, technological advancements in the neurointervention field made the endovascular treatment be considered the first option for recurrent or remnant aneurysms. This approach has also remarkably reduced the occurence of seizures, wound healing complications and postoperative pain.

Starting from the previously mentioned aspects and a continuous development of endovascular techniques for occlusion of complex intracranial aneurysms, it was a natural way that endovascular coil embolization became the alternative treatment modality for remnant or recurrent aneurysms. After Fraser et al. reported the results of coil embolization in cases of incompletely clipped aneurysms for the first time in 1994, many subsequent studies have presented the advantages of this technique[2,6,10].

In this article, we demonstrate the successfully use of endovascular technique in the management of recurrent ACom region aneurysms after surgical clipping. Even if endovascular techniques can be considered an ideal means of treatment under these circumstances, a series of inconveniences have been reported, especially for the aneurysms of the anterior communicating complex. Firstly, fluoroscopic visualization of the aneurysm neck related to the origin of the adjacent vessels can be quite difficult because the clip lies across them. Secondly, the neck of the aneurysm crossed by the clip is much more rigid and thus, during the placement of the coil, it may push the coils back with a possible obstruction of the origins of the adjacent vessels. Moreover, the shape of residual aneurysms is frequently complex with a shallow depth, making coil stabilization challenging or even impossible. Providing a reconstructive technique such as stent-assisted coiling rather than simple coiling might improve the stability and durability of the treatment. The stents intended for stent-assisted coiling have a certain flow-diversion effect which allows for parent vessel reconstruction.

Conclusions

After surgical clipping, remnant growth or recurrence of the aneurysm can occur due to a hemodynamic change over the years at the clip site. Follow-up imaging for a long period of time is essential for all patients that underwent surgical clipping. In our experience, endovascular treatment is a good strategy for residual or recurrent aneurysms, but careful evaluation for each particular case is required.

References

1. Cekirge, H. S., Islak, C., Firat, M. M., Kocer, N., & Saatci, I. (2000). Endovascular coil embolization of residual or recurrent aneurysms after surgical clipping. Acta Radiologica, 41(2), 111-115.
2. Chiriac, A., Dobrin, N., Ion, G., Faiyad, Z., & Poeata, I. (2021). The stent-assisted coil-jailing technique for very small intracranial aneurysm treatment. Romanian Neurosurgery, 148-151.
3. Chung, J., Park, I. S., Park, H., Hwang, S. H., Jung, J. M., & Han, J. W. (2014). Endovascular coil embolization after clipping: endovascular treatment of incompletely clipped or recurred cerebral aneurysms. Journal of Cerebrovascular and Endovascular Neurosurgery, 16(3), 262.
4. Kang, H. S., Han, M. H., Kwon, B. J., Chang, K. H., Oh, C. W., & Han, D. H. (2004). Endovascular Treatment in Post-Surgical Cerebral Aneurysms. Journal of Korean Neurosurgical Society, 36(1), 1-6.
5. Kim, S. T., Baek, J. W., Jin, S. C., Park, J. H., Kim, J. S., Kim, H. Y., ... & Jeong, Y. G. (2019). Coil embolization in patients with recurrent cerebral aneurysms who previously underwent surgical clipping. American Journal of Neuroradiology, 40(1), 116-121.
6. Kim, P., & Jang, S. J. (2018). Management of recurrent cerebral aneurysm after surgical clipping. Journal of Korean Neurosurgical Society, 61(2), 212-218.
7. Lin, L. M., Iyer, R. R., Bender, M. T., Monarch, T., Colby, G. P., Huang, J., ... & Coon, A. L. (2017). Rescue treatment with pipeline embolization for postsurgical clipping recurrences of anterior communicating artery region aneurysms. Interventional Neurology, 6(3-4), 135-146.
8. Jabbarli, R., Pierscianek, D., Wrede, K., Dammann, P., Schlamann, M., Forsting, M., ... & Sure, U. (2016). Aneurysm remnant after clipping: the risks and consequences. Journal of Neurosurgery, 125(5), 1249-1255.
9. Mangiafico, S., Cellerini, M., Villa, G., Ammannati, F., Paoli, L., & Mennonna, P. (2005). Endovascular Coiling of Aneurysm Remnants after Clipping in Patients with Follow-up: A Single Center Experience. Interventional Neuroradiology, 11(1), 41-48.
10. da Silva Júnior, N. R., Trivelato, F. P., Nakiri, G. S., Rezende, M. T. S., de Castro-Afonso, L. H., Abud, T. G., ... & Giannetti, A. V. (2021). Endovascular treatment of residual or recurrent intracranial aneurysms after surgical clipping. Journal of Cerebrovascular and Endovascular Neurosurgery, 23(3), 221-232.

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Double cerebral abscess with Stenotrophomonas Maltophilia secondary to pulmonary abscess and with septic sigmoid sinus and jugular vein thrombosis

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ABSTRACT

The patient, 35 years old, left-handed, admitted for mixed aphasia, left hemiparesis, temporal-spatial disorientation, later stupor, symptoms appeared for about 24 hours and progressively intensified. Cranial CT scan with contrast and lung with contrast revealed 2 brain abscesses, one large frontal abscess on the right (54/51/47 mm) extended subcortically to the wall of the lateral ventricle and right parietal (32/26/22 mm). Right mediobasal corticalized lung abscess 47/51/28 mm. Toraco-pulmonary CT scan revealed millimetric pulmonary microlesions (some calcified), predominantly in the right upper lobe and a right parietal abscess 47/51/28 mm. The patient underwent emergency surgery (Right frontal craniotomy, subtotal excision of the abscess under magnification, right parietal craniotomy, excision of the abscess under magnification). Along with the surgical treatment, antibiotic treatment was administered according to the antibiogram administered iv and in aerosols, neurotropics, Vitamins B1, B6, anticoagulant treatment for venous thrombosis.

Keywords
brain abscess, stenotrophomonas maltophilia

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INTRODUCTION

Stenotrophomonas maltophilia, , is an aerobic, Gram-negative, multi-drug resistant germ 1. Most often, Stenotrophomonas maltophilia grows in drinking water, presenting an increased risk of infection. Most patients with infections caused by Stenotrophomonas maltophilia are patients with comorbidities, such as neoplasms, chronic lung diseases[1].

Treatment of respiratory infections caused by Stenotrophomonas maltophilia is very difficult, both because of the intrinsic resistance of this germ to a large number of antibiotics and its ability to develop resistance during antibiotic treatment.

Brain abscess is a severe intracranial infectious disease that has a prevalence of 0.4–0.9 per 100,000 population (Nicolosi et al., 1991)[4].

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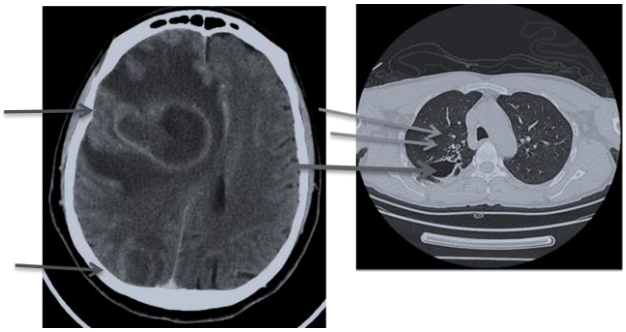

Figure 1. Cranial CT scan with contrast. Right frontal (54/51/47 mm) compressive on the lateral ventricle (subfalcorial herniation) and parietal abscess (32/26/22 mm) (Red arrows).

Figure 2. Thoracal CT scan with contrast. Right Parietal abscess 47/51/28 mm posibil bacilar(Blue arrow). Micronodules (some of them calcified) of bacilar etiology- ancient infection green arrows.

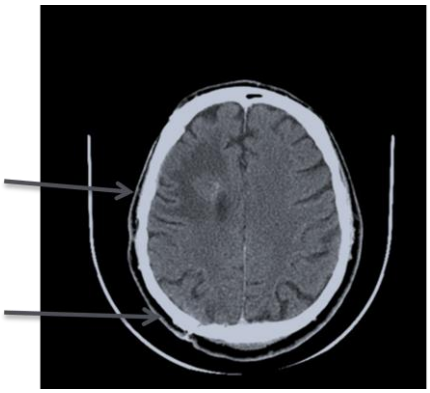

Figure 3. Subtotal excision of massive frontal abscess. Total excision under magnification of occipital abscess (red arrows)

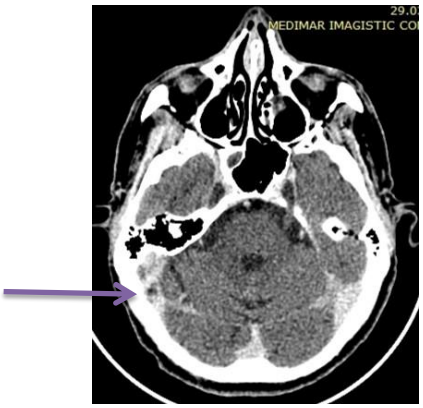

Figure 4. Thrombosis of the right sigmoid sinus (mauve arrow)

CASE REPORT

Patient, 35 years old, left-handed, was urgently admited in our unit for mixed aphasia, left hemiparesis (ASIA 2/5), stupor (GCS 11), temporospatial disorientation.

The patient was known to have type 2 diabetes for which he followed the regimen indicated by the diabetologist.

Cranial CT scan with contrast and lung with contrast revealed 2 brain abscesses, one large frontal abscess on the right (54/51/47 mm) extended subcortically to the wall of the lateral ventricle and right parietal (32/26/22 mm). Right mediobasal corticalized lung abscess 47/51/28 mm. Toraco-pulmonary CT scan revealed millimetric pulmonary microlesions (some calcified), predominantly in the right upper lobe and a right parietal abscess 47/51/28 mm.

The patient underwent emergency surgery (Right frontal craniotomy, subtotal excision of the abscess under magnification, right parietal craniotomy, excision of the abscess under magnification). The deep part, about 4-5 mm, glued to the side wall of the frontal sinus was left untouched to prevent the installation of a ventriculitis.

Empiric antibiotic treatment followed initially with Ceftamil 2 g every 8 hours, Vancomycin 1 ampoule 2 times/day, Metronidazole 500 mg vials 3 times/day for 3 days. Bacteriological examination revealed Stenotrophomonas maltophilia sensitive to Bseptol. In accordance with the antibiogram, the patient was administered Biseptol 2 tb every 12 hours during the hospitalization (3 weeks)and another 6 weeks later, at home.

The patient neurologic and clinical status was good : normal status of conscience, disapearance of the left hemiparesis.

Vitamin B1 and B6 2 tablets each, Cerebrolizin 30 ml/day iv, Spirulina, and Molekin immuno 1 tb/day were also administered.

The patient was diagnosed with thrombosis of the right sigmoid sinus and right internal jugular vein, which required anticoagulant treatment (Heparin sodium 4 weeks)

The Gold Quantiferon TB test was negative. The pulmonologist did not recommend antituberculosis treatment.

The patient was monitored for 2 years with a very good evolution.

DISCUSSIONS

Brain abscesses pose a challenge in diagnosis and treatment, because microbiological diagnosis is not

always achieved, antibiotic drugs may not penetrate well into the CNS and some bacteria have resistances to typical empirical antibiotic drugs[7]. Bacteria with biofilm properties and a problematic resistance spectrum like Stenotrophomonas maltophilia should be included in the differential diagnosis, because they will not respond to the typical empirical treatment[7].

S. Maltophilia is intrinsically drug resistant to an array of different antibiotics and uses a broad arsenal to protect itself against antimicrobials[8]. The World Health Organization currently lists Stenotrophomonas maltophilia as an important Gram-negative multidrug-resistant bacterial pathogen in hospitals (https://www.who.int/drugresistance/AMR_Importance/en/). Infections by this environmental and opportunistic intrinsically drug-resistant organism are of significant concern among the immunocompromised patient population and can be fatal[8]. S. maltophilia was one of the top six pathogens isolated from pneumonia patients in U.S. intensive care units (ICUs) during 2015 to 2017[8] . Its common sources of infection include otogenous, odontogenic, cardiogenic, post-traumatic, haematogenous or secondary-to-pulmonary infections, urinary tract infections, intracranial and meningeal lesions, and skull osteomyelitis[5].

At this case I realised a subtotal microsurgical excission of the large frontal abscess to avoid a risc of ventriculitis. I left a small area of capsule stuck to the wall of the lateral ventricle in order to avoid having to open the ventricle. (Total excision of the abscess extending from the cortical surface to the lateral ventricle led to ventriculitis[2]).

The patient's hospitalization was prolonged due to the presence of a lung abscess that was not operated on by the thoracic surgeon and was not treated by pneumologist and the presence of septic thrombosis of the sigmoid venous sinus and the right jugular vein. I treated the patient with anticoagulants, (without reaching the effective anticoagulant dose (INR 2) so as not to induce an increased intracranial hemorrhagic risk) with effective oral hydration (minimum 2 l/day fluids) and intravenous solution (Ringer and Glucose 10% 2000 ml/day).

Conclusions

When a patient develops the classical triad of fever, headache, and focal neurologic deficits, the possibility of brain abscess should be investigated.

Early diagnosis and antibiotic treatment are mandatory to minimize various complications and the number of deaths and to offer the chance of healing.

The anticoagulant treatment induced by the presence of septic thrombosis of the sigmoid sinus and internal jugular vein was performed below the limit of the effective dose (without reaching the INR of 2-to prevent intracranial hemorhage) but hidrating the patient appropriately (minimum 2 l/day oral fluids, respectively 2 l/day intravenous solutions.

References

1. M. O. Mărginean, C. Mărginean, V. Săsăran ,N. Suciu, L. E. Meliţ- PNEUMONIA, O PROVOCARE CONTINUĂ PENTRU PEDIATRU – PREZENTARE DE CAZ. R EVISTA R OMÂNĂ DE BOLI I NFEC°IOASE – VOLUMUL XIX, N R . 4, AN 2016.
2. Prasad, A., Madan, V.S., Suri, M.L. et al. Cryptogenic osteomyelitis of the skull and intracerebral abscess. Child's Nerv Syst 8, 142–143 (1992).
3. Macko C, Ahmed S, Seifi A. Brain Abscess in a Patient With Radiotherapy-Treated Adenoid Cystic Carcinoma: A Misdiagnosis Case Report and Review of the Literature. Journal of Neurology Research Volume 10, Number 5, October 2020, pages 199-202.
4. Nicolosi, A., Hauser, W. A., Musicco, M., and Kurland, L. T. (1991). Incidence and prognosis of brain abscess in a defined population: Olmsted County, Minnesota,1935–1981. Neuroepidemiology 10, 122–131.
5. Zhou W, Shao X and Jiang X (2019) A Clinical Report of Two Cases of Cryptogenic Brain Abscess and a Relevant Literature Review. Front. Neurosci. 12:1054.
6. Allan RT, W Michael S: Brain Abscess. Youmans Neurological Surgery. H Richard W (6th edition) 1(2011): 588-599.
7. Remi J, Loesch-Biffar A M, Mehrkens J, Thon N, Seelos K, Pfister H-W. Stenotrophomonas maltophilia brain abscesses after implantation of motor cortex stimulator. Case Reports. J Neurol Sci . 2019 May 15:400:32-33.
8. Brooke J S. Advances in the Microbiology of Stenotrophomonas maltophilia. Clin Microbiol Rev 2021 Jun 16;34(3):e0003019.

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Effect of sparing S1 motion segment on spinopelvic-sagittal balance relationship and its impact on pain and functional outcome. A retrospective cohort study of single centre experience

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Keywords
spinopelvic parameters,
pain,
disability,
spine fixation,
s1 inclusion,
s1 sparing

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Abstract

Purpose: To assess the effect of S1 motion segment sparing in the setting of degenerative spondylosis and its effect on spinopelvic-sagittal balance parameters and long-term pain and disability using VAS (visual analogue scale) and ODI (modified Oswestry disability index-Arabic version).

Methods: 89 patients with multilevel lumbar canal stenosis underwent fusion surgery with or without S1 fixation were enrolled in the study. The patients were subsequently divided into 2 groups: S1 included (37 patients) and S1 sparing (52 patients); their clinical charts, radiological studies, and follow-up charts were retrieved and analysed with special consideration on pre- and post-surgical parameters was done.

Results: The mean Post-operative (LL) in S1 sparing group (37.57 ± 7.89) while in S1 included group (12.2 ±2.69). The mean Post-operative (SS, PT) in S1 sparing group (26.95 ± 10.8, 19.5 ± 6.37) while in S1 included group (21.2 ± 5.24 , 28.3 ± 6.97) .The mean immediate Post-operative (VAS) in S1 sparing group Dropped from (7.56 ± 0.87) to (4.12 ± 0.97) while in S1 included group (7.59 ± 0.96), while 6-12 Months follow up VAS was (4.12 ± 0.97, 4.95 ± 1.31) in S1 sparing, S1 included respectively

Conclusions: S1 motion segment sparing in the setting of decompression and fusion of lower lumber spine seems to positively impact the post-operative lumber lordosis, pelvic tilt and sacral slope with respect to sagittal balance parameters, hence muscle strain and energy expenditure of the adjacent level decreased leading to better immediate as well as long term follow up VAS, ODI scores compared to S1 inclusion.

Introduction

The lumbosacral junction is a significant contributor to the motion of the lumbar spine segments. It is a point where weights are being transferred from the axial spine to the appendicular skeleton through the pelvic girdle, this transitional zone hold a significant amount of focal axial weight stress that reach up to 200 N in some circumstances

explaining the possible reason behind the very high prevalence of lower lumbosacral degenerative pathologies and thus the reason behind increased surgical management of this critical stress holding motion segment (1).

Because of the obliquity of the L5-S1 segment and the sacrum's less cortical bone reserve than other lumbar spine segments, thus when fusions are extended to S1, a strong lever arm forms that transmits the axial weight, torsional, flexion, and extension forces to it. As a result, the cortical purchase of the S1 pedicle screw is lower than other instrumented levels (2–4).

Surgical management is indicated in many cases of advanced lumbosacral degenerative disease, especially when multiple levels are affected. In majority of cases the need for multilevel laminectomies, flavectomies as well as medial facetectomies is needed thus raising the need for achieving fusion of these levels to restore normal lumbar spine alignment as well as preventing iatrogenic spondylolisthesis (5,6)

Long-segment fixations (i.e. ≥ 4 levels) with sacral inclusion, are more prone to failure than short-segment ones due to longer lever arm exertion by the proximal column on the distal sacral instrumentation (7)

Lumbosacral fixation carries a high rate of complications including pedicle screw loosening or pseudoarthrosis in up to 20–60% and it was the frequently cited reason for reoperation (25%). The first reason might be that the instrumentation at L5-S1 was under more stress as a result of inappropriate bony fusion due to inadequate decortication and bone grafting (8)

S1 screw loosening is still in the dispute. Besides, there is still a lacks of evidence that inserting the iliac screws simply for preventing S1 screw loosening can contribute to a better clinical outcome for patients. On the other hand, iliac screws require extensive subfascial dissection, increasing the rate of complications such as implant prominence deep infection and poor wound-healing. Meanwhile, several studies have shown increased rigidity of lumbosacral fixation techniques contributing to late sacroiliac joint arthritis and pain (9)

The relationship of the spine to the pelvis is the key determinant of the sagittal spinal alignment and is analyzed by the following parameters: the pelvic tilt (PT), the pelvic incidence (PI), the sacral slope (SS), lumbar lordosis (LL) and sagittal vertical axis (SVA). S1 instrumented fusion in cases of advanced degenerative spondylolisthesis affect different spinopelvic parameters thus requiring pre-operative comprehensive measurement of different parameters so as not to disrupt it postoperatively rendering it sagittally imbalanced thus more muscle strain to achieve balance is advocated resulting in back pain (10,11)

Our study assesses in retrospective manner the effect of sparing vs. including S1 in fusion segment and the effect on different spinopelvic parameters in relation to sagittal balance parameters and long-term pain and disability using VAS (visual analogue scale) and ODI (Oswestry disability index- Arabic version) (12).

PATIENTS AND METHODS

Patient population & study design

This is a single center comparative retrospective cohort study conducted in our tertiary care center. All the cases with multilevel disco-ligamentous lumbar canal stenosis (LCS) underwent fusion surgery with or without S1 fixation between January 2021 to February 2023 were enrolled in the study. Inclusion criteria included all patients who had posterolateral fusion with posterior transpedicular screw-rod systems and recurrent cases that were managed with re-decompression and fixation. Exclusion criteria included morbid obesity (BMI more than 35), advanced spondylolithesis more than grade III, traumatic fracture spine, pathological fracture due to primary or metastatic tumor, spondylodiscitis, osteoporotic patients, associated congenital anomalies (Fig.1).

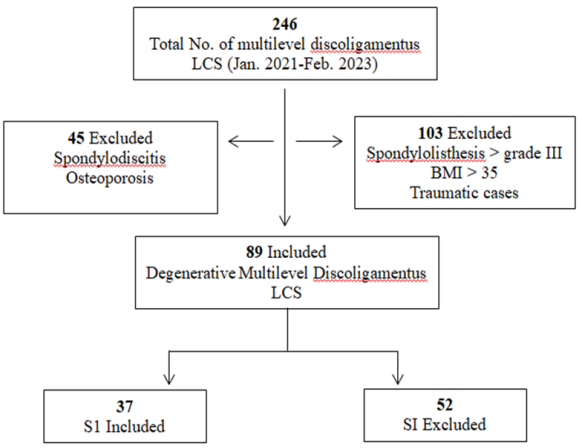

Figure 1. Patients' stratification and selection.

89 patients satisfied the inclusion criteria and enrolled in the study; they were subsequently divided into 2 groups: S1 included (37 patients) vs. S1 sparing fixation (52 patients) were included; their clinical charts, radiological studies, operative notes and follow-up charts results were retrieved and analyzed with special consideration on pre- and post-surgical parameters was done.

Radiological evaluation was obtained in a standing position when there was no neurological deficit. We used Surgimap© to evaluate the different spino-pelvic parameters and relation with sagittal balance parameters. Spinopelvic parameters are geometrical and anatomical measures that evaluate how the spine and pelvis line up. The pelvic incidence was measured by measuring the angle between the line drawn from the center of the femoral heads to the sacral promontory and a line perpendicular to the sacral plate. It is a morphological parameter that does not change with position. The pelvic tilt was measured by measuring the angle between the vertical and the line connecting the midpoint of the sacral plate to the femoral heads' axis. It reflects the position of the pelvis with respect to the femurs and changes with posture. Sacral slope was measured by measuring the angle between the sacral plate and the horizontal plane. It varies with the position of the pelvis and is related to the orientation of the sacrum. Lumbar lordosis is the curvature of the lower spine. It is measured as the angle between the top of the lumbar spine and the bottom. Lumbar lordosis should ideally be proportionate to pelvic incidence for optimal spinal alignment. Sagittal vertical axis was measured by a plumb line from the center of the C7 vertebral body to the posterior superior corner of the sacrum. It assesses the overall balance of the spine in the sagittal plane, and a larger distance indicates a forward shift of the body's center of mass (Fig.2).

Post operatively, the patients were routinely followed up immediately and 6-12 months follow-up period to record their functional, and radiological results. Functional outcomes were measured using VAS and mODI (modified Oswestry disability index-Arabic version). Documentation of surgical parameters was also done, including blood loss and surgery length. At the final follow-up, a CT scan was performed to evaluate fusion, and patients were monitored at regular intervals with imaging and clinical evaluation.

Figure 2. Plain x-ray whole spine in standing position lateral view showing measurement of different spinopelvic parameters (PL= plumb line, LL= lumbar lordosis, SS= sacral slope, PT= pelvic tilt, PI= pelvic incidence, FH= femoral head, SVA= sagittal vertical axis)

Surgical Procedure

Patients were positioned in a neutral prone position using rolls to achieve a near-normal lumbar lordotic curve. Antiseptic solutions were rubbed on the skin for five minutes. C-arm fluoroscopy was used to navigate throughout the whole steps of the procedure, after determining the pedicle projections; the facet joint surfaces were decorated. Using a pedicle finder; a nest was carefully opened in the vertebral body.

A round-tip probe was used to examine every hole. Under the guidance of C-arm fluoroscopy, transpedicular screws were inserted into these entry points in accordance with pre-operative estimations. Every screw was positioned so that its point reached ahead of two thirds of the length of the vertebral body, rigid rods modeled after the lumbar curve was employed to anchor transpedicular screws. Also there was reduction, facetectomy, osteotomy to achieve the optimal lordotic curve of the lumbar spine in some cases. Microsurgical principles were used in each case in accordance with the pathology. Following the facet and transverse process

decortication, autogenous bone grafts were implanted and screws were secured. The patients were ambulated with a lumbar corset reinforced by steel bars on the same day after the surgery.

On the first day after the operation, direct full spine erect radiographs were obtained. In necessary instances, Lumbosacral CT was performed. The patients were advised to place lumbar brace for 3 months.

Data sources

The Patients medical registry between January 2021 to February 2023 was examined and data of interest were extracted. The PACS system (patients' radiological investigations record) was revised for all patients with multilevel disco-ligamentous lumbar canal stenosis that underwent decompression and fixation with or without S1 fixation, recurrent discs who managed with re-decompression and fixation. Full comprehensive review of the sample using (Ibn-sina system for patient medical records) to assess long term post-operative pain and to evaluate different spino-pelvic parameters in serial plain x-ray studies.

Ethical considerations

The study protocol was approved by ethical committee "Local Institutional Review Board" (R.23.09.2331.R1), Faculty of Medicine, Mansoura University. All procedures for data collection were treated with confidentiality according to Helsinki Declarations of Biomedical Ethics.

Statistical Analysis

Once the data was collected and tabulated, descriptive statistics were used for continuous variables. All the measurements were made on radiographs by two independent experts who were blinded to the results and the mean of their readings was taken as the final value.

Data was analyzed using Statistical package for Social Science (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Chi-Square test was used to examine the relationship between two qualitative variables. Student t-test was used to assess the statistical significance of the difference of parametric variable between two study group means. ANOVA with repeated measure test was used to assess the statistical significance of the difference of parametric variable between more two study periods. While Mann Whitney Test was used to assess the statistical significance of the difference of a non-parametric variable between two study groups. A p-value is considered significant if <0.05 at confidence interval 95%.

Results

There were a total of 89 cases. The majority of the patients were male (61.8%), while females accounted for 38.2%. The mean age was 41.8 ± 13 (range=19-62) years. The average BMI was 27.3 kg/m2. Various pathologies were observed, with L4-5-S1 stenosis being the most prevalent (49.4%), followed by L5-S1 spondylolisthesis (22.5%). Recurrent cases constituted 29.2% of the cohort. The surgeries performed for all cases were decompression and fixation, with a mean operation time of 120 minutes. Complications were reported in 13.48.1% of cases, with an average follow-up duration of 13.7 months (Table 1).

Table 1. Demographic, clinical, surgical parameters among the studied cases.

	All Cohort *(*N = 89*)*
Age (years)	41.8 ± 13 (1.38)
Sex	
Male	55 (61.8%)
Female	34 (38.2%)
BMI (kg/m^2)	27.3 ± 6.9 (0.73)
Pathology	
L4-5-S1 Stenosis	44 (49.4%)
L5-S1 Spondylolithesis	20 (22.5%)
L3-4-5-S1 Stenosis	9 (10.1%)
L4-5 Spondylolithesis	7 (7.9%)
L3-4-5 Stenosis	6 (6.7%)
L3-4 Stenosis	3 (3.3%)
Recurrent cases	26 (29.2%)
Operation time (minutes)	120 ± 26.2 (2.78)
Complications	**12 (13.48%)**
Dural tear	5 (5.6%)
Wound Dehiscence	2 (2.2%)
CSF Leakage	1 (1.1%)
Root Injury	1 (1.1%)
S1 Peudoarthrosis	1 (1.1%)
Screw Neck Fracture (SNF)	2 (2.2%)
S1 Included	37 (41.6%)
S1 Sparing	52 (58.4%)
Follow-up(months)	13.7 ± 3.47 (0.37)

Numerical data was expressed by using Mean ± SD. (SE.), Non-numerical data was expressed by using no. (%).

The whole patient's sample was stratified into two groups: S1 transpdicular fixation 41.6% (37 patients) where S1 sparing was in 58.4% (52 patients). There were no significant differences in age and sex between the two groups. However, BMI was significantly higher in the S1 included group (mean of 33.3 kg/m2) compared to the S1 sparing group (mean of 23.1 kg/m2). The mean operation time did not differ significantly between the two groups. Complications were reported in 10.8% of S1 included cases and 18.91% of S1 sparing cases (table 2). Postoperative complications were encountered in 12 cases (13.48%): dural tear in 5 cases, wound dehiscence in 2 cases while CSF leakage in only 1 case, 2 cases with screw neck fracture, only one case of S1 pseudoarthrosis and root injury in only 1 case (table 1).

Recurrent cases were 26 patients; 12 cases with no S1 fixation and 14 with S1 inclusion, patients had significant past surgical history of previous canal decompression. With evidence of clinical as well as radiological recurrence, patient managed operatively according to the patient's complaint as well as evidence of progressive iatrogenic spondylolithesis by dynamic standing flexion and extension X –ray.

Table 2. Comparison of S1 exclusion group versus S1 inclusion group regarding demographic, clinical and surgical parameters.

	S1 Sparing (N = 52)	**S1 Included (N = 37)**	**P**
Age (years)	42.8 ± 12.6 (1.74)	40.5 ± 13.7 (2.25)	0.419
Sex Male Female	 34 (65.4%) 18 (34.6%)	 21 (56.8%) 16 (43.2%)	 0.409
BMI (kg/m^2)	23.1 ± 4.92 (0.68)	33.3 ± 4.31 (0.71)	<0.001 *
Pathology L4-5-S1 Stenosis L5-S1 Spondylolithesis L3-4-5-S1 Stenosis L4-5 Spondylolithesis L3-4-5 Stenosis L3-4 Stenosis	 29 (55.8%) 0 (0.0 %) 9 (17.3%) 7 (13.5%) 5 (9.6%) 2 (3.8%)	 15 (40.5%) 20 (54.1%) 0 (0.0%) 0 (0.0%) 1 (2.7%) 1 (2.7%)	 <0.001 *
Recurrent	12 (23.1%)	14 (37.8%)	0.131
Operation time (minutes)	119 ± 28.6 (3.97)	122 ± 22.7 (3.73)	0.602
Complications	5 (9.6%)	7 (18.91%)	1.000

Numerical data was expressed by using Mean ± SD. (SE.).
Non-numerical data was expressed by using no. (%).
X2: Chi Square, t: Student t test, U: Mann Whitney, P: Comparing Non S1 and SI, *: Significant.

Spinopelvic parameters

For the S1 sparing group, the mean preoperative PI was 55, while for the S1 included group, it was significantly higher at 62.9 (P<0.001). mean value of preoperative LL in S1 included group was 12.2 while in S1 sparing group was 11.45 with no statistically significant difference between the two groups (p<0.005), as regard preoperative SVA in S1 included group was 7.2 while in S1 sparing group was 7.42, as regard PT in S1 included group was (21+5.12) while in S1 sparing group was (21.4+5.87), SS was (34.1+9.79, 41.9+6.34) S1 included versus S1 sparing respectively.

The immediate post-operative PI was 28.1 for the S1 sparing group and 25.4 for the S1 included group, both significantly lower than the preoperative values (P1<0.001, P2<0.001). LL in S1 included group was 25 while in S1 sparing group was 36 with statistically significant difference between the two groups (P<0.005), as regard SVA was (5.23, 7) in S1 included versus S1 sparing respectively. As regard SS was (21.2+5.24, 26.95+6.14) in S1 included versus S1 sparing respectively. As regard PT was (25.3+6.97, 21.5+10.4) in S1 included versus S1 sparing respectively.

The 6-12 months follow-up PI in S1 included group was (55.4+7.42) while in S1 sparing group was (44+0). As regard LL in S1 included group was 25 while in S1 sparing group was 30 with no statistically significant difference. As regard SVA was (3+.6, 4.52+.7) in S1 included versus S1 sparing respectively. While SS was (21.2+5.24, 26.95+10.8) in S1 included versus S1 sparing respectively. PT was (28.3+6.97, 19.5+ 6.37) in S1 included versus S1 sparing respectively (table 3, fig. 3,4,5).

Table 3. Comparison of S1 exclusion group versus S1 inclusion group regarding spinopelvic parameters in preoperative, immediate postoperative and follow-up

	S1 sparing		**S1 included**		**P3**
	N = 52	**P1**	**N = 37**	**P2**	
PI Preoperative Immediate postop. Follow up	 55 ± 0 (0) 48.45 (1.31)	 <0.001 *	 62.9 ± 6.68 (1.10)	 <0.001 *	 <0.001* 0.150 <0.001*

	44 ± 0 (0)		50.4 ± 7.42 (1.22) 55.4 ± 7.42 (1.22)		
PT Preoperative Immediate postop. Follow up	21.4 ± 5.87 (0.81) 21.5 ± 10.4 (1.44) 19.5 ± 6.37 (0.88)	<0.001 *	21.0 ± 5.12 (0.84) 25.3 ± 6.97 (1.15) 28.3 ± 6.97 (1.15)	<0.001 *	0.713 0.379 <0.001*
SS Preoperative Immediate postop. Follow up	34.1 ± 9.79 (1.36) 26.95 ± 6.14 (0.85) 26.95 ± 10.8 (1.49)	<0.001 *	41.9 ± 6.34 (1.04) 21.2 ± 5.24 (0.86) 21.2 ± 5.24 (0.86)	<0.001 *	0.028 * 0.468 <0.001*
LL Preoperative Immediate postop. Follow up	11.45 ± 3.14 (0.76) 36.25 ± 8.15 (1.12) 37.57 ± 7.89 (1.58)	<0.001 *	12.2 ±2.69 (1.24) 25.23 ±1.66 (0.89) 25.69 ±1.84 (1.05)	<0.001 *	0.014 * 0.258 <0.001*
SVA Preoperative Immediate postop. Follow up	7.42 ± 2.13 (1.01) 5.23 ± 1.46 (0.69) 4.52 ± 1.0 (0.82)	<0.001 *	7.2 ± 2.0 (1.28) 7 ± 1.39 (1.00) 3 ± 0.6 (0.66)	<0.001 *	0.035 * 0.396 <0.001*

Non-numerical data was expressed by using no. (%). Numerical data was expressed by using Mean ± SD. (SE.), t: Student t-test, U: Mann Whitney, p1: Comparing preoperative to immediate postoperative and follow up periods in S1 sparing group, p2: Comparing preoperative to immediate postoperative and follow up periods in S1 included group, p3: Comparing S1 sparing to S1 included groups, *: Significant.

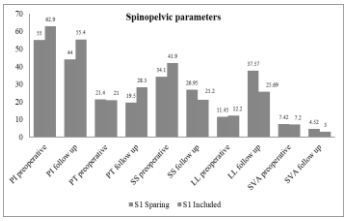

Figure 3. Spinopelvic parameters comparison of preoperative and follow up in both groups of sparing versus S1 included fixation.

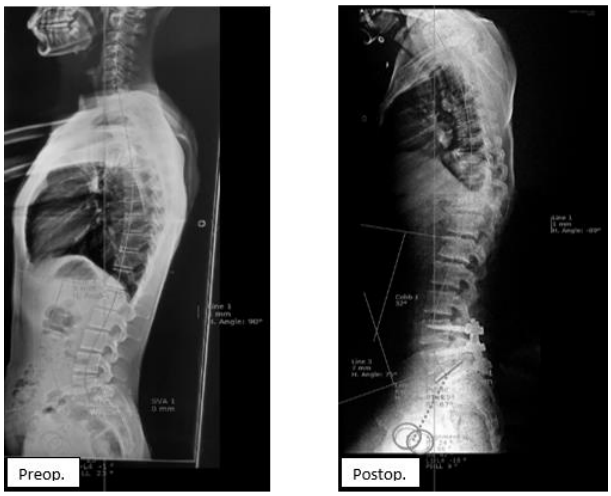

Figure 4. Pre and postoperative radiological evaluation of spinopelvic parameters in S1 included fixation.

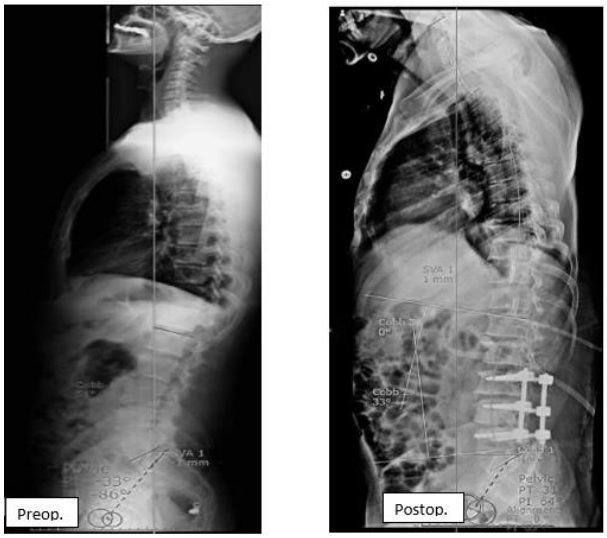

Figure 5. Pre and postoperative radiological evaluation of spinopelvic parameters S1 spared segment. Noted the compensatory tilting of S1 segment led to increased pelvic tilt, lumber lordosis and compensatory balance.

Pain and functional indices

Analysis and comparison of pain indices in both groups in preoperative, immediate postoperative and at follow-up reveal preoperatively, there were significant differences in VAS or ODI between the S1 sparing and S1 included groups (p3=<0.001).

The immediate post-operative VAS scores decreased to 6.52 for the S1 sparing group and 6.30 for the S1 included group (p1<0.001, p2<0.001). The follow-up VAS scores further decreased to 4.35 for the S1 sparing group and decreased to 5.24 for the S1 included group (p1<0.001, p2<0.001). Comparison between both groups revealed no significant

differences regarding immediate postoperative changes (p3=0.339). While SI sparing group showed statistically significant decrease in VAS at follow up when compared to SI included group (p3<0.001).

Regarding ODI, the immediate post-operative mODI scores decreased moderately in SI included group (p2=0.020), and non-significantly in SI sparing group (p1=0.138). Comparison between both groups revealed no significant differences regarding immediate postoperative changes (p3=0.397). While SI sparing group showed better significant improvement in ODI at follow up when compared to SI included group (p3<0.001).

The FABER test (flexion, adduction and external rotation) showed significant differences between the two groups as 11 patients out of 33 had improved in S1 sparing group while there was no improvement in S1 included group (statistically significant p3=0.019) (Table 4, Fig. 6).

Table 4. Comparison of S1 exclusion group versus S1 inclusion group regarding pain indices in preoperative, immediate postoperative and follow-up.

	S1 Sparing		S1 Included		P3
	N = 52	P1	N = 37	P2	
VAS					
Preoperative	7.56 ± 0.87 (0.12)	<0.001*	7.59 ± 0.96 (0.16)	<0.001*	0.851
Immediate postop.	4.52 ± 1.35 (0.19)		5.24 ± 1.31 (0.22)		0.441
Follow up	4.12 ± 0.97 (0.13)		4.95 ± 1.31 (0.22)		<0.001*
mODI					
Preoperative	27.4 ± 7.73 (1.07)	0.138	25.1 ± 7.61 (1.25)	0.020*	0.160
Immediate postop.	24.4 ± 7.04 (0.98)		23.3 ± 7.39 (1.21)		0.461
Follow up	27.4 ± 7.89 (1.09)		23.3 ± 7.39 (1.21)		0.016*
FABER (+ve)					
Preoperative	33 (63.5%)	1.000	21 (56.8%)	1.000	0.523
Immediate postop.	32 (61.5%)		21 (56.8%)		0.651
Follow up	22 (42.3%)		21 (56.8%)		0.019*

Numerical data was expressed by using Mean ± SD. (SE.), t: Student t test, U: Mann Whitney,
p1 Comparing preoperative to immediate postoperative and follow up periods in S1 sparing group,
p2: Comparing preoperative to immediate postoperative and follow up periods in S1 included group,
p3: Comparing S1 sparing to S1 included groups, *: Significant.

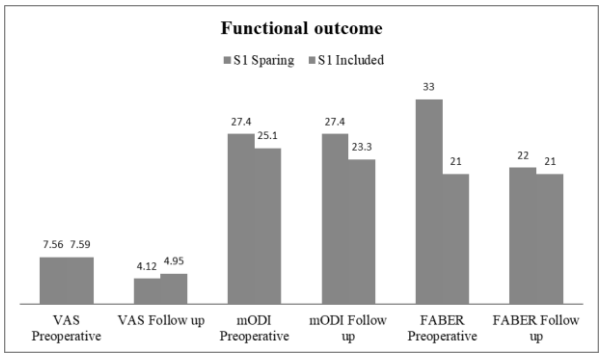

Figure 6. Functional and clinical outcome comparison of preoperative and follow up in both groups of sparing versus S1 included fixation.

Discussion

Lumbar spinal stenosis is common neurosurgical problem; the overall prevalence of lumbar spinal stenosis varies among studies. It has been reported that the prevalence reaches approximately 11% in the general population. The point prevalence of LSS in Egypt is not well studied; however, many patients are diagnosed clinically and radiologically with LSS on daily basis (13)

Based on the nature of the lower lumbar spine, it is responsible for the highest mobility of the spine as well as a site for compensation for axial load. Referring it to the principles of spinal biomechanics, the lower 3 lumbar vertebrae L4-5-S1 carries the highest proportion of the axial load exerting upon the lumbar spine. It represents the transition zone between the spine and the appendicular skeleton (hips, knee) joints (6)

Furthermore it is common site for degeneration as a response for substantial axial load leading to disc degeneration, facet and ligamentous hypertrophy, resulting in spinal stenosis. Surgically treating cases of advanced lumbar canal stenosis, it usually requires generous decompression of the lateral recess as well as discectomies and foraminotomies and occasionally facetectomies rendering this high load bearing segment theoretically unstable (14–16)

S1 segment of the lumbar spine is a greater contribution of the mobility of lower lumbar segment. And a common station for pelvic compensation in response to axial load and

degeneration. Leading to specific changes in spinopelvic parameters to regain the sagittal balance reducing the axial skeletal strain. It carries burden of resisting heavy axial load resulting in subsequent degenerative changes and frequently included in aggressive surgical decompression (15). The question of "iatrogenic instability is raised every time after surgical decompression, to fix or not is a question and to include S1 or not?" Is another hard question.

Our study aims to answer the question with retrospective analysis of large number of patients' population who underwent surgical decompression and fusion with inclusion of S1 segment in fusion and with sparing it, assessing different pre and post-operative changes in spinopelvic parameters as well as the pain using visual analogue scale (VAS) and long term follow up using Oswestry disability index (ODI).

Sagittal Balance is a dynamic process responsible for balancing spine with aging of the spine some of this balance can be lost, resulting in compensation that sometimes produces pain and disability. There are multiple radiological parameters that can help in assessing the sagittal balance, the sagittal vertical axis (SVA), T1 pelvic angle (TPA), lumbar lordosis (LL), pelvic tilt (PT), sacral slope (SS) and pelvic incidence (PI) being the most frequently used. It is a morphological parameter that influences the others and serves as a reference under sagittal imbalance conditions. It helps us to discriminate between balanced, imbalance but compensated or imbalanced decompensated patients, which guides both diagnosis and therapeutic decision-making. It is important to reinforce that the radiographic analysis should be carried out in both planes (coronal and sagittal), complementing the clinical evaluation (17,18)

When fusions are extended to S1 a strong lever arm is formed, transmitting the axial weight, torsional, flexion and extension forces to it, these exerting forces on L5-S1 motion segment in the context of the obliquity of L5-S1 segment, further transmitting axial load to adjacent hip and sacroiliac joints (19)(6)

In our study there was a significant contribution to the functional outcome in cases where S1 segment was spared in fusion this was noticed on post op follow up period in the form of achieving normal range of lumbar lordotic angle (preoperative LL was 11.45o that was corrected to 37.57o postoperative), in relation to the SVA making the principle of cone of economy more prone to be achieved, we can explain by sparing S1 segment in fusion as a principle contribution to lower lumbar spine motion leading to compensatory retroversion of the sacral segment leading to partially balanced spine, thus decreasing the energy expenditure from the upper lumbar, dorsal and cervical segment musculature leading to better tolerance of post-operative period in term of axial muscle pain as well as the resultant hip and knee compensation to achieve balanced spine; these results cope with Shetty AP et al. where there was a significant correlation between maintaining the lumbar lordosis and good functional outcome. Restoration of this lordosis has definite biomechanical advantages and improves the functional outcome of patients (20,21)

In our study immediate post-operative sacral slope was significantly higher in S1 spared group compared to S1 included (21.2+5.24o, 26.95+6.14o) respectively, whereas PT was lower in S1 spared group compared to inclusion group (25.3+6.97o, 21.5+10.4o), thus indicate the freedom of movement of non-fixed S1 segment leading to spinopelvic compensation to achieve the sagittal alignment, these results shows the effect of sacral slope and pelvic tilt on restoring lumbar lordosis and supported by the same results of Liow et al. study in which they assess a 63 patients with degenerative spondylolisthesis and the effect of sacral slope and lumbar lordosis on functional outcomes. The study group found out that increased sacral slope patients in the post-operative period experienced less pain and good functional outcomes (21–23)

In fact we can assume that S1 segment sparing led to better spinopelvic compensatory biomechanics in terms of increasing sacral slope and decreasing pelvic tilt leading to better outcome. our study showed better immediate and long-term follow up in S1 sparing compared to S1 included group in the form of lower immediate post op VAS scores the mean Immediate post op VAS score in S1 spared group dropped from (7.56 ± 0.87) to (4.52 ± 1.35) ($P<0.001$) compared to S1 included group where per op mean VAS score was (7.59 ± 0.96) and dropped to (5.24 ± 1.31) ($P<0.001$); These results follows the landmark article of examining the relationship between sagittal alignment and clinical status by Glassman et al. (17) The spine, pelvis, and lower limb areas are involved in compensation to

balance the axis of gravity. Any failure to compensate and maintain the normal sagittal balance of the body leads to poor clinical outcomes. The positive sagittal balance has a strong correlation with poor health-related scores and the proper restoration of sagittal plane alignment is critical for improving the clinical outcomes in patients with deformities (20,24,25)

Our study highlighting the value of sparing S1 segment and its effect on better immediate as well as long term follow up achieving better lumbar lordosis was significantly higher in the setting of S1 sparing compared to inclusion which in turn reflect upon sagittal alignment and less muscle strain of the adjacent lumbar levels. The lordosis of the lumbar spine is due to the last two vertebrae and disc spaces. When there is involvement of these vertebrae by the disease process, the lordosis decreases drastically, and the sagittal balance is also compromised Barrey et al. reflecting the value of S1 sparing and its effect on achieving better lumbar lordosis (26,27)

Limitation of the study

Our study didn't include the details of the correlation between pelvic parameters and the overall sagittal alignment due to lack of preoperative full-length whole spine from occiput to mid femur x-rays in standing in many cases. Also, some of our patients were non- familiar with ODI responses, others had insufficient data record. So, further larger sample size studies should be planned to study the sagittal spinal alignment and its effect on the functional outcomes.

Conclusions

S1 motion segment sparing in the setting of decompression and fusion of lower lumber spine seems to positively impact the post-operative lumber lordships, pelvic tilt and sacral slope with respect to sagittal balance parameters, hence muscle strain and energy expenditure of the adjacent level decreased leading to better immediate as well as long term follow up VAS, ODI scores compared to S1 inclusion.

Abbreviations

SNF = Screw Neck Fracture
PT = Pelvic Tilt
PI = Pelvic Incidence
SS = Sacral Slope
LL = Lumbar Lordosis
LCS = Lumbar canal stenosis
FH = Femoral head
LL = Lumbar Lordosis
SVA = Sagittal Vertical Axis
PL = Plumb Line
VAS = Visual Analogue Scale
mODI = Modified Oswestry Disability Index.
CT = Computed Tomography
MRI = Magnetic Resonance Imaging
BMI = Body Mass Index
TPA = T1 Pelvic Angle
FABER= Flexion, Adduction and External Rotation

References

1. Wang Y, Li XY, Zhu WG, Liu CX, Kong C, Lu SB. Compensatory classification in spine sagittal malalignment with lumbar degeneration. BMC Musculoskelet Disord. 2023 Mar 27;24(1):229.
2. Matz PG, Meagher RJ, Lamer T, Tontz WL, Annaswamy TM, Cassidy RC, et al. Guideline summary review: an evidence-based clinical guideline for the diagnosis and treatment of degenerative lumbar spondylolisthesis. The Spine Journal. 2016 Mar;16(3):439–48.
3. Labelle H, Roussouly P, Berthonnaud É, Dimnet J, O'Brien M. The Importance of Spino-Pelvic Balance in L5–S1 Developmental Spondylolisthesis. Spine (Phila Pa 1976). 2005 Mar;30(Supplement): S27–34.
4. Labelle H, Roussouly P, Chopin D, Berthonnaud E, Hresko T, O'Brien M. Spino-pelvic alignment after surgical correction for developmental spondylolisthesis. European Spine Journal. 2008 Sep 4;17(9):1170–6.
5. Zhou H, Liang Z, Li P, Shi H, Liang A, Gao W, et al. Correlation analysis of surgical outcomes and spino-pelvic parameters in patients with degenerative lumbar scoliosis. Front Surg. 2024 Jan 4;10.
6. McCord DH, Cunningham BW, Shono Y, Myers JJ, McAfee PC. Biomechanical Analysis of Lumbosacral Fixation. Spine (Phila Pa 1976). 1992 Aug; 17:235–43.
7. Xu F, Zhou S, Zou D, Li W, Sun Z, Jiang S. The relationship between S1 screw loosening and postoperative outcome in patients with degenerative lumbar scoliosis. BMC Musculoskelet Disord. 2022 Feb 28;23(1):186.
8. Potter BK, Kuklo TR, O'Brien MF. Sacro-iliac fixation for treatment of high-grade spondylolisthesis. Semin Spine Surg. 2004 Jun;16(2):119–25.
9. Kebaish KM. Sacropelvic Fixation. Spine (Phila Pa 1976). 2010 Dec;35(25):2245–51.
10. Mac-Thiong JM, Roussouly P, Berthonnaud É, Guigui P. Sagittal Parameters of Global Spinal Balance. Spine (Phila Pa 1976). 2010 Oct;35(22): E1193–8.
11. Roussouly P, Gollogly S, Berthonnaud E, Dimnet J. Classification of the Normal Variation in the Sagittal Alignment of the Human Lumbar Spine and Pelvis in the Standing Position. Spine (Phila Pa 1976). 2005 Feb;30(3):346–53.

12. Algarni AS, Ghorbel S, Jones JG, Guermazi M. Validation of an Arabic version of the Oswestry index in Saudi Arabia. Ann Phys Rehabil Med. 2014 Dec;57(9–10):653–63.
13. Korovessis P, Syrimpeis V, Tsekouras V. Short Lumbosacral Decompression Plus Fixation Does Not Change the Spinopelvic Balance on Patients with Moderate Degenerative Spondylolisthesis and Associated Spinal Stenosis. Spine Deform. 2019 Mar;7(2):346–55.
14. Hsieh MK, Liu MY, Chen JK, Tsai TT, Lai PL, Niu CC, et al. Biomechanical study of the fixation stability of broken pedicle screws and subsequent strategies. PLoS One. 2019 Jun 28;14(6): e0219189.
15. Roussouly P, Pinheiro-Franco JL. Biomechanical analysis of the spino-pelvic organization and adaptation in pathology. European Spine Journal. 2011 Sep 2;20(S5):609–18.
16. Pei B, Xu Y, Zhao Y, Wu X, Lu D, Wang H, et al. Biomechanical comparative analysis of conventional pedicle screws and cortical bone trajectory fixation in the lumbar spine: An in vitro and finite element study. Front Bioeng Biotechnol. 2023 Jan 19;11.
17. Glassman SD, Bridwell K, Dimar JR, Horton W, Berven S, Schwab F. The Impact of Positive Sagittal Balance in Adult Spinal Deformity. Spine (Phila Pa 1976). 2005 Sep;30(18):2024–9.
18. Kawakami M, Tamaki T, Ando M, Yamada H, Hashizume H, Yoshida M. Lumbar Sagittal Balance Influences the Clinical Outcome After Decompression and Posterolateral Spinal Fusion for Degenerative Lumbar Spondylolisthesis. Spine (Phila Pa 1976). 2002 Jan;27(1):59–64.
19. Hsu HT, Yang SS, Chen TY. The Correlation Between Restoration of Lumbar Lordosis and Surgical Outcome in the Treatment of Low-grade Lumbar Degenerative Spondylolisthesis with Spinal Fusion. Clinical Spine Surgery: A Spine Publication. 2016 Feb;29(1): E16–20.
20. Shetty AP, Bosco A, Rajasekaran S, Kanna RM. Does Preserving or Restoring Lumbar Lordosis Have an Impact on Functional Outcomes in Tuberculosis of the Lumbosacral Region? Spine Deform. 2019 Mar;7(2):356–63.
21. Schwab F, Patel A, Ungar B, Farcy JP, Lafage V. Adult Spinal Deformity—Postoperative Standing Imbalance. Spine (Phila Pa 1976). 2010 Dec;35(25):2224–31.
22. Liow MHL, Goh GSH, Chua JL, Ling ZM, Soh RCC, Guo CM, et al. Sagittally Balanced Degenerative Spondylolisthesis Patients with Increased Sacral Slope and Greater Lumbar Lordosis Experience Less Back Pain After Short-Segment Lumbar Fusion Surgery. Clinical Spine Surgery: A Spine Publication. 2020 Jun;33(5): E231–5.
23. Park SJ, Lee CS, Chung SS, Kang KC, Shin SK. Postoperative Changes in Pelvic Parameters and Sagittal Balance in Adult Isthmic Spondylolisthesis. Operative Neurosurgery. 2011 Jun;68: ons355–63.
24. Yeh KT, Lee RP, Chen IH, Yu TC, Liu KL, Peng CH, et al. Correlation of Functional Outcomes and Sagittal Alignment After Long Instrumented Fusion for Degenerative Thoracolumbar Spinal Disease. Spine (Phila Pa 1976). 2018 Oct 1;43(19):1355–62.
25. Elmorsy SEH, Abulnasr HA, Hassan Y, Samra M, Eissa EM. Functional outcome of surgical management of low mid-grade lumbar spondylolisthesis when considering the sagittal balance parameters preoperatively: a prospective study. Chin Neurosurg J. 2022 Nov 25;8(1):35.
26. Barrey C. Current strategies for the restoration of adequate lordosis during lumbar fusion. World J Orthop. 2015;6(1):117.
27. Barrey C, Jund J, Noseda O, Roussouly P. Sagittal balance of the pelvis-spine complex and lumbar degenerative diseases. A comparative study about 85 cases. European Spine Journal. 2007 Sep 10;16(9):1459–67.

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Subaxial transfacet fixation with/without laminectomy for cervical compressive myelopathy. A single institution tailored approach

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ABSTRACT

Introduction. Cervical compressive myelopathy manifests mainly as spastic paralysis, exaggerated reflexes, and clumsiness of the hand, with/without gait disturbances. It mainly results from degenerative changes in cervical spine along with infolding of the ligamentum flavum, the presence of spondylolisthesis, the development of osteophytes, and the hypertrophy of facet joints. Though the recent pathology appears to be facetal instability, hence facetal fixation with or without laminectomy in these patients should be advocated.

Materials and Methods. 25 patients with cervical compressive myelopathy were operated with transfacet cervical spine fixation with or without laminectomy, decided on the basis of clinical symptomatology and MRI features.

Results. All patients with laminectomy showed improved power and significant lightness in limbs post-surgery. In two patients, there was CSF leak, which was stopped by suture re-enforcing of the wound, and one patient required a lumbar drain to be kept for five days. One patient had a temporary deterioration of power in the left upper limb. Among patients undergoing only transfacet fixation, one patient had no change in symptoms, and three patients had a significant lightness in limbs.

Conclusion. The decision to perform transfacet fixation with laminectomy versus transfacet fixation alone is based on the severity and type of spinal cord compression and the clinical presentation of the patient.

Keywords
cervical compressive myelopathy, laminectomy, transfacet screw

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INTRODUCTION

Cervical compressive myelopathy is a condition in which there is compression of the cervical part of the spinal cord, which manifests in the form of spastic paralysis, exaggerated reflexes, and clumsiness of the hand, with/without gait disturbances. Degenerative changes typically occur from C4-7 levels due to the increased range of motion in these areas. Other factors that can narrow the spinal canal include the infolding of the ligamentum flavum, the presence of spondylolisthesis, the development of osteophytes, and the hypertrophy of facet joints[8,9,10]. Cervical myelopathy often leads to compression of the lateral corticospinal tracts, affecting voluntary control of skeletal muscles and

the spinocerebellar tracts and impacting proprioception. These impairments commonly result in a wide-based spastic gait and uncoordinated upper extremity movements, which are characteristic of cervical myelopathy. Other spinal cord regions frequently affected include the spinothalamic tracts, which are involved in sensing contralateral pain and temperature; the posterior columns, responsible for the ipsilateral position and vibration sense; and the dorsal nerve root, which affects dermatomal sensation[4,6,14]. Classically, it is insidious in onset and gradually progressing in nature with functional decline in a stepwise manner. Treatment can be surgical and non-surgical. Conservative management includes using anti-inflammatory medications, engaging in physical therapy, utilising ultrasound therapy, and occasionally administering corticosteroid injections. However, these approaches generally provide temporary relief from pain and are not considered definitive treatments for patients experiencing progressive symptoms. For patients with worsening symptoms, surgical intervention should be strongly considered. The primary goal of surgery is to enlarge the spinal canal, thereby reducing or eliminating compression on the spinal cord. The current trend is to opt for earlier surgical intervention rather than waiting.

Surgery can be in the form of either anterior or posterior decompression of the constricted part and fusion of the vertebra. A posterior approach is generally recommended for cases involving lordosis deformities or when the pathology is located at the back of the spinal canal. Posterior approaches may have a higher risk of infection compared to anterior approaches[1,3,7,11]. Anterior cervical discectomy and fusion (ACDF) is a standard procedure performed through an anterior approach and can involve up to three disc levels[2,13].

We evaluated patients with cervical compressive myelopathy undergoing transfacet cervical spine fixation with or without laminectomy, and tried to streamline certain indications for patients to undergo laminectomy or not.

Material and methods

This study was conducted on 25 patients with cervical compressive myelopathy in a single institution from June 2022 to May 2024. All of these patients had varying levels of spastic paralysis, exaggerated reflexes, and clumsiness of the hand, with/without gait disturbances. MRI cervical spine and plain CT cervical spine was done in all patients which showed infolding of the ligamentum flavum, the presence of spondylolisthesis, the development of osteophytes, and the hypertrophy of facet joints. Patients were counselled for surgery. All the patients underwent transfacet fixation of the subaxial cervical spine with or without laminecto9my of the involved segments. Among them, 20 had a laminectomy done concomitantly, and five were operated without laminectomy.

Indications for laminectomy were:

1. Significant compression with no CSF sleeve seen.
2. Power less than or equal to 3/5
3. Hoffman's positive
4. Patients having severe spasticity

Indications for Subaxial transfacet fixation without laminectomy were:

1. Patients having some weakness in the grip and shoulder
2. Compression only at the level of lig flavour
3. Patients who can carry out daily activities with some discomfort
4. Patients with heaviness in limbs

Illustrative case 1

56 years old male patient with spastic quadriparesis for six months. Power was found 3/5 in upper lims at all joints and 2/5 in lower limbs. Pre operative MRI sagittal and axial cervical scans (Figure 1. a,c) showed significant compression in subaxial cervical spine with infolding of ligamentum flavum and no CSF sleeve seen. The patient underwent transfacet subaxial cervical spine screw fixation with wide laminectomy from C4-6. Post operative MRI sagittal and axial cervical cuts showed good decompression with CSF sleeve and some malacic changes (Figure 1. b,d). Immediately in the evening of surgery, patient reported significant lightness in his limbs, reduced spasticity and improvement in hand grip. At 3 months follow up, he was able to walk with support and able to perform most daily activities with his hands.

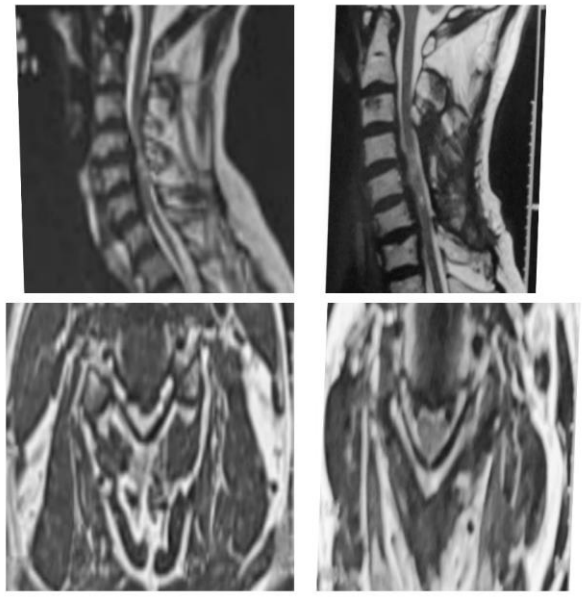

Figure 1. a,c; Pre- operative MRI sagittal and axial images of cervical spine showing significant compression; **b,d**: Showing post operative MRI sagittal and axial scan images of patient with laminectomy.

Illustrative case 2

A 72-year-old male patient presented with weakness in hand grip and shoulder with clumsiness in limbs for 2 years. He was able to walk with some support, but otherwise able to acrry most of his daily activities. MRI sagittal cervical spine showed compression of cervical spine with inbuckling of ligamentum flavum, but some preserved CSF sleeve (Figure 2a). Transfacet screw fixation was performed without laminectomy. In post operative period, patient reported lightness in limbs. Post operative MRI sagittal scan showed well preserved CSF sleeve (Figure 2 b). At 6 months follow up, he was able to walk with some support and able to carry his daily activities.

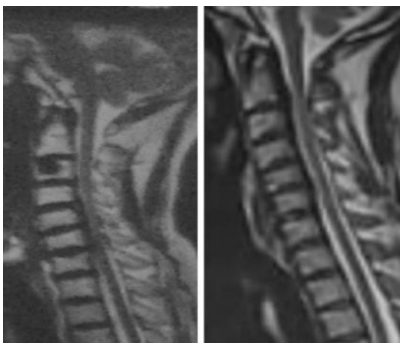

Figure 2. a,b; Showing Pre and post op MRI sagittal scan images of patient without laminectomy.

Illustrative case 3

A 35 year old lady presented with weakness in bilateral upper and lower limbs for 6 years. Power was found 4/5 in bilateral limbs with significant reduced hand grip. Pre operative MRI sagittal and axial cervical scans showed significant compression in cervical spine with no CSF sleeve (Figure 3 a,c). The patient underwent transfacet C2-7 cervical spine screw fixation with C3-6 laminectomy and C2 laminoplasty. The patient reported improvement in hand grip in post operative period. Post operative MRI sagittal and axial cervical cuts showed preserved CSF sleeve (Figure 3 b,d).

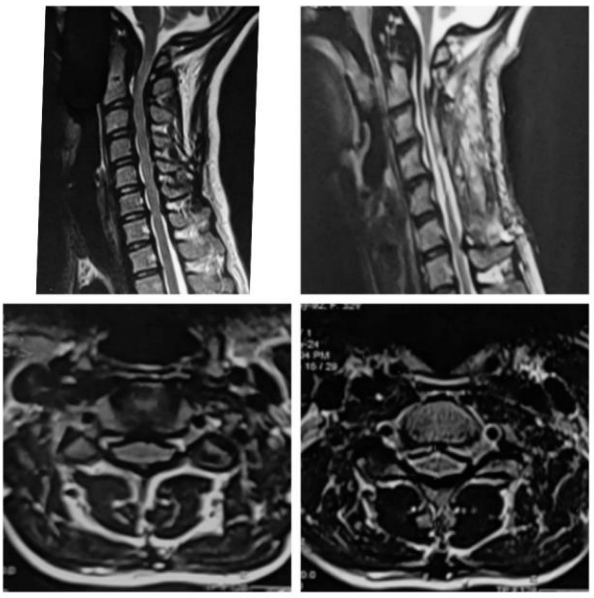

Figure 3. a,c; Pre-operative MRI sagittal and axial scan images of patient showing severe compression with no CSF sleeve, **b,d**; post operative MRI sagittal and axial cuts in the same patient with transfacet fixation with laminectomy.

Results

All of these patients were followed up for a minimum of six months. All patients with laminectomy showed improved power and significant lightness in limbs post-surgery.

In two patients, there was CSF leak, which was stopped by suture re-enforcing of the wound, and one patient required a lumbar drain to be kept for five days.

One patient had a temporary deterioration of power in the left upper limb, which improved on conservative management over the next three days. Among patients undergoing only transfacet fixation, one patient had no change in symptoms, and three

patients had a significant lightness in limbs. They could carry out their daily activities on their own.

Discussion

The cervical spine bears a significant portion of compressive loads, with 36% transmitted through the anterior column and 64% through the posterior column, specifically via the facet joints. There is considerable debate over the best surgical approach for multilevel cervical myelopathy. Anterior surgery is favoured for directly removing compressive issues like disc herniations and osteophytes and is particularly beneficial for myelopathy involving one or two segments. However, when three or more segments are affected, the increased complication rates, especially those related to long fusion grafts, make anterior surgery less appealing.

In contrast, posterior surgeries provide indirect decompression, are technically simpler than multilevel anterior corpectomies, and avoid the complexities of reconstructing the anterior column. They also allow for faster decompression across multiple segments, which is advantageous for patients needing urgent relief.

Surgeons must be aware of the potential destabilising effects when performing surgery, primarily through a posterior approach. Procedures, such as laminectomy, can disrupt the spine's stability. This disruption can lead to instability or deformity if not carefully managed. The potential for these outcomes necessitates a thorough understanding of the biomechanical consequences of surgical interventions in this region.

Laminectomy is often considered in cases where there is significant compression of the spinal cord, leading to severe neurological symptoms. When there is substantial Compression with No CSF Sleeve, the cerebrospinal fluid (CSF) sleeve around the spinal cord acts as a protective cushion. This CSF sleeve may be obliterated when significant compression occurs, meaning the spinal cord is in direct contact with the compressing structure (e.g., bone, disc material). The absence of a CSF sleeve around the compressed spinal cord indicates severe compression, which could lead to irreversible damage to the spinal cord if not relieved. A laminectomy helps by removing the lamina, thereby decompressing the spinal cord and restoring some space for the CSF. Secondly, when the Power is Less Than or Equal to ⅗, the patient has significant muscle weakness, mainly due to spinal cord compression. This level of weakness suggests that the nerve impulses from the spinal cord to the muscles are significantly impeded. The power (3/5 or less) typically indicates that the spinal cord compression is severe enough to interfere with motor function, so laminectomy is indicated to relieve this compression and prevent further neurological deterioration. Thirdly, when Hoffman's sign is positive, the spinal cord is compressed enough to alter its normal function, particularly in the cervical spine. A positive Hoffman's sign is an indication of severe compressive cervical myelopathy, which is suggested by hyperreflexia; it is a sign warranting decompressive surgery like laminectomy.

Lastly, when a patient has severe spasticity - Spasticity occurs when there is damage to the upper motor neurons in the spinal cord, which are responsible for controlling muscle tone. Severe spasticity is often a sign of significant spinal cord compression. A laminectomy can relieve the pressure on the spinal cord, which may help reduce the spasticity and improve the patient's quality of life.

Indications for Transfacet Fixation Without Laminectomy. It is done in cases where laminectomy is unnecessary, and stabilisation through transfacet fixation alone might suffice.

Patients with Some Weakness in Grip and Shoulder- Mild to moderate weakness in the grip and shoulder suggests a mild degree of nerve compression. Still, it is not severe enough to cause profound motor deficits or significant disability. In these cases, the goal is stabilising the spine to prevent further deterioration without decompression. The compression might not be severe enough to necessitate a laminectomy, and the patients can be managed with a less aggressive approach, i.e. fixation alone. Secondly, when compressions only at the level of Ligamentum Flavum. In some patients, ligamentum flavum can thicken and compress the spinal cord or nerves. Still, this compression is typically less severe than that caused by bony structures or herniated discs. If the compression is limited to the ligamentum flavum, stabilising the spine might be sufficient without a laminectomy. This approach is often chosen when the compression is not causing severe symptoms or when the ligament can be managed without more extensive surgery. Thirdly, when the patient can perform daily activities with some discomfort, it

suggests no significant compression. These patients might experience symptoms like mild pain or heaviness, but they can still manage their routine tasks; since these patients are not severely debilitated, a more conservative approach with just transfacet fixation might be appropriate. The fixation stabilises the spine, preventing further degeneration or instability without requiring more invasive decompression. Lastly, the Patients with Heaviness in Limbs- The heaviness in the limbs is an early sign of myelopathy, where the patient feels a sense of weakness or fatigue in their arms or legs but without severe weakness or spasticity. In this situation, the goal might be to stabilise the spine to prevent the progression of symptoms. The absence of more severe signs, like significant weakness or spasticity, suggests that decompression via laminectomy might not be necessary, and fixation alone could be sufficient to manage the condition.

The root cause of cervical compressive myopathy appears to be facetal instability, which leads to a cascade of pathologies causing cord compression[5,12].Few surgeons advocate only fixation of the cervical spine[5,12]

At times, the compression over the cord by ligamentum flavour is so severe that any fixation provides stabilization only, but does not relieve compression. Laminectomy should be advocated only in those cases; for the remaining cases, just fixation of the posterior surgical spine would suffice.

Conclusions

The decision to perform transfacet fixation with laminectomy versus transfacet fixation alone is based on the severity and type of spinal cord compression and the clinical presentation of the patient.

Laminectomy with transfacet fixation should be reserved for patients with severe neurological symptoms and significant spinal cord compression, where immediate decompression is necessary to prevent permanent damage.

Transfacet fixation alone is considered for patients with less severe symptoms, where stabilisation might prevent further progression without the need for more invasive decompression.

This tailored approach helps to balance the risks and benefits of surgery, ensuring that patients receive the most appropriate treatment based on their specific clinical presentation.

References

1. Acaroğlu E, Nordin M, Randhawa K, Chou R, Côté P, Mmopelwa T, Haldeman S. The Global Spine Care Initiative: a summary of guidelines on invasive interventions for the management of persistent and disabling spinal pain in low- and middle-income communities. Eur Spine J. 2018 Sep;27(Suppl 6):870-878. doi: 10.1007/s00586-017-5392-0. Epub 2018 Jan 10. PMID: 29322309.
2. Donnally CJ 3rd, Butler AJ, Rush AJ 3rd, Bondar KJ, Wang MY, Eismont FJ. The most influential publications in cervical myelopathy. J Spine Surg. 2018 Dec;4(4):770-779. doi: 10.21037/jss.2018.09.08. PMID: 30714009; PMCID: PMC6330587.
3. Fehlings MG, Kwon BK, Tetreault LA. Guidelines for the Management of Degenerative Cervical Myelopathy and Spinal Cord Injury: An Introduction to a Focus Issue. Global Spine J. 2017 Sep;7(3 Suppl):6S-7S. doi: 10.1177/2192568217701714. Epub 2017 Sep 5. PMID: 29164034; PMCID: PMC5684836.
4. Grelat M, Gimenez C, Madkouri R. Cervical Cord Compression by Exostosis. J Orthop Sports Phys Ther. 2019 Feb;49(2):112. doi: 10.2519/jospt.2019.7942. PMID: 30704359.
5. Goel A. 'Only fixation' as rationale treatment for spinal canal stenosis. J Craniovertebr Junction Spine. 2011 Jul;2(2):55-6. doi: 10.4103/0974-8237.100049. PMID: 23125488; PMCID: PMC3485997.
6. Hitchon PW, Woodroffe RW, Noeller JA, Helland L, Hramakova N, Nourski KV. Anterior and Posterior Approaches for Cervical Myelopathy: Clinical and Radiographic Outcomes. Spine (Phila Pa 1976). 2019 May 1;44(9):615-623. doi: 10.1097/BRS.0000000000002912. PMID: 30724826.
7. Heary RF, MacDowall A, Agarwal N. Cervical spondylotic myelopathy: A two-decade experience. J Spinal Cord Med. 2018 Jul 26;42(4):1-9. doi: 10.1080/10790268.2018.1471780. Epub ahead of print. PMID: 30048224; PMCID: PMC6718135.
8. Nagoshi N, Iwanami A, Isogai N, Ishikawa M, Nojiri K, Tsuji T, Daimon K, Takeuchi A, Tsuji O, Okada E, Fujita N, Yagi M, Watanabe K, Nakamura M, Matsumoto M, Ishii K, Yamane J. Does Posterior Cervical Decompression Conducted by Junior Surgeons Affect Clinical Outcomes in the Treatment of Cervical Spondylotic Myelopathy? Results From a Multicenter Study. Global Spine J. 2019 Feb;9(1):25-31. doi: 10.1177/2192568218756329. Epub 2018 Oct 15. PMID: 30775205; PMCID: PMC6362553.
9. Nagoshi N, Tsuji O, Okada E, Fujita N, Yagi M, Tsuji T, Nakamura M, Matsumoto M, Watanabe K. Clinical indicators of surgical outcomes after cervical single open-door laminoplasty assessed by the Japanese Orthopaedic Association Cervical Myelopathy Evaluation Questionnaire. Spinal Cord. 2019 Aug;57(8):644-651. doi: 10.1038/s41393-019-0258-4. Epub 2019 Feb 21. PMID: 30792540.
10. Nakajima H, Uchida K, Taguchi T, Yamashita T, Tominaga

T, Tanaka M, Yamagata M, Kaito T, Ushida T. Multicenter cross-sectional study of the clinical features and types of treatment of spinal cord-related pain syndrome. J Orthop Sci. 2019 Sep;24(5):798-804. doi: 10.1016/j.jos.2019.01.012. Epub 2019 Feb 15. PMID: 30777363.

11. Park MK, Lee SJ, Kim SB, Lee KW, Lee HJ, Han EY, Kim BR. The effect of positive changes during intraoperative monitoring of the functional improvement in patients with cervical compressive myelopathy. Clin Interv Aging. 2018 Jul 5;13:1211-1218. doi: 10.2147/CIA.S163467. PMID: 30013332; PMCID: PMC6038868.
12. Rhee JM, Basra S. Posterior surgery for cervical myelopathy: laminectomy, laminectomy with fusion, and laminoplasty. Asian Spine J. 2008 Dec;2(2):114-26. doi: 10.4184/asj.2008.2.2.114. Epub 2008 Dec 31. PMID: 20404967; PMCID: PMC2852088.
13. Zakaria HM, Bazydlo M, Schultz L, Pahuta MA, Schwalb JM, Park P, Aleem I, Nerenz DR, Chang V; MSSIC Investigators. Adverse events and their risk factors 90 days after cervical spine surgery: analysis from the Michigan Spine Surgery Improvement Collaborative. J Neurosurg Spine. 2019 Feb 15;30(5):602-614. doi: 10.3171/2018.10.SPINE 18666. PMID: 30771759.
14. Zhang L, Chen J, Cao C, Zhang YZ, Shi LF, Zhai JS, Huang T, Li XC. Anterior versus posterior approach for treating multilevel cervical spondylotic myelopathy: a meta-analysis and systematic review. Arch Orthop Trauma Surg. 2019 Jun;139(6):735-742. doi: 10.1007/s00402-018-03102-6. Epub 2019 Feb 9. PMID: 30739192.

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Traumatic ipsilateral acute extradural and subdural hematoma. A rare but fascinating occurrence

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ABSTRACT

Occurrence of concomitant extradural hematoma (EDH) and acute subdural hematoma (SDH) after trauma on the same side is a rare occurrence. EDHs are usually coup lesions, due to direct trauma with seepage of blood from overlying skull fracture or injury to the dural arteries. Acute SDH, on the other hand, is a countercoup injury, due to brain shift causing damage to the cortical bridging veins. In all our cases, the patient presented the following impact with metal rods overhead. The impact force resulted in fracture of the bone, resulting in stripping of underlying dura, along with cortical injury eventually forming EDH and SDH. It is of importance to note the mechanism of injury and the area of major impact in these cases. Overlapping EDH and SDH shall give rise to the characteristic "CT comma sign." 3, 4 CT comma sign in our series was seen in only one case. During a retrospective analysis of the radiology of the cases, each of the hematomas had an indentation on the cortical side. These cases must undergo urgent surgery with the principal aim of evacuating extradural hematoma and then noting the status of the dura. If the dura is bulging and has a bluish tinge, then the dura must be opened and acute SDH evacuation must be undertaken. Flap must be planned keeping in mind that we may need to undertake a decompressive craniectomy and wherever possible a trauma flap must be planned.

Keywords
neurotrauma, physical assault, intracranial hematoma, skull fracture

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INTRODUCTION

Occurrence of concomitant extradural hematoma (EDH) and acute subdural hematoma (SDH) after single trauma and on the same side is a rare occurrence. EDHs are usually coup lesions and thought to be due to direct trauma with seepage of blood from overlying skull fracture or injury to the dural arteries.[1] Acute SDH, on the other hand, is a countercoup injury, due to brain shift causing damage to the cortical bridging veins.[1] It is the SDH that determines the severity of injury and outcome, due to its associated underlying brain injury.[2] As a mechanism, it is unusual to find both EDH and SDH on the same side in patients with head trauma unless there is direct trauma.[2] We present here a case series of three traumatic brain injury who presented with concomitant EDH and SDH in the same region.

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Case 1

A 21 year old male presented to emergency room (ER) around 14 hour following alleged history of assault. He was hit by a metal rod over his left frontal region. He had suffered loss of consciousness and multiple episode of vomiting. There was no seizure episode or ear nose and throat bleed. At admission his GCS was E4V4M6, bilateral normal size and reacting pupils. The CT (computed tomography) scan showed left fronto parietal SDH with right temporal contusions (Fig 1). At first he was planned for conservative treatment with elective CT scan after 24 hours. Repeat scan was suggestive of increase in mid line shift and he was taken in operation for emergency decompression. Intra operatively, there was thin fracture line over temporal bone and EDH in fronto temporal region which was not evident in the pre procedural CT scan. After evacuation of EDH, the dura was assessed and there was significant bulge present. Dura was opened and underlying SDH evacuated and a proper decompressive craniectomy was undertaken. Following surgery he responded well and could be weaned off oxygen and discharged on 7th post operative day.

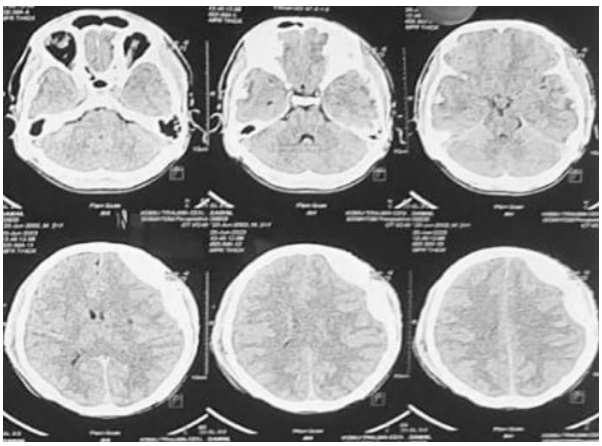

Figure 1. CT scan showing left fronto parietal SDH with right temporal contusion.

Case 2

A 50 year male presented with severe headache, multiple episodes of vomiting and altered sensorium. He had a history of physical assault around 7 days back for which he did not consult any medical practitioner. A CT brain was obtained which was suggestive of left fronto parietal acute on chronic SDH with parietal EDH (Fig 2). After raising the flap, linear temporo-parietal bone fracture was seen and underlying EDH was evacuated. After evacuation of EDH, there was bluish tinge over dura and dura was opened and concomitant SDH evacuated. In this case a large trauma flap was raised in anticipation of brain bulge and need for decompressive craniectomy. After evacuation of SDH there was bulge and decompressive craniectomy was undertaken. He was operated at a GCS of E2V2M5 and was discharge on 9th post op day at a GCS of E4V4M6.

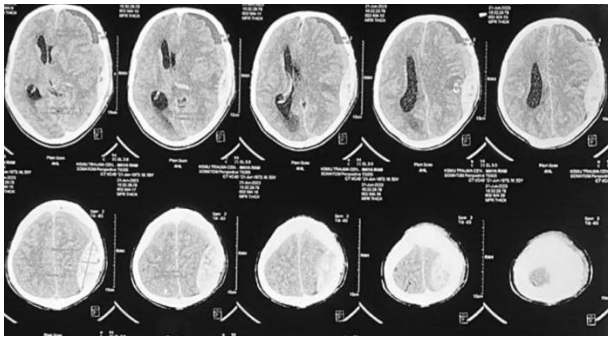

Figure 2. CT scan showing left hemispheric acute on chronic SDH with parietal EDH.

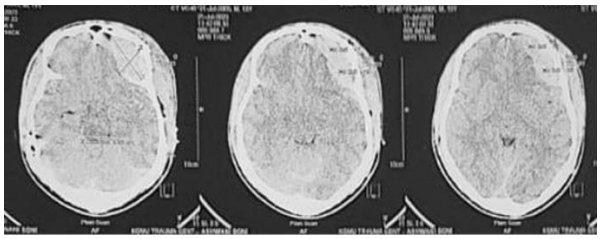

Figure 3. Left frontal EDH with underlying frontal hematoma.

Case 3

A 35 year old male was admitted in neurosurgery ward after 6 hour following alleged history of assault with iron rod. He was hemodynamically stable with a GCS E4V2M5 with bilaterally reacting pupils and mild paucity of movement on right side. CT scan of brain was suggestive of frontal EDH with underlying right frontal hematoma (Fig 3). Patient was taken to surgery after relevant pre anesthetic check up; right frontal flap raised. there was underlying linear frontal and temporal bone fracture. After evacuation of EDH, dura was tensed. A dural nick was given using tenotomy scisoors which reveled underlying SDH. Frontal flap was revised to trauma flap and a fronto temporo parietal decompressive craniectomy was done with evacuation of SDH. After proper hemostasis, augmentation duraplasty was done and

patient was ventilated electively for 12 hours, He had an uneventful post operative period and was discharged on 6th post operative day.

Discussion

Following traumatic brain injury, EDH and SDH appear in opposite locations as EDH is a coup injury and SDH is a contrecoup injury. The mechanism of formation of traumatic EDH and SDH are entirely different. EDH, mostly located in the temporo-parietal region is due to tear of anterior or posterior divisions of the middle meningeal arteries, rarely vein and dural venous sinus, with an associated linear vault fracture.[2] Acute SDH on the other hand is mostly due to bleeding from contused cortex, torn bridging veins, or torn cortical blood vessel.[2] In all our cases, the patient presented following impact with metal rods over head.

The impact force resulted in fracture of the bone, resulting in stripping of underlying dura, along with cortical injury eventually forming EDH and SDH. It is of importance to note the mechanism of injury, and the area of major impact in these cases. Our series had all cases being of physical assault, thus making such mode of injury a etiology for such concomitant presentation.

Following trauma to brain CT scan is the investigation of choice both as the initial modality of imaging as well as for follow-up imaging.[3] Overlapping EDH and SDH shall give rise to characteristic "CT comma sign." [3, 4] CT comma sign in our series was seen in only one case. Moreover, CT comma sign will be more appreciable when the underlying SDH is hemispheric. On retrospective analysis of the radiology of the cases, each of the hematoma had an indentation in the cortical side. (Figure 4) This can explained by the fact that the biconvex EDH and underlying biconcave SDH, both being hyperdense gives this peculiar appearance. Although, whether such appearances are always related to concomitant presentation or not couldn't be stated at present.

The outcome of head injury is mostly determined by the neurologic status of the patient, severity of brain injury, and time interval from injury to neurosurgical intervention. [5, 6] Surgical evacuation of the traumatic EDH is one of the most 'cost effective' of all surgical procedures in terms of quality of life and years preserved.[2] In our cases, 2 patients presented within a day of injury, and one presented almost a week after injury. All three underwent intervention on emergency basis. The presenting GCS was comparatively good and we can attribute the post operative outcome to this factor more than the time of presentation.

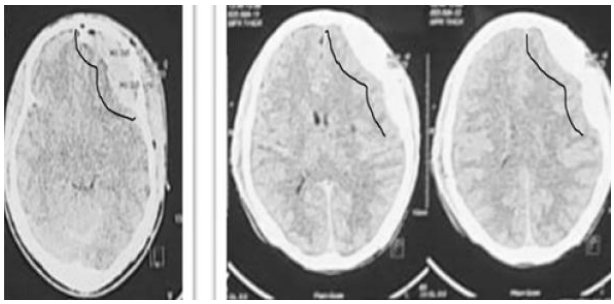

Figure 4. Indentation in the cortical surface of the hematoma

Conclusions

When EDH and SDH happens in the same side, the cause of the EDH is direct injury of dural artery or seepage from fracture and the SDH is due to injury of cortical artery and/ or vein. We conclude that we must be more vigilant when we approach a case of physical assault, as these cases seemingly have more chances of such occurrences. Next, we should be more vigilant while reading the scans. The presence of an indentation in the cortical border of the hematoma should raise the suspicion of an underlying SDH. In some cases CT comma sign is seen with ease and in those cases surgery must be planned accordingly to evacuate both the components. These cases must undergo urgent surgery with the principle aim to evacuate extradural hematoma and then note the status of the dura. If the dura is bulging, having a bluish tinge, then dura must be opened and acute SDH evacuation must be undertaken. Flap must be planned keeping in mind that we may need to undertake a decompressive craniectomy and wherever possible a trauma flap must be planned.

References

1. Venkatesh S Madhugiri, Arivazhagan Arimappamagan, Chandramouli BA (2012) Traumatic epidural and subdural hematomas and extensive brain infarcts in a patient with pial arterio venous malformation: Mechanisms underlying clinical and radiological findings. Asian J Neurosurg Oct-Dec 7(4): 210–213.
2. Massaro F, Lanotte M, Faccani G, Triolo C. One hundred and twenty-seven cases of acute subdural haematoma

operated on. Correlation between CT scan findings and outcome. Acta Neurochir (Wien) 1996 ; 138 : 185-91.
3. Agrawal A, Hegcde K, Reddy V. The "CT Comma Sign" in concurrent extradural and hyperacute subdural hematomas is revisited. West Afr J Radiol 2016;23(1):52–53.
4. Monsalve GA. The "CT comma sign" in head trauma: concur¬rent epidural and subdural acute intracranial hematomas. J Trauma 2007;63(1):195–196.
5. Agrawal A. Bilateral symmetrical parietal extradural hematoma. J Surg Tech Case Rep 2011;3(1):34–36.
6. Agrawal A, Agrawal C, Kumar A, Adhikari S. Outcome of traumatic extradural haematoma managed surgically: our experience. Nigerian J Orthopaed Trauma 2007;6:74–76.

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Transcranial approach for venous embolization of dural arteriove-nous fistula

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Keywords
dural arteriovenous fistulas (DAVF), transvenous embolization, interdisciplinary approach, venous transcranial approach

ABSTRACT

Transvenous embolization emerges as a viable intervention for addressing intracranial dural arteriovenous fistulas (DAVF). Accessibility to the fistulous site via the internal jugular vein (IJV) may be impeded by associated dural sinus apoplexy or thrombosis, prompting the development of a transcranial approach for venous embolization in such scenarios. The presented case details the utilization of a transcranial approach for venous embolization of DAVF. This method allows unobstructed entry to DAVFs situated on superficial dural sinuses that lie beyond the reach of the IJVs. The efficacy of this approach parallels that of the conventional retrograde venous methodology. The precise location and appropriate extent of the craniectomy play pivotal roles in ensuring the success of this technique.

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INTRODUCTION

Dural arteriovenous fistulas (DAVFs) denote aberrant communications within the dural layers, linking meningeal arteries with dural and/or venous sinuses and subarachnoid veins. They constitute 10 to 15% of all cerebral arteriovenous malformations. While numerous DAVFs remain asymptomatic and may not necessitate intervention, the presence of cortical venous reflux, intracranial hemorrhage, elevated intracranial pressure, and intolerable symptoms serve as primary indications for treatment.

A comprehensive understanding of the natural history of DAVFs is of paramount importance in guiding decision-making and managing

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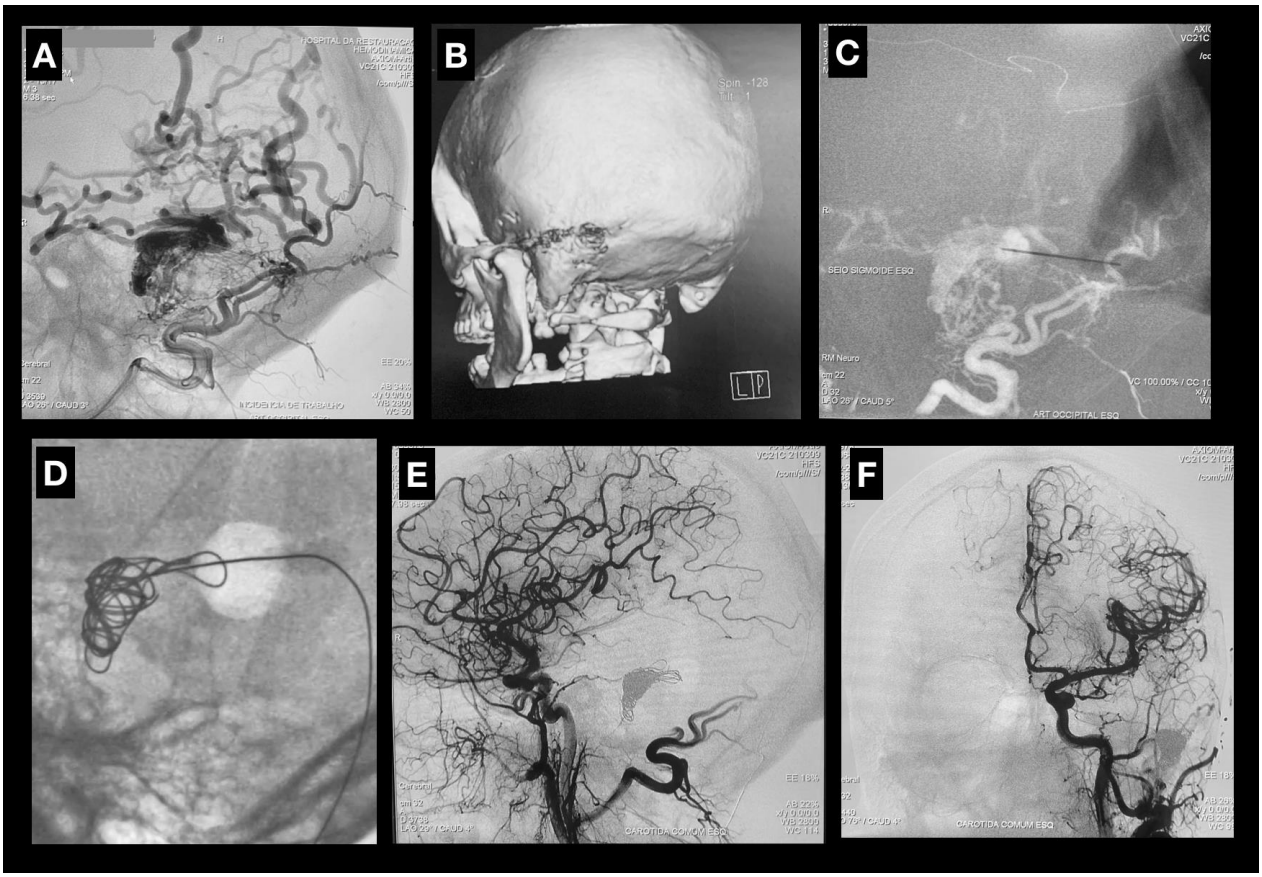
these lesions, including consideration of associated stenoses in the endovascular treatment access routes. With continuous advancements in endovascular technologies, the majority of DAVFs can be effectively addressed through transarterial or transvenous embolization. Cases resistant to complete endovascular resolution may require adjunctive surgery or radiotherapy.

Moreover, challenges may arise when dealing with compromised venous routes due to thrombosed sinus venosus, and arterial access may pose a certain level of difficulty. In such instances, alternative access routes present themselves as formidable challenges for minimally invasive procedures.



OBJECTIVE

Report an unusual fistula embolization technique dural arteriovenous by venous transcranial approach.

CASE REPORT

A patient in their 40s presented with a history of worsening headache and dizziness. DSA disclosed DAVF involving the left transverse-sigmoid sinus transition, supplied by multiple feeders from the left external carotid branches (occipital, superficial temporal, middle meningeal and posterior auricular arteries). The transverse-sigmoid junction was cloistered by distal transverse and proximal sigmoid sinus occlusion, leading to a prominent retrograde drainage into infratentorial engorged veins (Figure 1A). With DSA pinpointing, a small guided craniectomy was performed (Figure 1B). After that, transcranial direct puncture of the transverse-sigmoid junction under high-quality road-mapping guidance was performed (Figure 1C). A 18 G Jelco was used as a sheath for a 2.6F microcatheter insertion, packing the sinus with seven detachable coils (Figure 1D). The final angiography showed complete obliteration of the lesion (Figure 1E and 1F). The patient woke up in postoperative and was completely asymptomatic after one week.

In this scenario, when a dural arteriovenous fistula (DAVF) involves a sinus proximal to the skin, a viable and efficacious solution entails accessing the

sinus through a direct puncture facilitated by a carefully planned craniectomy. Houdart et al. have documented their experience employing a curative transcranial approach for venous embolization of DAVFs in ten patients, nine of whom had previously undergone unsuccessful interventions, with coils being the predominantly utilized embolic agent. Our preference is to conduct the embolization procedure in the neuroangiographic suite, leveraging superior angiographic equipment and a more extensive array of endovascular tools, thereby instilling greater confidence in the intervention.

Conclusions

The endovascular approach stands as the gold standard for treating dural arteriovenous fistulas (DAVFs). It is crucial to underscore that the transcranial venous access represents an unconventional method for embolizing dural fistulas. Nevertheless, it should be regarded as a noteworthy alternative, particularly in cases involving dural fistulas with entrapped sinuses. The precise localization and optimal extent of the craniectomy are indispensable factors for the successful execution of this technique.

References

1. Houdart E, Saint-Maurice JP, Chapot R, Ditchfield A, Blanquet A, Lot G, Merland JJ. Transcranial approach for venous embolization of dural arteriovenous fistulas. J Neurosurg. 2002 Aug;97(2):280-6. doi: 10.3171/jns.2002.97.2.0280. PMID: 12186454.
2. Andrade G, Marques R, Pires NB, Abath C. Dural arteriovenous fistulas: unusual access routes in the elderly. Interv Neuroradiol. 2005 Dec 20;11(4):377-81. doi: 10.1177/159101990501100411. Epub 2006 Feb 10. PMID: 20584451; PMCID: PMC3399755.
3. Niimi Y. Endovascular treatment of pediatric intracranial arteriovenous shunt. Pediatr Int. 2017 Mar;59(3):247-257. doi: 10.1111/ped.13159. PMID: 27601322.
4. Elhammady MS, Ambekar S, Heros RC. Epidemiology, clinical presentation, diagnostic evaluation, and prognosis of cerebral dural arteriovenous fistulas. Handb Clin Neurol. 2017;143:99-105. doi:10.1016/B978-0-444-63640-9.00009-6. PMID: 28552162.
5. Pierot L, Visot A, Boulin A, Dupuy M. Combined neurosurgical and neuroradiological treatment of a complex superior sagittal sinus dural fistula: technical note. Neurosurgery. 1998 Jan;42(1):194-7. doi: 10.1097/00006123-199801000-00044. PMID: 9442524.
6. Pradilla G, Coon AL, Huang J, Tamargo RJ. Surgical treatment of cranial arteriovenous malfor-mations and dural arteriovenous fistulas. Neurosurg Clin N Am. 2012 Jan;23(1):105-22. doi: 10.1016/j.nec.2011.10.002. PMID: 22107862.
7. Garg K, Agrawal D. Role of Stereotactic Radiosurgery in the Management of Dural AV Fistula. Neurol India. 2023 Mar-Apr;71(Supplement):S109-S114. doi: 10.4103/0028-3886.373634. PMID: 37026341.

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Pitfall in surgical treatment of patients with ankylosing spondylitis and fractures

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Abstract
This article presents a brief description of the concept of fractures in patients with ankylosing spondylitis and the most commonly used surgical techniques, followed by the report of four cases treated for circumferential arthrodesis.

Keywords
ankylosing spondylitis,
arthrodesis,
cervical vertebrae

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Introduction

Achylosing spondylitis is a chronic autoimmune inflammatory disease, predominantly affecting the spine and sacro-iliac joints. It affects males 3 times more than females.[1]

Chronic inflammation of vertebral and paravertebral tissues results in their ossification, fusion and increased stiffness of the spine. Another characteristic of spondylitic spines is the presence of osteoporosis and kyphotic deformity, the latter leading to reduced visual range and less balance, thus predisposing to a greater risk of falls. All of these factors increase the risk of fractures of the cervical and thoraco-lumbar spine in this subgroup of patients.[2,3]

Fractures in spondylitic columns behave like long bone fractures, producing fractures that affect the three columns of Denis[10], which increases the risk of unstable behavior, as well as an increased risk of associated neurological injury.[4]

The characteristic vertebral calcification of these columns results in altered vertebral anatomy, making safe transpedicular instrumentation in these fractures difficult. Surgical treatment of spinal fractures in patients with spondylithic spines therefore presents a greater risk of postoperative complications.[5]

In approximately 50 to 70% of spondylitic fractures, they occur at the C5-C6 level.[6] Therapeutic discussions have debated between isolated anterior, isolated or combined posterior instrumentation.[7]

Isolated anterior fixation has the highest rate of non-union and instrumentation failure, as it only fixes the anterior and middle spine.[8] Isolated posterior fixation presents better results than anterior fixation, however, there is still a risk of spinal non-union. previous.[9] In this sense, combined fixation has been shown to be the approach with the highest

fusion rates, as it fixes all three columns. However, it still presents a high risk of postoperative complications.[7]

The objective of this study was to report four clinical cases of fractures of the cervicodorsal region in patients with ankylosing spondylitis treated surgically with circumferential arthrodesis. The question we intend to answer is whether combined cervicodorsal circumferential arthrodesis is a safe and effective procedure for obtaining arthrodesis of these fractures.

CLINICAL CASES

Case 1

66-year-old patient, with a complex somatic history: Ankylosing spondylitis diagnosed at age 42; End-stage renal disease on hemodialysis; Arterial hypertension; Dyslipidemia; Type II diabetes mellitus; Ischemic heart disease, with angioplasty in 2001, 2003 and 2006; Benign thyroid nodules; Pericarditis due to Staphyloccous epidermidis in 2017; Ex-smoker. The patient went to the Emergency Department due to a fall from his own height, with cervical and back pain complaints, without neurological deficit. The patient also reported loss of horizontal vision secondary to dorsal kyphosis marked over years of evolution. A CT scan of the cervicodorsolumbar spine was performed, which revealed a trans discal fracture of C6-C7 and T12-L1. Cervical MRI was not performed due to a conflict between the patient's kyphosis and the space available to perform the respective examination (Figures 1A,B).

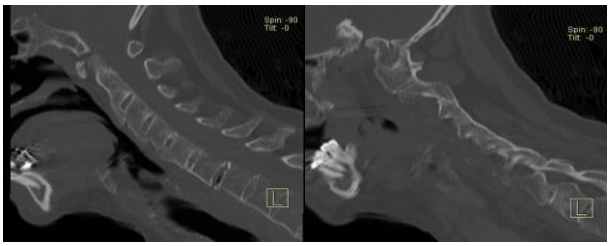

Figure 1. **A.** Cervical CT: Transdiscal C6-C7 fracture.

The patient initially refused surgical treatment and was discharged with an indication for conservative treatment with a cervical collar and dorsalumbar external rigid fixation. After 3 months of evolution of the traumatic episode, he reported worsening cervical and dorsal pain, without neurological deficit, and also reported poor adherence to the prescribed conservative treatment. Cervical and dorsolumbar CT revealed the presence of a non-union of C6-C7 and T12-L1 (Figure 2A and 3A).

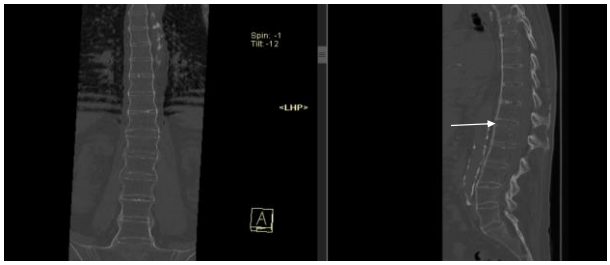

Figure 1. **B.** Discontinuity of the anterior and posterior longitudinal ligament Th12-L1.

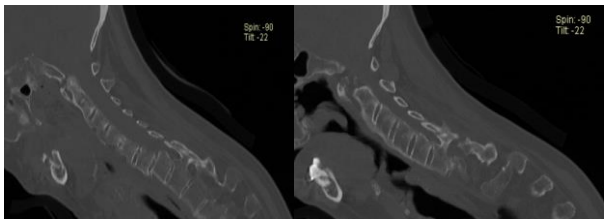

Figure 2. **A.** C6 anterior lithesis, larger opening of the posterior fracture.

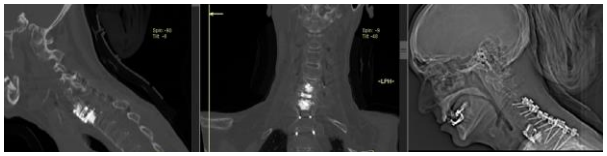

Figure 2. **B.** Postoperative CT reveals good positioning of the arthrodesis material.

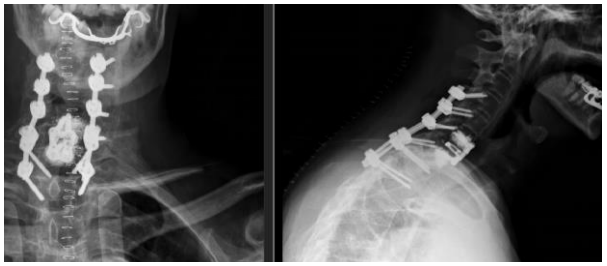

Figure 2. **C.** Postoperative cervical x-ray.

Figure 3. **A.** Preoperative CT - Non-union of Transdiscal Th12-L1 Fracture.

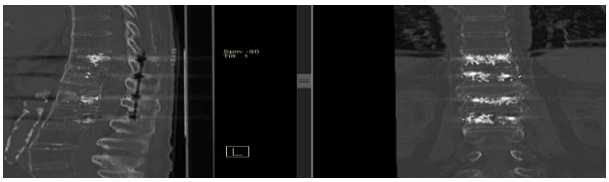

Figure 3. **B.** Postoperative dorsolumbar CT: posterior cemented fixation T11-L2.

He accepted surgical treatment and underwent combined cervical arthrodesis and T11-L2 percutaneous fixation with cemented screws (Figure 3B). Cervical surgery began with C6-C7 anterior arthrodesis with an interbody cage and anterior plate with cemented screws, with reduction of C6-C7 segmental kyphosis. After an anterior approach, he underwent C5-T2 posterior arthrodesis with C5-C7 posterior fixation to the lateral masses, T1-T2 transpedicular instrumentation and C5-C7 laminectomy (Figure 2 B,C). After combined cervical surgery, T11-L2 percutaneous fixation was performed with cemented screws. The postoperative period was uneventful, with recovery of horizontal vision.

After a year of follow-up without axial complaints, he died suddenly after a dialysis session.

Case 2

A 74-year-old patient with a long history of ankylosing spondylitis suffered a road accident that resulted in neck trauma. She presented with cervical pain complaints, without neurological deficits. Cervical MRI revealed a C7 transnasomatic fracture (Figure 4A).

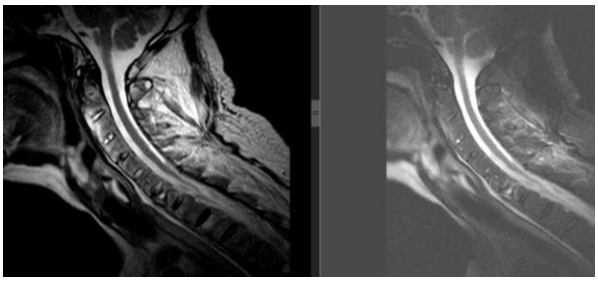

Figure 4. **A.** Cervical CT: C7 transomatic fracture.

The patient underwent combined surgery, with a C6-C7-T1 anterior arthrodesis with an anterior plate and cemented screws being performed first, followed by C5-C7 posterior fixation to the lateral masses, T1-T2 transpedicular. It was decided intraoperatively to perform a C5-C7 laminectomy due to extravasation of intracanal cement during the execution of the anterior cemented screws, detected with fluoroscopy (Figures 4 B,C), which on the postoperative control CT scan was considered irrelevant.

Figure 4. **B.** Postoperative CT and X-ray.

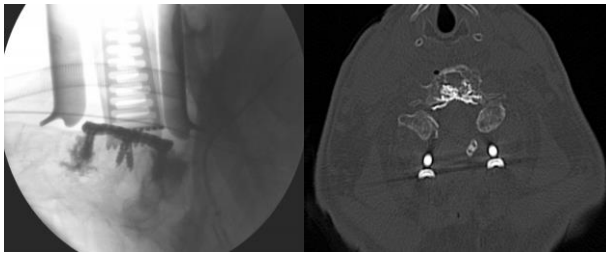

Figure 4. **C.** Intra-canal cement leakage was detected intraoperatively, asymptomatic and considered irrelevant in the axial sections of the cervical CT.

In the immediate postoperative period, he presented paresthesias of the left upper limb, with spontaneous resolution after 2 days of evolution.

Case 3

An 81-year-old man with a history of ankylosing spondylitis had an episode of lipothymia. During the episode of lipothymia, a third person held the patient, preventing him from falling, which resulted in a cervical flexion movement.

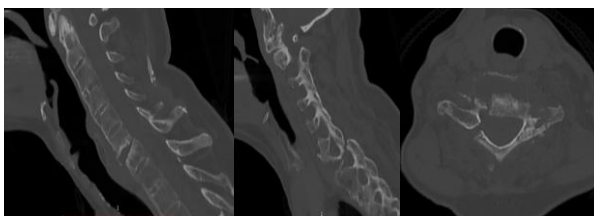

Figure 5. **A.** C6-C7 transdiscal fracture, C7 lamina fracture on the right.

After recovering from lipothymia, the patient reported intense neck pain and went to primary

health care, where he underwent a simple cervical x-ray and was advised to use a cervical collar. The patient continued to have the aforementioned neck pain, associated with clinical neurological worsening after a week of evolution. He reported loss of muscle strength in his right upper limb and dexterity in his right hand. Neurosurgery consultation was referred 3 months after the trauma, with grade 3 muscle strength of the right upper limb. He underwent CT and MRI which revealed a C6-C7 transdiscal fracture (Figure 5A, B).

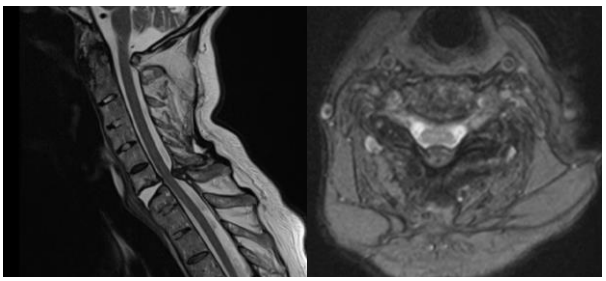

Figure 5. **B.** MRI confirms C6-C7 fracture, posterior ligament cord compression.

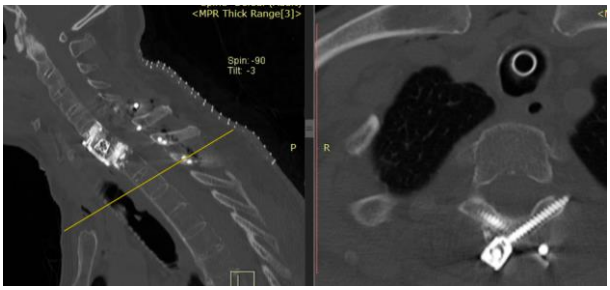

Figure 5. **C.** Cervicodorsal CT: cervical circumferential arthrodesis: C6-C7 anterior arthrodesis with cylinder and anterior plate with cemented screws. C5-Th2 posterior arthrodesis, in C5, C6 with transpedicular screws and in C7 with unilateral intralaminar screw, Th1, Th2 with crossed intralaminar screws, cross link.

Figure 5. **D.** Postoperative cervico-dorsal radiography

He underwent surgery, and cervicodorsal circumferential arthrodesis was performed: C6-C7 anterior arthrodesis with cylinder and anterior plate with cemented screws and C5-T2 posterior arthrodesis (transpedicular screws in C5-C6, C7 unilateral intralaminar screw and crossed intralaminar screws T1 and T2 (Figures 5C,D). Postoperatively, dehiscence of the posterior cervical surgical wound was observed, which was treated with vacuum dressings and, to facilitate closure of the wound, a resection of the dorsal spine apophyses was performed, with the wound appearing fragile, but stable during the operation. follow up (Figure 5 E)

Figure 5. **E.** Appearance of the wound after epithelialization.

Case 4

An 84-year-old man went to the hospital 10 days after the fall with superior paraparesis (FM 0 distally and FM2 proximally) with a C6 transomatic fracture with dissociation (Figure 6A).

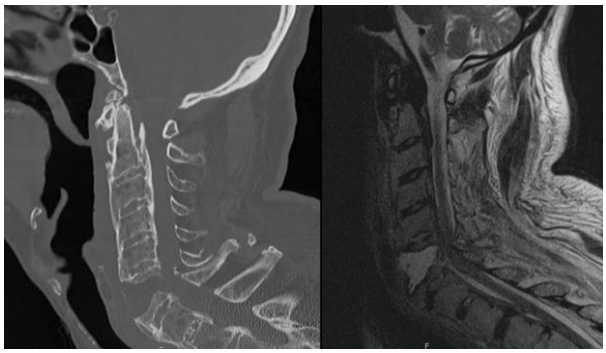

Figure 6. **A**. Preoperative cervical CT and MRI: C6 transomatic fracture.

It was decided to stabilize the fracture by performing circumferential arthrodesis, starting via the anterior approach. After anterior fixation with a C5-C6 plate with cemented screws in anterior cervical flexion to reduce dissociation, the patient was placed in a ventral position with the head fixed in Mayfield and when performing radiography, dislocation of the C5

body screws was soon noticed (Figure 6B) . The initial plan was maintained and continued with C3-Th2 posterior fixation (C3-C7 lateral mass and Th1, Th2 with intralaminar cruciate screws (Figure 6C) and C3-C6 laminectomy, without complications. Cervical CT and post-preratorial radiography reveal acceptable fixation with restoration of fracture alignment. He was discharged 10 days postoperatively with slow, progressive improvement in motor deficit.

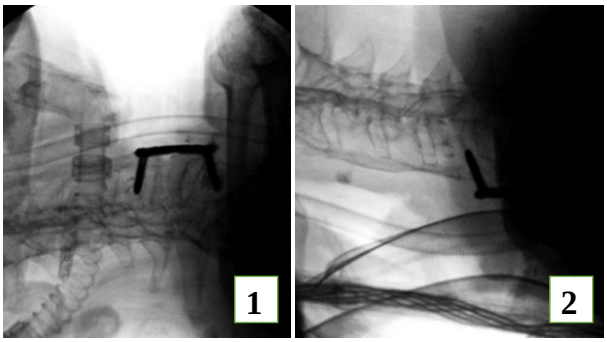

Figure 6. **B**. **1.** Intraoperative radiography after fixation with anterior plate with cemented screws. **2**. Radiograph after ventral positioning with pull out of the C5 body screws.

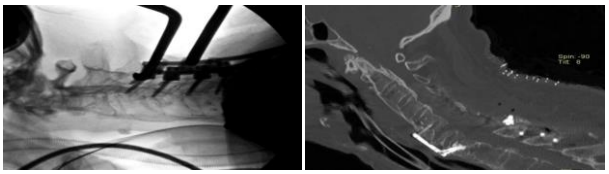

Figure 6. **C**. Intraoperative radiography and post-operative cervical CT reveal good alignment of the fracture.

Discussion

The four cases reported and submitted to cervicodorsal arthrodesis via a combined approach in patients with fractures and ankylosing spondylitis, occurred without major complications and with the achievement of fracture arthrodesis.

Patients with ankylosing spondylitis are usually patients with multiple associated comorbidities, often with respiratory and renal impairment and advanced age. These patients thus represent a systemic medical-anesthetic challenge, but also a local one, since cervico-dorsal fractures represent, from a technical point of view, a difficult area for the anesthesiologist, with neurological risk associated with intubation and positioning of the patient.[1,2,5,7].

At the surgical level, they also represent a challenge, both due to the instability of these fractures and the technical difficulty that these patients present to the surgeon. Surgical treatment must be meticulously planned and adapted case by case, taking into account comorbidities, type and degree of instability of the fracture. The high mechanical instability of these fractures, the high rigidity of the spondylitic columns, osteopenia and the technical difficulty of the instrumentation caused by the change in the local anatomy of the spine of these patients, significantly increases the risk of non-union of these fractures and mechanical failure of the instrumentation. Several strategies can be used to improve the safety and quality of instrumentation with the aim of obtaining stable fixation and fracture consolidation associated with minimizing instrumentation-related complications. These fractures can be fixed via a posterior, anterior or combined approach. Isolated pathways carry an increased risk of fixation failure, Figure 7 illustrates the failure of the isolated anterior pathway.

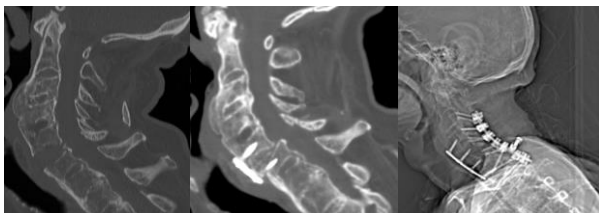

Figure 7. Cervical fracture initially treated only via the anterior approach with construction failure and neurological worsening and the need for circumferential arthrodesis.

The advantage of the isolated posterior approach lies in less aggression and surgical time, and is therefore associated with a lower risk of complications than the combined approach, but the isolated posterior approach is inferior in terms of robustness to the combined approach (Figure 8).

In turn, the combined approach allows superior mechanical fixation, as well as the reconstruction of comminution/deficient bone stock in the anterior column. In this sense, the posterior route should be reserved for patients without anterior column comminution or in patients who cannot tolerate the combined route. The combined approach should therefore be reserved in cases with significant loss of anterior bone stock or comminution of the vertebral body, in order to obtain anterior support and reduce mechanical stress on the posterior fixation. [1,2,5,6,7,8,9].

In our reported cases, circumferential arthrodesis via a combined approach was always chosen, in order to obtain an anterior reconstruction, increase the mechanical resistance of the construction in order to obtain a safe arthrodesis, as well as reduce segmental kyphosis and thus restore the horizontal vision of these sick. It is worth highlighting a case of dehiscence of the posterior surgical wound, which may be due either to the greater risk of healing difficulties inherent to the posterior route compared to the anterior route, or to the underlying inflammatory pathology of these patients, with marked paravertebral muscular atrophy secondary to disuse. caused by the rigidity of these columns.

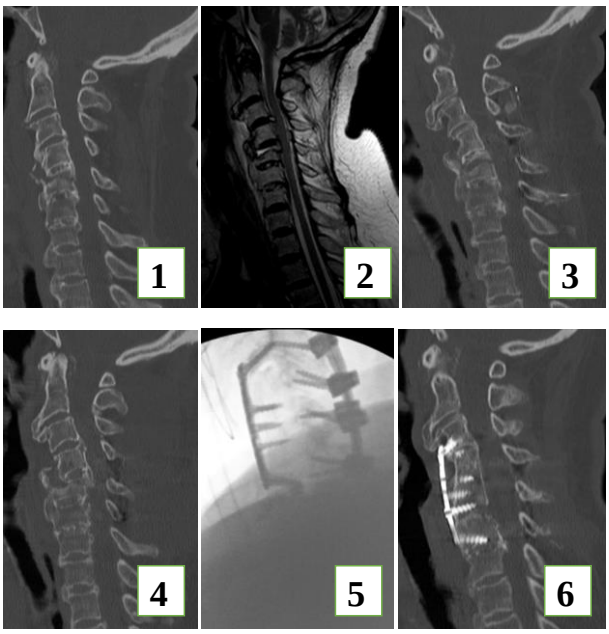

Figure 8. **1.** CT-C5 transomatic fracture. **2.** MRI confirms the C5 transomatic fracture. **3.** CT scan after posterior fixation with good fracture alignment. **4.** CT in the immediate postoperative period, after dramatic neurological worsening, reveals disassembly of the posterior construction and misalignment of the fracture. **5.** Intraoperative images during anterior arthrodesis with tricortical iliac self-graft and plate. **6.** Postoperative CT reveals good positioning of the graft and plate.

The use of anterior plates is associated with a risk of screw pull-out, associated with high osteopenia of these spines. The use of cemented screws is an option that increases the mechanical resistance of the previous construction[1,2]. In our clinical cases, all screws used in the anterior plate were reinforced with cement, with one case of screw pull-out occurring. It should be noted, however, that in one case there was leakage of endocanal cement without neurological sequelae, meaning that the use of mechanical reinforcement is not without risks.

At a posterior level, the change in local anatomy, as well as the overlap of the glenohumeral joints, makes safe transpedicular instrumentation of C7 and the upper thoracic vertebrae difficult through the use of fluoroscopy or free-hand. Two solutions can be used to overcome this difficulty: the use of transpedicular screws for navigation or the use of intralaminar screws, the latter of which have the advantage of being able to be used in a free-hand manner, reducing exposure to radiation and reducing time surgical, hemorrhage and infectious risk when compared with navigated transpedicular instrumentation. The disadvantage in relation to transpedicular navigated instrumentation is that they are biomechanically inferior, since they instrument only the posterior column, compared to the instrumentation of the three columns provided by the transpedicular screw [1,2,5,6,7,8,9], although there are comparative studies between fixation with transpedicle screws and intralaminar crossed screws that reveal similar resistance.

Mc Guird compared Th1, Th2 transpedicular fixation versus intralaminar fixation in cadavers and determined the minimum biomechanical difference in cases of long cervicodorsal fixation11. Kretzer in another cadaveric study determined similar stability in cases of transnaspedicuar and intralaminar fixation involving Th1 and Th2[12].

In two reported cases, the instrumentation of T1 and T2 was free-hand transpedicular, since adequate bone references were identified intraoperatively for the safe performance of this technique. In the third and fourth case, it was decided to use intralaminar screws in T1 and T2, due to the fact that the local anatomy was distorted by the underlying pathology and the fact that the hospital unit did not offer the navigation option at the time of the surgery, Surgical technique has been previously described[13].

The main limitation of this study is that it deals with reports of four clinical cases, and therefore, without statistical power. The main strength of the study lies in the fact that the cases were operated on by the same surgeon, subjected to the same surgical technique and with thorough pre-, intra- and post-operative preparation and description, thus allowing reliable conclusions to be drawn from the reported cases.

Conclusions

We can conclude that combined cervicodorsal arthrodesis in patients with fractures and ankylosing spondylitis is a safe treatment and allows good arthrodesis rates to be obtained without mechanical failure of the construction. These cases are challenging, need good preoperative assessment and correct surgical planning. The patients usually are old, fragile, with comorbidities and every mistake or misunderstanding of complexity of pathology can lead to catastrophic complications. The follow up must be very tight during first years, until the fusion is confirmed.

References

1. He A, Xie D, Cai X, et al. One-stage surgical treatment of cervical spine fracture-dislocation in patients with ankylosing spondylitis via the combined anterior-posterior approach. Medicine (Baltimore) 2017;96(27):e7432.
2. Qian SJ, Ye XS, Chen WS, Li WL. Missed diagnosis of oesophageal perforation in ankylosing spondylitis cervical fracture: Two case reports and literature review. J Int Med Res 2016;44(1):170-175.
3. Munoz-Ortego J, Vestergaard P, Rubio JB, et al. Ankylosing spondylitis is associated with an increased risk of vertebral and nonvertebral clinical fractures: a population-based cohort study. J Bone Miner Res 2014; 29(8):1770–1776.
4. Miao J, Chen Y, Zhang B, et al. Surgical Treatment for Odontoid Fractures in Patients with Long-Standing Ankylosing Spondylitis: A Report of 3 Cases and Review of the Literature. World Neurosurg 2018;116:88-93.
5. Min Y, Hui-Yun G, Hou-Cheng Z, et al. The surgical treatment strategies for thoracolumbar spine fractures with ankylosing spondylitis: a case report. BMC Surg 2019;19(1):99.
6. Lee CK, Yoon DH, Kim KN, et al. Characteristics of Cervical Spine Trauma in Patients with Ankylosing Spondylitis and Ossification of the Posterior Longitudinal Ligament [published correction appears in World Neurosurg. 2017 Oct;106:1048]. World Neurosurg 2016;96:202-208.
7. El Tecle NE, Abode-Iyamah KO, Hitchon PW, Dahdaleh NS. Management of spinal fractures in patients with ankylosing spondylitis. Clin Neurol Neurosurg 2015;139:177-182.
8. Guo Q, Cui Y, Wang L, Lu X, Ni B. Single anterior approach for cervical spine fractures at C5-T1 complicating ankylosing spondylitis. Clin Neurol Neurosurg. 2016;147:1-5.
9. Lindtner RA, Kammerlander C, Goetzen M, et al. Fracture reduction by postoperative mobilisation for the treatment of hyperextension injuries of the thoracolumbar spine in patients with ankylosing spinal disorders. Arch Orthop Trauma Surg. 2017;137(4):531-541.
10. Denis F, The three-column spine and its significance in the classification of acute thoracolumbar spinal injuries Spine 1983 Nov-Dec;8 (8):817-31.
11. McGirt MJ, Sutter EG, Xu R, Sciubba DM, Wolinsky JP, Witham TF, Gokaslan ZL, Bydon A. Biomechanical comparison of translaminar versus pedicle screws at T1 and T2 in long subaxial cervical constructs. Neurosurgery. 2009 Dec; 65 (6 Suppl): 167-72; discussion 172. doi: 10.1227/ 01.NEU.0000345642.50726.A3. PMID: 19934991.
12. Kretzer, Ryan M. MD*†; Hu, Nianbin MD†; Kikkawa, Jun MD†; Garonzik, Ira M. MD*‡; Jallo, George I. MD*; Tortolani, P. Justin MD§; McAfee, Paul C. MD§; Cunningham, Bryan W. MS†. Surgical Management of Two- Versus Three-Column Injuries of the Cervicothoracic Junction: Biomechanical Comparison of Translaminar Screw and Pedicle Screw Fixation Using a Cadaveric Model. Spine: September 1, 2010-Volume 35-Issue 19-p E948-E954 doi: 10.1097/BRS.0b013 e3181c9f56c.
13. Sincari, M. and Conceição, M. (2023) Crossed Intralaminar Screws for Fusion of the Cervicothoracic Junction and the Thoracic Spine: The Experience in an Iberic Service with Case Series and Review of the Current Literature with Technique Description. Surgical Science, 14, 203-220. doi:10.4236/ss.2023.143024.

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A tale of the nail: post-traumatic brain abscess from impalement injury

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ABSTRACT

Impalement injuries to the head are rare but serious and potentially life-threatening. They comprise approximately 0.3% of all head injuries and require emergency surgical intervention. These injuries are mostly accidental however increasing cases arising from assault is being reported with often satisfactory outcomes.

The management of impalement injuries to the brain presents peculiar challenges due to their complexities, associated neurological disruptions and impairments, and the risk of central nervous system infection.

Cerebral abscess is a rare but potentially devastating complication of cranial impalement injuries often associated with late presentations and cases receiving suboptimal treatment.

We report a fatal case of cerebral abscess in a 33-year-old man who presented late following assault with a nail to his head. We outline the principles of management, emphasize the need for early presentation and management by qualified professionals.

Keywords
impalement,
brain abscess,
nail injury,
assault,
outcome

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INTRODUCTION

Brain abscess is a focal suppurative infection that begins in an area of cerebritis or devitalized brain tissue and develops into a collection of pus surrounded by a well-vascularized capsule.[1, 2]

Despite the development of modern neurosurgical techniques, potent antibiotics, and modern imaging technologies, suppurative central nervous system infections remain potentially fatal.[3]

The epidemiology and clinical spectrum of brain abscesses have changed in recent years due changing spectra of aetiologic agents amidst the age-long limitations in anaerobic culture techniques. Brain abscesses may arise by direct spread from an exogenous focus, endogenous source via the haematological route, or sometimes be of cryptic origin. In post-traumatic (exogenic) brain abscesses, the duration between the predisposing injury and occurrence of an abscess varies, and may initially be designated an “idiopathic brain abscess”

contributing to the 15% of cases whose sources are unidentified. [4-6] This is commonly associated with mild closed head injuries.[7]

Impalement brain injuries are caused by foreign exogenous objects that penetrate the brain along any of its axes, producing a wound track corresponding to its depth of penetration. They are often accidental and constitute a neurosurgical emergency. [8] There are reported cases occurring following assault with reported outcomes being largely satisfactory [8]

The authors present a case of cerebral abscess complicating an impalement brain injury in a 33-year-old man who was assaulted with a nail.

Case report

A 33-year-old man presented to our facility with a history of recurring headache, blurry vision, impaired short-term memory, unsteady gait and frequent urination following being assaulted with a nail to his head 3-months back.

He was attacked by a group of suspected hoodlums who drove a 6-inch nail into the right side of his head once, with a hammer. The nail was forcefully pulled out by passers-by who came to his aid at the scene. He lost consciousness which he regained some minutes later. The headache was severe enough to impair activity. There was no history of seizures. He was noted to have incoherent speech afterwards and resorted treatment at home by a nurse.

At presentation, there was a healed puncture wound in the right frontal region of his scalp. He was afebrile, conscious and well oriented. His pupils were equal and reactive bilaterally. He had impaired short-term memory, mild dysarthria and left hemiparesis with power of 4/5. There were no signs of meningeal irritation.

Neuroimaging revealed an encapsulated supratentorial lesion in the right frontal lobe with leftward subfalcine brain shift and an overlying right paramedian defect in the frontal calvarium depicting the entry point of the nail. (Fig 1a-c) The lesion demonstrated a hyperintense/hyperdense capsule with hypointense/hypodense core on brain magnetic resonance imaging (MRI) and computed tomography (CT) scan images respectively. There was oedema of the surrounding uninvolved brain parenchyma. The proximity of the lesion to the frontal superior sagittal sinus (SSS) led to suspicion of an abscess involving the SSS and an aneurysm of the SSS as a possible differential diagnosis.

Empirical broad-spectrum antibiotic therapy was instituted and patient was worked-up for emergency surgical evacuation. He had an episode of generalised tonic-clonic seizures shortly before the surgery and was administered a loading dose of intravenous phenytoin. He was noticed to be diuretic and was administered desmopressin.

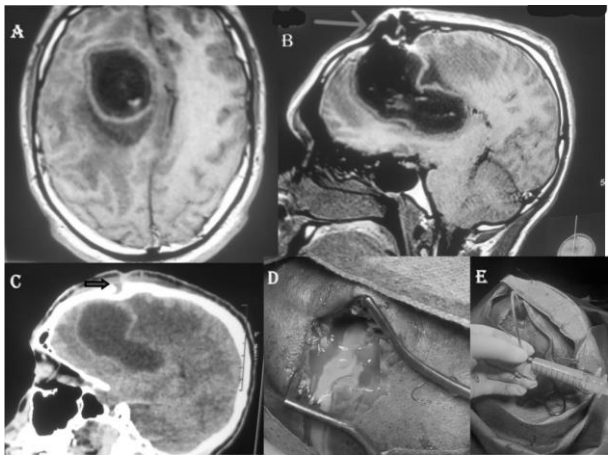

Figure 1 A-E: Cerebral abscess from impalement injury with a nail.

A: MRI Brain, axial cut of T1W sequence showing paramedian frontal abscess with significant midline shift. **B**: Sagittal view of the MRI (same sequence) showing point of entry of the impaled nail which had been extracted by non-experts before presentation (red arrow). **C**: Non-contrast sagittal CT reconstruction demonstrating a frontal bone defect and underlying abscess. **D-E**: intraoperative view of mini-craniectomy with abscess evacuation.

Surgical evacuation was done on the same day of presentation. He had a right-sided frontal paramedian mini-craniectomy under general anaesthesia. A linear incision was made incorporating the puncture wound and deepened to expose the skull defect. A paramedial burr hole was sited and widened with Kerrison rongeur to incorporate the skull fracture and expose the SSS medially. There was a dural defect with ??granulation tissue situated about 5mm from the SSS. Durotomy was done and directed laterally from the dural defect. There was egress of thick, yellowish, foul-smelling pus under pressure. A size-10 nasogastric tube was guided through virgin scalp into the abscess cavity and about 650mls of pus was evacuated (Fig 1d-e). Samples for microbiology analyses and sensitivity testing was taken. The

abscess cavity was gently irrigated with normal saline to which 0.32mg/ml of gentamycin was added. The wound was closed in layers with the nasogastric tube left in situ and secured as a passive drain to be removed when inactive.

Post-operatively, he was admitted to the intensive care unit (ICU) with a Glasgow Coma Score of 12 (E3V4M5). He was administered triple antibiotic therapy with Ceftriaxone, Gentamycin and Metronidazole, Phenytoin for seizure prophylaxis, antipyretics, steroids and intranasal oxygen.

Second day post-operatively, his level of consciousness dropped with Glasgow Coma Score of 9/15 necessitating intubation and ventilation. The post- operative period was turbulent.

He died on the third post-operative day. Culture and sensitivity results yielded Staphylococcus aureus, Escherichia coli Anaerobic culture was negative.

Discussion

Impalement injuries to the head are rare but serious and potentially life-threatening. They constitute about 0.3% of all head injuries and require emergency surgical intervention.[9] Depending on the location, the spectrum of injury severity can range from minor to life-threatening.

The list of impaled objects reported in literature include, but are not limited to nails, knives, spears, wooden chopsticks, brush, scissors, crowbar, pitch fork prongs, door keys, fishing harpoon, rotor fan blade, grinder tool, ceramic stone, iron rod, hunting arrow and screwdrivers[8, 10-12] Most of these injuries in adults follow some form of assault while those in children are mostly accidental.[8, 12]. The rarity of impalement injuries to the cranium has been partly attributed to the relative small size of the head compared to the rest of the body and the protective reflexes in the face that allow the victim to move away from the injurious objects.[9]

The management of impalement brain injury presents peculiar challenges because of the injury complexity, associated neurological damage and functional impairment, as well as the risk of intracranial infection .[8]

Brain abscess is a rare but potentially devastating complication of cranial impalement injuries that often follow late presentation or inadequate treatment. The exact frequency is however not established due to insufficient data. Generally, brain abscesses from penetrating traumatic brain injuries develop often from retained foreign mater and debris that were driven-in during the trauma, and in patients who neither received adequate antibiotic prophylaxis at early presentation nor appropriate intervention following late presentation to the hospital.[13]

The most common bacterial pathogens isolated following impalement injuries include Staphylococcus aureus, Streptococcus pneumoniae, Escherichia coli and anaerobic organisms.[9, 13] Most patients in published series presented within hours to one-week post-injury and had the impaled object in-situ.[8, 9] Our index patient however presented 3-months post-injury after having the offending object removed by an unqualified person who did not pay attention to, nor take the necessary precautions to prevent infection.

The management of impalement brain injuries with retained object requires that retrieval of the culprit weapon or object be removed in the operating room setting, in a controlled manner, usually by a circumferential craniotomy incorporating the object. Preoperatively, brain CT scan with angiography and/or venography provides information about the depth of penetration, presence or absence of vascular injuries, associated haematomas and penetrating bone or foreign body fragments. The information garnered preoperatively maya inform the surgeon of the need for vascular interventions or larger craniotomy to evacuate significant haematomas. The role of brain MRI in this setting is remote, as a brain CT scan with angiogram provides all the information needed pre-operatively, is faster and cheaper to perform. The possibility of ferromagnetic matter being present in the impaled object rules out MRI as a first imaging modality of choice also.

It is established that the anatomy of the rostral superior sagittal sinus varies, and hypoplasia does occur in about 4.3% to 7%.[14-17] In our patient, the diagnosis of cerebral abscess was made with an MRI before presentation. We entertained the possibility of a traumatic aneurysm based on the outline of the lesion though venogram could not be done for financial reasons. Patients in the low- and middle-income countries (LMICs) often pay out-of-pocket for treatment due to low health insurance coverage. The country of the authors falls within this category.[3, 18-20]. The probability that the index patient's injury

may have involved a cult clash contributed to late presentation as victims of injuries following illegal activities like robbery and cultism, in a bid to avoid the arm of the law, prefer to seek care outside formal hospital settings till major complications set in.

Intraoperatively, impalement injuries generally require a mini-craniectomy and adequate debridement under prophylactic antibiotic cover. Necrotic and devitalized brain tissue should be excised to reduce infection risk as these areas are often impregnable by antibiotics. In the event of an abscess complicating the case, or late presentations, it is recommended that broad spectrum empirical antibiotic therapy be instituted pending sensitivity results. Abscess evacuation is often required as an emergent procedure. Antibiotic therapy may subsequently be tailored to microscopy and sensitivity results and continued for 6 to 8-weeks with at least 4-weeks of parenteral administration.[3]

In our environment, cultures are often negative due to high rate of antibiotic abuse. In this scenario, we continue the broad-spectrum empirical antibiotic therapy till symptoms abate. This is administered parenterally for the first 4-weeks followed by 2 weeks of oral therapy.[19-21] The prevalence of anaerobes and difficulty in isolating them in cultures informs our routine addition of metronidazole to our broad-spectrum regimen even when the cultures are negative.[18]

The location of this lesion along the midline with involvement of the superior sagittal sinus could have led to venous stasis and formation of sinus thrombi that could dislodge and cause early post-operative death. For our patient, anticoagulation therapy was commenced two days after surgical evacuation of the cerebral abscess considering the risk of bleeding.

Conclusions

Brain abscesses complicating impalement injury to the brain are rare but potentially devastating, and require prompt medical attention. Early diagnosis and optimum treatment by qualified professionals are crucial to prevent severe or fatal neurological sequalae.

References

1. Chen, M., Low, D.C.Y., Low, S.Y.Y., Muzumdar, D. and Seow, W.T., Management of brain abscesses: where are we now? Childs Nerv Syst, 2018. 34(10): p. 1871-1880.
2. Kothari, M., Goel, A. and Muzumdar, D., Brain abscess: Heuristics, principles, pathobiology, practice. Neurol India, 2015. 63(3): p. 329-37.
3. Kanu, O.O., Ojo, O., Esezobor, C., Bankole, O., Olatosi, J., Ogunleye, E., et al., Pediatric brain abscess - etiology, management challenges and outcome in Lagos Nigeria. Surg Neurol Int, 2021. 12: p. 592.
4. Arlotti, M., Grossi, P., Pea, F., Tomei, G., Vullo, V., De Rosa, F.G., et al., Consensus document on controversial issues for the treatment of infections of the central nervous system: bacterial brain abscesses. Int J Infect Dis, 2010. 14 Suppl 4: p. S79-92.
5. Brouwer, M.C. and van de Beek, D., Epidemiology, diagnosis, and treatment of brain abscesses. Curr Opin Infect Dis, 2017. 30(1): p. 129-134.
6. Na, K.Y., Jang, J.H., Sung, J.Y., Kim, Y.W. and Park, Y.K., Actinomycotic brain abscess developed 10 years after head trauma. Korean J Pathol, 2013. 47(1): p. 82-5.
7. Winter, A. and Shoshkes, M., Brain abscess and head trauma. JAMA, 1961. 176: p. 1039-41.
8. Yusuf, A.S., Mahmud, M.R., Alfin, J.D. and Adeleke, N.A., Clinical Presentation and Outcome of Impalement Craniocerebral Injuries - A CASE SERIES. J West Afr Coll Surg, 2017. 7(2): p. 112-123.
9. Koko, A.M. and Lasseini, A., Impalement brain injury: report of five consecutive clinical cases. Egyptian Journal of Neurosurgery, 2020. 35(1): p. 5.
10. Onimisi, J.A., Apollos, G.D., Mesi, M. and Sale, D., Cranial Impalement of a Falling Fence Spike in a Child: A. Journal of Surgery, 2016. 4(2): p. 31-34.
11. Aremu, S.K., Makusid, M.M. and Ibe, I.C., Oro-cranial penetrating pencil injury. Annals of Saudi medicine, 2012. 32(5): p. 534-536.
12. Damm, A., Lauritsen, A.Ø., Klemp, K. and Nielsen, R.V., Transorbital impalement by a wooden stick in a 3-year-old child. Case Reports, 2015. 2015: p. bcr2015211885.
13. Ganga, A., Leary, O.P., Sastry, R.A., Asaad, W.F., Svokos, K.A., Oyelese, A.A., et al., Antibiotic prophylaxis in penetrating traumatic brain injury: analysis of a single-center series and systematic review of the literature. Acta neurochirurgica, 2023. 165(2): p. 303-313.
14. Ruíz, D.S.M., Fasel, J. and Gailloud, P., Unilateral hypoplasia of the rostral end of the superior sagittal sinus. American journal of neuroradiology, 2012. 33(2): p. 286-291.
15. Koko, A. and Alyafei, T., Case report of coexistence of two variant anatomy, hypoplastic rostral superior sagittal sinus and hypoplastic right side transverse sinus and internal jugular vein. Open J Clin Med Images, 2022. 2(1): p. 1040.
16. Yasmin, K., Al-Qureshi, F.T., Islam, M.M., Sultana, A. and Ony, T.A., Anatomical Variations of the Superior Sagittal, Transverse and Sigmoid Dural Venous Sinuses in the Cerebral MRV Images of Adult Bangladeshis. Sch J App Med Sci, 2022. 4: p. 485-490.
17. Pallewatte, A., Tharmalingam, T. and Liyanage, N., Anatomic variants and artefacts in non enhanced MRV–Potential pitfalls in diagnosing cerebral venous sinus

thrombosis (CVST). Sri Lanka Journal of Radiology, 2016. 2(1).
18. Kanu, O., Asoegwu, C., Adebayo, B., Ukponmwan, E., Jolayemi, E., Bamigboye, B., et al., Intracranial Complications of Otitis Media in Adult Nigerians–An Institutional Experience.
19. Kanu, O.O., Esezobor, C.I., Ojo, O.A., Asoegwu, C.N., Nnoli, C., Dawang, Y., et al., Infantile supratentorial subdural empyema managed by percutaneous aspiration: an outcome study in a Nigerian city. Sudanese Journal of Paediatrics, 2019. 19(1): p. 37.
20. Kanu, O.O., Nnoli, C., Olowoyeye, O., Ojo, O., Esezobor, C., Adeyomoye, A., et al., Infantile subdural empyema: The role of brain sonography and percutaneous subdural tapping in a resource-challenged region. Journal of neurosciences in rural practice, 2014. 5(4): p. 355.
21. Jolayemi, E.O., Bankole, O.B., Ojo, O.A., Bamigboye, B., Adebayo, B.O., Arekhandia, B.J., et al., Contemporary management of intracranial subdural empyema: an institutional experience. Journal of West African College of Surgeons, 2022. 12(3): p. 56-63.

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Endovascular treatments, predictors and outcomes of cerebral aneurysm. A systematic review

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aneurysm, endovascular, vasospasm, surgical techniques, therapy, coils, clips

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ABSTRACT

Background: Recent studies in surgical techniques have significantly transformed therapeutic approaches, leading to substantial decreases in morbidity and mortality rates. Differential diagnosis plays a pivotal role in determining the most suitable surgical strategies for addressing aneurysms. Historically, clipping has been considered a longstanding tradition in the vascular field between 1937 and 1975, pioneered by Microneurosurgery pioneers Yasargil and Fox.

Methods: This study followed the PRISMA (Preferred Reporting Items for Systematic Reviews), and the statistical analysis was performed using IBM SPSS Statistics for Windows, Version 26.0 (released 2020; IBM Corp., Armonk, New York, United States). And EXCEL: A comprehensive review of neurosurgical care for cerebral aneurysms in controlling subarachnoid haemorrhage through endovascular clipping and coiling was conducted by the followers' methods used on aneurysm patients. Databases like Science Direct and PubMed were utilized, and articles were searched from the earliest available dates up to January 2024. Tables 1-2-3 are shown. The search focused primarily on publications in English, adhering to PRISMA guidelines. The search process for scientific papers, including meta-analysis, centred on PubMed and Science Direct.

Results: A total of 45,223.00 patients with aneurysms who underwent endovascular procedures or surgical methods involving clipping or colling are displayed in Table 1. Of these, 2769 patients had ruptured aneurysms associated with subarachnoid haemorrhage, while 985.00 patients did not rupture. In Table 2, 6090.14 patients with

aneurysms are evaluated, and in Table 3, 36,251.00 patients with coils 31,502.00 and clips 28,803.00 were assessed.

Conclusion: From the synthesis of various reviewed studies, effective management strategies involve early detection of bleeding using diagnostic tests like MRI or CT angiography, considering neurological functioning levels assessed through scales such as the Fisher scale or the Hunt and Hess scale for subarachnoid haemorrhage or potential stroke.

INTRODUCTION

Recent studies in surgical techniques have significantly transformed therapeutic approaches, leading to substantial decreases in morbidity and mortality rates [1]. Differential diagnosis plays a pivotal role in determining the most suitable surgical strategies for addressing aneurysms. Historically, clipping has been considered a longstanding tradition in the vascular field between 1937 and 1975, pioneered by Microneurosurgery Pioneers Yasargil and Fox [1]. Yasargil and Fox's introduction of the microscope paved the way for today's recognized safe and effective exposure of the polygon of Willis. The primary objective of clipping was to achieve direct access to the aneurysm through an open craniotomy and isolate it from the surrounding parenchyma. [2]. The aneurysm development process begins within the first week of induction and progresses through mastoid cell activation in the fourth week, ultimately leading to rupture. Surgical intervention aims to minimize infiltration and inflammation, although its impact on aneurysm formation is limited [3]. Cerebral strokes (MI) exhibit a significant frequency of 282.9 per 100,000 individuals, with 106-110 thousand cases occurring annually, predominantly affecting working-age adults (35.5%) [4]. Aneurysms and vascular abnormalities contribute substantially to brain hemorrhages, encompassing approximately 30 different aneurysm types and nearly a dozen types of vascular abnormalities. Their etiology, pathophysiology, clinical symptoms, diagnosis, therapy, and prognosis vary significantly, necessitating further investigation. [5]. Aneurysm accounts for 70–85% of non-traumatic subarachnoid hemorrhages (SAH), playing a substantial role in hemorrhagic stroke etiology. Treatment objectives focus on complete occlusion of the AMs while preserving blood flow in maternal, branching, and perforating veins. Table 1 illustrates the short frequency of aneurysm rupture or unruptured. [6].

The objectives of this study are to evaluate and demonstrate the significance and advantages of managing aneurysms in controlling subarachnoid hemorrhages, as well as compare the effectiveness of clipping and coiling through endovascular therapy.

MATERIALS AND METHODS

Literature search strategy

This study followed the PRISMA (Preferred Reporting Items for Systematic Reviews). The statistical analysis was performed using IBM SPSS Statistics for Windows, Version 26.0 (released 2020; IBM Corp., Armonk, New York, United States). And EXCEL: A comprehensive review of neurosurgical care for cerebral aneurysms in controlling subarachnoid hemorrhage through endovascular clipping and coiling was conducted by the followers' methods used on aneurysm patients. Databases like Science Direct and PubMed were utilized, searching from the earliest available articles up to January 2024. Tables 1-2-3 are shown. The search focused primarily on publications in English, adhering to PRISMA guidelines. The search process for scientific papers, including meta-analysis, centered on PubMed and Science Direct. (refer to Fig. 1).

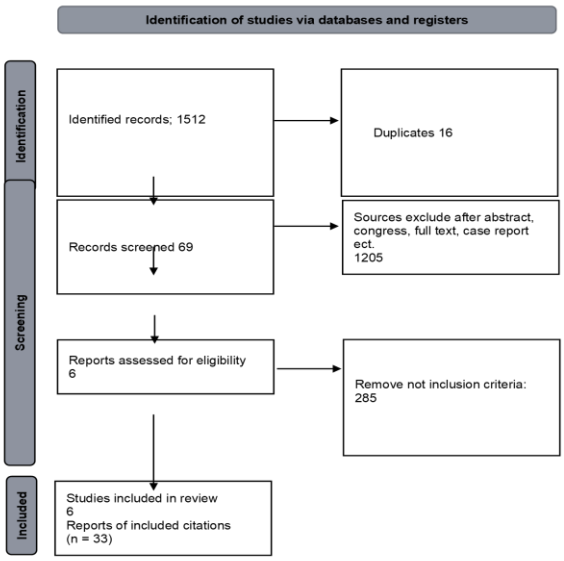

Figure 1. Flowchart systematic review.

Search strategy development

Comprehensive search strategy keywords

The comprehensive search strategy incorporated the following MeSH terms:

(("Intracranial Aneurysm/classification"[Mesh] OR "Intracranial Aneurysm/complications"[Mesh] OR "Intracranial Aneurysm/diagnosis"[Mesh] OR "Intracranial Aneurysm/diagnostic imaging"[Mesh] OR "Intracranial Aneurysm/epidemiology"[Mesh] OR "Intracranial Aneurysm/etiology"[Mesh] OR "Intracranial Aneurysm/genetics"[Mesh] OR "Intracranial Aneurysm/immunology"[Mesh] OR "Intracranial Aneurysm/mortality"[Mesh] OR "Intracranial Aneurysm/pathology"[Mesh] OR "Intracranial Aneurysm/physiopathology"[Mesh] OR "Intracranial Aneurysm/prevention and control"[Mesh] OR "Intracranial Aneurysm/rehabilitation"[Mesh] OR "Intracranial Aneurysm/surgery"[Mesh] OR "Intracranial Aneurysm/therapy"[Mesh])) AND ("Intracranial Aneurysm/blood"[Mesh] OR "Intracranial Aneurysm/embryology"[Mesh] OR "Intracranial Aneurysm/enzymology"[Mesh] OR)

Study inclusion criteria

The studies considered needed to meet specific inclusion criteria, including the development of both ruptured and unruptured cerebral aneurysms, involvement of the adult population by clipping and coiling, utilization of pterional craniotomy, middle meningeal artery involvement, subarachnoid and epidural hemorrhage, pre- and post-clipping risk factors, calcification and epileptic mechanisms, and risks associated with vasospasm.

Study exclusion criteria

Studies involving pediatric populations found cases of patients not receiving timely treatment on time, resulting in death due to ruptured aneurysms, sudden death cases with unknown bleeding, and recurring bleeding and instant mortality.

Data extraction

Data extraction from studies that met the inclusion criteria involved the use of standardized search systems. This included demographic data, intervention and control details, and methodologies relevant to the study's scope, focusing on cerebrovascular diseases such as intracranial aneurysms.

Potential bias

Every report was evaluated for bias and applicability using Kaplan's survival approach and the paths for endovascular or surgical therapy of aneurysms. In order to ascertain whether the data sets under examination included aneurysms that are typical of the adult population, published research data were obtained. The evaluation was centered on the term "aneurysm treatments and outcomes" and was founded on widely acknowledged practices for therapeutic therapy, diagnosis, and prognosis.

Statistical analysis

Summary statistics such as mean differences and odds ratios (OR) were employed for relevant occurrences. The weighted mean difference and 95% confidence interval (CI) defined the outcomes of interest. A random effects model estimated outcome measures using individual data from included studies. The statistical analysis was performed using Review Manager Rayyan software version 5.3, Excel, with statistical significance set at a P value of 0.05.

RESULTS

A total of 45,223.00 patients with aneurysms who underwent endovascular procedures or surgical methods involving clipping or colling are displayed in Table 1. Of these, 2769 patients had ruptured aneurysms associated with subarachnoid hemorrhage, while 985.00 patients did not rupture.

Table 1. The most common major lesions associated with subarachnoid hemorrhages were observed around the meningeal artery in several investigations that examined aneurysms with and without rupture.

Year	Patients	Rupture Aneurysm-SAH	Unrupture
2014 Backes et al. [63].	124	88	36
2018 2021 van der Kamp et al. [64].	312	25	226
2022 Yamanouchi et al. [65].	113	10	18
2020 Rinaldo et al. [66].	568	157	411
2015 Hishikawa et al. [67].	1577	8	182
2020 Tanioka et al. [68].	188	112	112

In Table 2, 6090.14 patients with aneurysms are evaluated, and in Table 3, 36,251.00 patients with coils 31,502.00 and clips 28,803.00 were assessed. From 2004 to 2014, a total of 79,600 patients with intracranial aneurysms underwent endovascular coiling, whereas 42,256 patients received surgical interventions in America. Surgical and endovascular methods were used on aneurysm patients,[2]. The evolution of treatment options for specific disorders was considered, and in 2005, vascular patency intraoperatively was initially assessed.

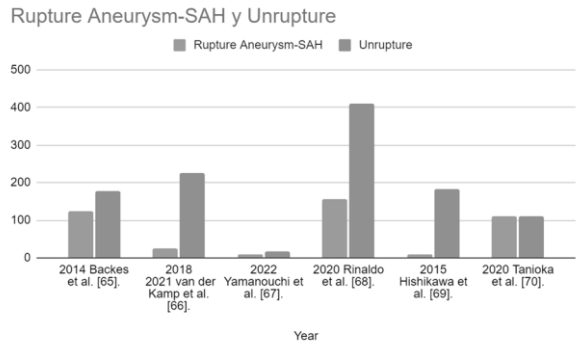

Figure 2. Diagram showing the study group's intervention for both ruptured and unruptured aneurysms.

Early studies by Raabe et al. involving 114 patients demonstrated the efficiency of Indocyanine Green Videoangiography (ICGVA), displaying feedback [9]. However, this approach poses a risk of ischemia in vascular beds supplied by the proximal artery, warranting caution with occlusion time typically limited to 10-20 minutes [7]. In severe cases, multiple bouts of occlusion with 15-minute reperfusions have been deemed safe and effective [9]. A study on intraoperative hypothermia for aneurysm surgery concluded that neuroprotective hypothermia during surgery did not improve neurological outcomes after craniotomy in patients with SAH of WFNS grade 1-3 [2]. Advancements in microinstrument designs and clamp techniques have refined original microsurgical techniques, ranging from modified skull base approaches to minimally invasive and endoscopic surgeries. These advancements are associated with increased neuroprotection and innovative approaches for managing complex lesions intraoperatively [7].

Various endovascular approaches for proximal control, including intraluminal balloons, have been developed, resulting in more precise techniques and better outcomes [5–13]. The International Trial of Ruptured Intracranial Subarachnoid Aneurysms (ISAT) in 2002 demonstrated better survival outcomes for aneurysms treated with endovascular coils than those treated with surgical clipping, leading to a significant increase in endovascular-treated aneurysms. [15].

While clipping is an invasive procedure, coiling, being minimally invasive, has shown reduced vasospasm and rebleeding after subarachnoid hemorrhage control. The role of intra-to-intra shunting in aneurysm surgery has gained attention, with discussions on its benefits [15]. Shunting approaches involving revascularization and anastomosis of distal efferent branches have been considered more technically challenging but potentially associated with higher rates of aneurysm obliteration and shunt patency [8]. Shown in figure 4.

Table 2. Patients' endovascular management of endovascular clipping vs coiling.

Authors/ Year	Study type	No. Patients	SAH Patients intervention	Procedure	Predictor of rupture	95% CI	P-value
Molyneux A. et al. 2013. [14]	RCS	1644	81%	Endovascular coiling group 674 (83%) Neurosurgical clipping group 657 (79%).	Endovascular group, 504/657 (77%)	1·35, 95% CI 1·06-1·73	< 0.002
Molyneux A. et al. 2009 [15]	RCT	2143	11%	Endovascular coiling 83% Neurosurgical clipping 82%	coiling vs clipping group (relative risk 0.61-0.98;	0.77, 95% CI 0.61-0.98	< 0.0001
Dorhout Mees S. et al. 2012. [16].	RCT	2,143	99.6%	DCI 2 months 98.8% Clipped /8.7%	Clipping vs coiling: OR 1.01–1.5	(95% CI 1.01-1.51)	< 0.005

Darsaut T. at al. 2017 [17].	RCT	260	22.2%	The 1-year surgical surgical clipping 104 patients 5/48 (10.4%/4.5%/22.2%).	surgical clipping, 10/56	OR: 0.54 (0.13-1.90	< 0.0001
Laiwalla A. et al. 2017. [18]	CCT	21	8.6% vs. 47.5%	clipping vs coiling,	19.7%	OR: 5.17; 95% CI: 1.21–25.02	< 0.05
Darsaut T et al. 2022. [19].	RCT	1010	82%	18/60	18%	89%, 95% CI 82%–93%	< 0.003
Raymond J. et al. 2023 [20].	RCT	1010	116	pre Embolization 84%	70%	15 (14%, 95% CI 8%-22%	< 0.05

Table 3. According to various study variations, intracranial aneurysms are found in the vicinity of the following anatomical structures: the posterior communicating artery (25–35%), the anterior communicating artery (30–35%), the middle cerebral artery bifurcation (20%), the basilar artery (5%), the posterior wall or the terminal of the internal carotid artery (ICA), the superior cerebellar artery (SCA), and the posteroinferior cerebellar artery (PICA). [66].

Author	Kind of study	year	No. Patients	Coil	Clip	Follow up	Mortality	P-value
Zanaty et al. [23].	RCT	2016	1	182	70	180 days	13.2%	0.001
Berro et al. [24].	RCT	2019	187	88	90	N/A	N/A	0.04
Choi et al. [25].	RCT	2016	178	8	30	4–12 months	3	0.001
Darsaut et al. [26].	RCT	2019	103	48	55	1 year	N/A	N/A
Ayling et al. [27].	RCT	2015	212	212	181	3 months	N/A	0.0024
Kelly et al. [28].	Retrospective	2010	2342	778	2342	N/A	N/A	0.04
Bekelis et al. [29].	Retrospective	2016	3210	2004	1206	1-year	Clipping 36.3% Coiling 41.0%	0.03
McDonald et al. [30].	Retrospective	2014	5229	1227	1227	1-year	Clipping 23.5%- 30.9% Coiling 22%	0001
Zhao et al. [31].	Prospective	2016	262	133	129	12 months	N/A	.030
Yu et al. [32].	Retrospective	2007	169	80	89	6 and 18 months	coiling group (12/80 clipping group (30/89, 34%	0.004
Shen et al. [33].	Retrospective	2019	94	29	65	3-month and 6-month	coiling group (38% vs. 15%,	0.015
Heit et al. [34].	Retrospective	2017	100	50	50	3 months.	Clipping 3 (6.0) Coiling 7 (14.0)	03
Koh et al. [35].	Retrospective	2013	133	23	33	3-month and 6-month	16 (18.0%) ruptured intracranial aneurysms.	0.01
Scheller et al. [36].	RCT	2018	99	45	54	N/A	N/A	0.001
Li et al. [37].	Retrospective	2017	162	77	85	2 Months to one year	25%–30%	N/A
Varelas et al. [38].	Retrospective	2006	188	48	135	N/A	N/A	0.5
Deutsch et al. [41].	Retrospective	2018	6555	15350	6555	1-year	2.96 vs. 2.44	0.0001
Lusseveld et al. [40].	Retrospective	2002	44	44	44	N/A	N/A	0.28
Ryttlefors et al. [41].	Retrospective	2008	278	138	140	1-year	N/A	0.001

Zhang et al. [42].	Retrospective	2012	198	76	122	N/A	N/A	N/A
Wadd et al. [43].	Retrospective	2015	140	70	70	1-year	clipping (n=3, 4.3% coiling (n=1, 1.4%	0.310
Liao et al. [44].	Retrospective	2013	100	56	44	12 Month	32.0% and 27.0%	0.202
Hoh et al. [45].	Retrospective	2010	9635	3564	5783	N/A	N/A	0.0001
Klompenhouwer et al. [46].	Retrospective	2011	403	230	173	33.9 months	N/A	084
Zhao et al. [47].	Retrospective	2019	111	46	65	N/A	N/A	0.028
Taweesomboonyat et al. [48].	Retrospective	2019	189	84	105	6 Months	28% and 31%	0.734
Brunken et al. [49].	Retrospective	2009	598	145	370	1 year	clip: 51.1/13.8 % coil: 45.5 / 10.3 % non-rupt. A: 88.2/0 % coil: 88.5/1.3 %	< 0.01
Kim et al. [50].	Retrospective	2008	73	37	35	4-72 months	N/A	.05
Hoh et al. [51].	Retrospective	2011	10 899	4306	6593	N/A	N/A	.001
Zaidat et al. [52].	Retrospective	2009	216	98	118	N/A	N/A	.03
Li et al. [53].	Retrospective	2012	186 /192	94	92	12 months	13.33%	0.05
Rabinstein et al. [54].	Retrospective	2003	415	76	339	6 months	N/A	0.001
Liu et al. [55].	Retrospective	2013	642	281	361	642	N/A	0.01
Niskanen et al. [56].	Retrospective	2004	171	68	103	12-month	N/A	N/A
Koivisto et al. [57].	RCT	2000	109	52	57	12 months	Hunt and Hess grades I–II (1716 days; 95% CI 1600 to 1832 days) ONE patients died.	0.025
Gross et al. [58].	Retrospective	2014	258	52	203	N/A	N/A	0.01
Molyneux et al 59].	RCT	2005	2143	1073	1070	1 year	243 of 793 (30.6%)	0.0019
Suzuki et al. [60].	Prospective	2013	579	297	282	N/A	N/A	N/A
McDougall et al. [61].	Retrospective	2012	725	233	238	One year	1.24%	0.02

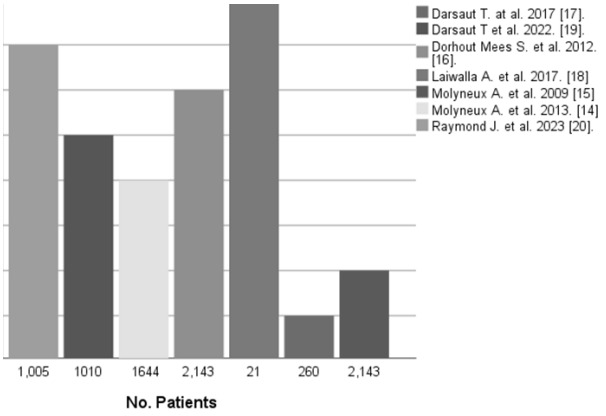

Figure 3. Graphic representation of Patients with Aneurysm and SAH Treated by Clipping and coiling.

Discussion

45,223.00 patients with aneurysms who underwent endovascular procedures or surgical methods involving clipping or colling are displayed in Table 1. Of these, 2769 patients had ruptured aneurysms associated with subarachnoid hemorrhage, and 1,127.00 patients did not rupture.

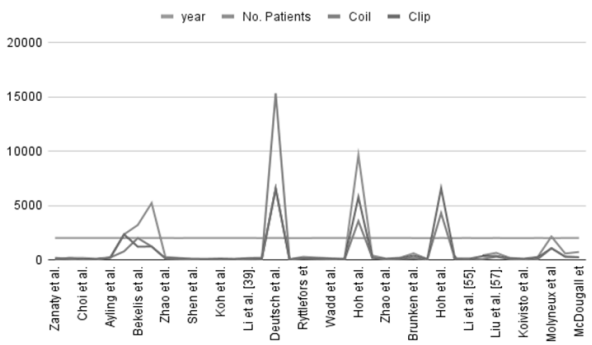

Figure 4. Endovascular and surgical techniques applied to aneurysm.

In Table 2, 6090.14 patients with aneurysms are evaluated, and in Table 3, 36,251.00 patients with coils 31,502.00 and clips 28,803.00 were assessed. Advancements in neuromonitoring play a pivotal role in enhancing surgical safety within the field of neurosurgery. Indocyanine Green Infrared Videoangiography (ICGVA) has gained attention for its recent development as a quality control adjunct. However, concerns have been raised regarding its exclusive use as the sole technique for intraoperative assessment during aneurysm clipping, as highlighted in studies by Cekirge H. et al. [5].

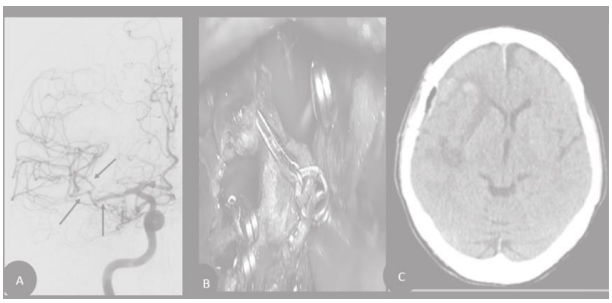

Figure 5. a) Intraoperative clip of the aneurysm with recurrence, **b)** postoperative with images of the M1-M2 and MCA segments, with active vasospasm, **c)** Post operatory computed tomography example after treated the patient.

In cerebrovascular neurosurgery, the use of extracranial-intracranial (EC-IC) or intracranial-intracranial (IC-IC) shunt methods has distinct clinical indications and technical approaches. For instance, Crowell-/Yasargil (EC-IC) first-shunting involves anastomosing the extracranial artery to the intracranial artery's distal branch carrying the aneurysm, aiding in the safe closure of the aneurysm's originating artery and subsequent obliteration in challenging clipping cases. The (EC-IC) bypass can be categorized into low-flow and high-flow bypass techniques [4, 11]. The low-flow shunt, connecting the superficial temporal artery (TSA) to the intracranial artery, is favored due to its smaller and gradual increase in inflow rate, reducing the risk of hyperperfusion injury compared to high-flow shunting [4].

Studies by Darflinge J. et al. [6] emphasize the safety of using EC-IC shunting for massive or complex aneurysms, particularly giant aneurysms, which often necessitate surgical removal to alleviate symptoms caused by their bulk effect. Recent research has linked increased usage of bypass procedures to improved patient outcomes, with lower surgical mortality rates and high graft patency in bypasses, even among patients with giant aneurysms [1, 4]. The surgical goal primarily aims for total lesion excision, although partial resections are sometimes employed for functional, cosmetic, or safety reasons [3].

Research comprising 138 individuals (19.6%) found a correlation between severe spasms and a bad prognosis based on cerebral retardation or late ischemia. As a result, in cases of vasospasm, C-reactive protein levels were higher, and in grade IV hemorrhage, the D dimers coincided with those of Fisher, a study that focused on the first 24 hours following the hemorrhage. over a span of six years. [69]. The risk of perforation was significantly higher in ruptured aneurysms compared to ruptured aneurysms, from 4.1% to 0.5% with a $p = 0.5\%$, $P < 0.001$, 38% for ruptured aneurysms, and 29% for unruptured ones, according to a study based on 17 reports on aneurysm perforations that complicated therapy with detachable aneurysms. demonstrating a similarity with 39% of spinal cord perforations and 33% of microcatheter perforations, as well as a morbidity and mortality. [70]..

Limitations

In certain measures, the use of intraoperative hypothermia for surgical intervention of aneurysms under neuroprotective hypothermia had no effect or improved postoperative neurological outcomes after the use of craniotomy in patients with subarachnoid hemorrhage. While in a report of 17 studies about aneurysm perforations during surgery as complications in detachable aneurysms with a 39% similarity in spinal cord perforations and microcatheter perforations increasing the mortality rate.

Conclusions

From the synthesis of various reviewed studies, effective management strategies involve early detection of bleeding using diagnostic tests like MRI or CT angiography, considering neurological functioning levels assessed through scales such as the Fisher scale or the Hunt and Hess scale for subarachnoid hemorrhage or potential stroke. Prompt actions can prevent adverse neurological outcomes such as aneurysm rupture, subarachnoid

hemorrhage, hemiparesis, or cerebral decortication following brain herniation. The evolution of these approaches over time indicates a synergistic relationship between microsurgery and endovascular therapies, which are now integrated with state-of-the-art equipment. Based on the insights from the reviewed studies, the following recommendations are suggested:

- Mini-pterional or open Craniotomy Pterional Clips are recommended for MCA reconstruction.
- Sealing off aneurysms using a flexible wire and catheter is advised.
- In cases of massive right MCA calcified aneurysms, consider employing an interposition shunt from the saphenous vein.
- Post-clipping, a decrease in vasospasm levels is beneficial in preventing bleeding and potential new subarachnoid hemorrhages, thereby improving the overall survival rate.

Future suggestions align with the evolving new materials, techniques, and advancements in the field, emphasizing the importance of tailored and swift intervention strategies in mitigating the risks associated with aneurysms and subarachnoid hemorrhages. Continued research and modern, nuanced strategies aim to further enhance patient outcomes and minimize associated neurological complications.

Abbreviations

ISAT: International subarachnoid aneurysm trial
ICGVA: Videoangiography
AVMs: Arteriovenous malformation
MCA: Middle cerebral artery
SAH: Subarachnoid hemorrhage
WFNS: World Federation of Neurological Surgeons
EC-IC: Extracranial-intracranial Superficial temporal artery
MRI: Magnetic resonance imaging
CT: Computed tomography

References

1. Furukawa H, Wada K, Tada Y. et al Mast cell promotes the development of intracranial aneurysm rupture. Stroke. 2020 Nov; 51(11): 3332–3339. doi: 10.1161/STROKEAHA.120.030834
2. Lauzier D, Huguenard A. et al. A review of technological innovations leading to modern endovascular brain aneurysm treatment. 2023 Apr 11. doi: 10.3389/fneur.2023.1156887
3. Bechan R, Sprengers M, Majoie C. et al. Stent-assisted coil embolization of intracranial aneurysms. 2016 Mar;37(3):502-7. DOI: 10.3174/ajnr.A4542
4. Brilstra E, Rinkel G. et al. Treatment of intracranial aneurysms by embolization with coils: 1999 Feb;30(2):470-6. DOI: 10.1161/01.str.30.2.470
5. Cekirge H, Yavuz K, Geyik S. et al. Clinical and angiographic follow-up results in 800 consecutive patients. 2011 Apr;114(4):944-53. DOI: 10.3171/2010.3.JNS081131
6. Darflinge J, Chao K. et al. Using the barrel technique, stent to treat a wide neck MCA bifurcation aneurysm. 2015 Jul;8(3):25-7. PMCID: PMC4535603
7. Dewan M, Rattani A, Fieggen G. et al. GN the current capacity and deficit in the provision of essential neurosurgical-care. 2018 Apr 27;130(4):1055-1064. DOI: 10.3171/2017.11. JNS171500
8. Dossani R, Patra D, Kosty J. et al. Early-versus delayed-flow diversion for ruptured -intracranial aneurysms: a meta-analysis. 2019 Jun; 126:4152. DOI: 10.1016/j.wneu.2019.02.044
9. Fiorella D, Gache L, Frame D. et al. How safe and effective are flow diverters for the treatment of unruptured small-medium intracranial-aneurysms. 2020 Sep;12(9):869-873. DOI: 10.1136/neurintsurg-2019-015535
10. Wang D, Su L, Han Y. et al. electrolytically detachable coil-assisted dominant-outflow vein occlusion. 2014 Nov;48(5):576-84. DOI: 10.1016/j.ejvs.2014.08.004
11. Wu J, Bisdorff A, Gelbert F. et al. Auricular arteriovenous malformation: evaluation, management, and outcome. 2005 Apr;115(4):985-95 DOI: 10.1097/01.prs.0000154207.87313.
12. Zou Y, Qiao C, Lin X., et al. Clinical-course of extracranial-arteriovenous malformations. 2020 Mar/Apr;31(2):372-376. DOI: 10.1097/SCS.0000000000006018
13. Lee K, Zhang J, Nguyen V., et al. The-evolution of intracranial-aneurysm-treatment-techniques and future directions. April 2021 45(1):1-25 DOI: 10.1007/s10143-021-01543-z
14. Molyneux A, Birks j, Clarke A. et al The durability of endovascular coiling versus neurosurgical clipping of ruptured cerebral aneurysms. 2015 Feb 21;385(9969):691-7. doi: 10.1016/S0140-6736(14)60975-2.
15. Molyneux A, Kerr R, Birks J. et al. R. of recurrent S.A. death, or dependence and standardized mortality R.after clipping or coiling of an intracranial aneurysm. 2009 May;8(5):427-33. doi: 10.1016/S1474-4422(09)70080-8.
16. Mees S, Kerr R, Rinkel G, Algra A. Occurrence and impact of delayed cerebral ischemia after coiling and after clipping. 2012 Apr;259(4):679-83. doi 10.1007/s00415-011-6243-2.
17. Darsaut T, Findlay J, Magro E. et al. Surgical clipping or endovascular coiling for unruptured intracranial aneurysms. 2017 Aug;88(8):663-668. doi: 10.1136/jnnp-2016-315433.
18. Laiwalla A, Ooi Y, Liou R. et al. The Ef. of L. Remote

Ischemic C. in Patients with AM. Subarachnoid H. 2016 Feb;7(1):42-8. doi 10.1007/s12975-015-0437-3.

19. Darsaut T, Magro E, Bojanowski M. et al. Surgical treatment of brain arteriovenous m. 2022 Sep. DOI link: https://doi.org/10.3171/2022.7.JNS22813.
20. Raymond J, Gentric JC, Magro E. et al. Endovascular treatment of brain arteriovenous m. 2022 Oct. doi: 10.3171/2022.9.JNS22987.
21. Stefini R. et al. aneurysm clipping. January 2016. https://commons.wikimedia.org/wiki/File:Clipped_aneurysm.jpg
22. Pillai P, Karim A, Nanda A. et al. Technical challenges to surgical clipping of aneurysmal. December 2007. doi:10.1186/1752-1947-1-168
23. Zanaty M, Chalouhi N, Starke RM, Daou B, Todd M, Bayman E, Torner J, Hasan D. et al. Short-Term Outcome of Clipping Versus Coiling of Ruptured Intracranial Aneurysms. 2016 Nov. 95:262-269. doi: 10.1016/j.wneu.2016.08.009.
24. Berro D, L'Allinec V, Pasco-Papon A, Emery E, Berro M, Barbier C, et al. Clip-first policy versus coil-first policy for the exclusion of the MCA aneurysms. J Neurosurg. 2019:1–8. 10.3171/2019.5.JNS19373.
25. Choi J, Park J, Kim M, Kim B, Shin Y. Aneurysmal neck clipping as the primary treatment option for both ruptured and unruptured MCA aneurysms. J Korean Neurosurg Soc. 2016. 59(3):269–275.
26. Darsaut T, Roy D, Weill A, Bojanowski M, Chaalala C, Bilocq A. et al. A randomized trial of endovascular versus surgical management of ruptured intracranial aneurysms. Neurochirurgie. 2019. 65(6):370–376. doi: 10.1016/j.neuchi.2019.05.008.
27. Ayling O, Ibrahim G, Drake B, Torner J, Macdonald L. Operative complications and differences in outcome after clipping and coiling of UICA. J Neurosurg. 2015;123(3):621–628. doi: 10.3171/2014.11.JNS141607.
28. O'Kelly C, Kulkarni A, Austin P, Wallace M, Urbach D. The impact of therapeutic modality on outcomes following repair of RIA . Clinical article. J Neurosurg. 2010.113(4):795–801. doi: 10.3171/2009.9.JNS081645.
29. Bekelis K, Gottlieb D, Su Y, O'Malley A, Labropoulos N, Goodney P. et al. Surgical clipping versus endovascular coiling for elderly SAH. J Neurointerv Surg. 2016. 8(9):913–918. doi: 10.1136/neurintsurg-2015-011890.
30. McDonald J, McDonald R, Fan J, Kallmes D, Lanzino G, Cloft H. et al. Comparative effectiveness of ruptured cerebral aneurysm therapies: propensity score analysis of clipping versus coiling. AJNR Am J Neuroradiol. 2014;35(1):164–169. doi: 10.3174/ajnr.A3642.
31. Zhao B, Tan X, Yang H, Li Z, Zheng K, Xiong Y, et al. Endovascular coiling versus surgical clipping for poor-grade ruptured intracranial aneurysms. AJNR Am J Neuroradiol. 2016.37(5):873–878. doi: 10.3174/ajnr.A4649.
32. Yu SC, Wong GK, Wong JK, Poon WS. Endovascular coiling versus neurosurgical clipping for ruptured intracranial aneurysms: significant benefits in clinical outcome and reduced consumption of hospital resources in Hong Kong Chinese patients. Hong Kong Med J. 2007 Aug;13(4):271-8. Epub 2007 Jun 4. PMID: 17592179
33. Shen J, Huang K, Shen J, Zhu Y, Jiang H, Pan J. et al. Clinical efficacy between microsurgical clipping and endovascular coiling in aneurysms. World Neurosurg. 2019.127 e321-e329. 10.1016/j.wneu.2019.02.248.
34. Heit J, Ball R, Telischak N, Do H, Dodd R, Steinberg G. et al. Patient outcomes and cerebral infarction after RACAA. AJNR Am J Neuroradiol. 2017;38(11):2119–2125. doi: 10.3174/ajnr.A5355.
35. Koh K, Ng Z, Low S, Chua H, Chou N, Low S. et al. Management of ruptured intracranial aneurysms in the post-ISAT era. Singapore Med J. 2013;54(6):332–338. doi: 10.11622/smedj.2013127.
36. Scheller C, Strauss C, Prell J, Simmermacher S, Brandt S. Increased rate of ventriculostomy-related hemorrhage following endovascular treatment of ruptured aneurysms. Acta Neurochir (Wien) 2018;160(3):545–550. doi: 10.1007/s00701-018-3471-6.
37. Li J, Su L, Ma J, Kang P, Ma L, Ma L. Endovascular coiling versus microsurgical clipping for patients with ruptured very small intracranial aneurysms. World Neurosurg. 2017;99:763–769. doi: 10.1016/j.wneu.2015.11.079.
38. Varelas P, Helms A, Sinson G, Spanaki M, Hacein-Bey L. Clipping or coiling of ruptured cerebral aneurysms and hydrocephalus. Neurocrit Care. 2006. ;4(3):223–228. doi: 10.1385/NCC:4:3:223.
39. Deutsch B, Neifert S, Caridi J. No disparity in outcomes between surgical clipping and endovascular coiling after ASH. World Neurosurg. 2018:120 e318-e325. 10.1016/j.wneu.2018.08.060.
40. Lusseveld E, Brilstra E, Nijssen P, van-Rooij W, Sluzewski M, Tulleken CA. et al. Endovascular coiling versus neurosurgical clipping in patients with a R. basilar tip aneurysm. J Neurol Neurosurg Psychiatry. 2002. 73(5):591–593. doi: 10.1136/jnnp.73.5.591
41. Ryttlefors M, Enblad P, Kerr R, Molyneux A. International subarachnoid aneurysm trial of neurosurgical clipping versus endovascular coiling. Stroke. 2008.;39(10):2720–2726. doi: 10.1161/STROKEAHA.107.506030.
42. Zhang Q, Zhang X, Wu Q, Shi J, Wang H, Hang C. et al. The impact of microsurgical clipping and endovascular coiling on the outcome of cerebral aneurysms. J Clin Neurosci. 2012;19(8):1115–1118. doi: 10.1016/j.jocn.2011.11.017.
43. Wadd IH, Haroon A, Habibullah, Ansari S, Mukhtar S, Rashid U, Vohra AH. et al. Aneurysmal Subarachnoid Hemorrhage Outcome of Aneurysm Clipping Versus Coiling. Physicians Surg Pak. 2015 Nov;25(11):798-801.
44. Liao C, Huang Y, Fang P, Lee T. Surgical and endovascular treatment for ruptured anterior circulation cerebral aneurysms. Int J Surg. 2013;11(9):998–1001. doi: 10.1016/j.ijsu.2013.05.038.
45. Hoh B, Chi Y, Lawson M, Mocco J, Barker F., 2nd Length of stay and total hospital charges of clipping versus coiling for ruptured and unruptured adult cerebral. Stroke. 2010;41(2):337–342.

doi: 10.1161/STROKEAHA.109.569269.

46. Klompenhouwer E, Dings J, van-Oostenbrugge R, Oei S, Wilmink J, van-Zwam W. Single-center experience of surgical and endovascular treatment of ruptured intracranial aneurysms. AJNR Am J Neuroradiol. 2011;32(3):570–575. doi: 10.3174/ajnr.A2326.
47. Zhao B, Xing H, Fan L, Tan X, Zhong M, Pan Y. et al. Endovascular coiling versus surgical clipping of very SRACAA.World Neurosurg. 2019:126 e1246–50. 10.1016/j.wneu.2019.03.074.
48. Taweesomboonyat C, Tunthanathip T, Kaewborisutsakul A, Saeheng S, Oearsakul T, Riabroi K. et al. Outcome of ruptured posterior communicating artery aneurysm treatment comparing between clipping and coiling techniques. World Neurosurg. 2019:125 e183–8. 10.1016/j.wneu.2019.01.037.
49. Brunken M, Kehler U, Fiehler J, Leppien A, Eckert B. Coiling vs. clipping: hospital stay and procedure time in intracranial. 2009;181(10):989–995. doi: 10.1055/s-0028-1109344.
50. Kim B, Kim D, Shin Y, Chung E, Kim D Suh S. et al. Clinical outcome and ischemic complication after treatment of anterior choroidal artery aneurysm. AJNR Am J Neuroradiol. 2008;29(2):286–290. doi: 10.3174/ajnr.A0806.
51. Hoh B, Nathoo S, Chi Y, Mocco J, Barker F., 2nd Incidence of seizures or epilepsy after clipping or coiling of ruptured and unruptured cerebral. Neurosurgery. 2011;69(3):644–650. doi: 10.1227/NEU.0b013e31821bc46d.
52. Zaidat O, Ionita C, Hussain S, Alexander M, Friedman A, Graffagnino C. Impact of ruptured cerebral aneurysm coiling and clipping on the incidence of cerebral. J Neuroima ging. 2009;19(2):144–149. doi: 10.1111/j.1552-6569.2008.00285.x.
53. Li Z, Wang Q, Chen G, Quan Z. Outcomes of endovascular coiling versus surgical clipping in the treatment of RIA. J Int Med Res. 2012.40(6):2145–2151. doi: 10.1177/030006051204000612.
54. Rabinstein A, Pichelman M, Friedman J, Piepgras D, Nichols D, Toussaint L, Mcclelland R, Fulgham J, Meyer F, Atkison L, Wijdiscks F. et al. Symptomatic vasospasm and outcomes following aneurysmal subarachnoid hemorrhage. 2003. Vol. 98-2- 319–325. https://doi.org/10.3171/jns.2003.98.2.0319
55. Liu H, Wong H, Lee K, Tu Y, Yeh Y, Chou C. et al. Taiwan aneurysm registry: multivariate analysis of two-month, one-year, and two-year outcomes after endovascular and microsurgical treatment. Interv Neuroradiol. 2013;19(1):35–42. doi: 10.1177/159101991301900105.
56. Niskanen M, Koivisto T, Ronkainen A, Rinne J, Ruokonen E. Resource use after subarachnoid hemorrhage: comparison between endovascular and surgical treatment. Neurosurgery. 2004;54(5):1081–1086. doi: 10.1227/01.neu.0000119350.80122.43.
57. Koivisto T, Vanninen R, Hurskainen H, Saari T, Hernesniemi J, Vapalahti M. et al. Outcomes of early endovascular versus surgical treatment of ruptured cerebral aneurysms..Stroke. 2000.31(10):2369–2377. doi: 10.1161/01.str.31.10.2369.
58. Gross B, Rosalind-Lai P, Frerichs K, Du R. Treatment modality and vasospasm after aneurysmal subarachnoid hemorrhage. World Neurosurg. 2014;82(6):e725–e730. doi: 10.1016/j.wneu.2013.08.017.
59. Molyneux A, Kerr A, Yu L, Clarke M, Sneade M, Yarnold J., et al. International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients. Lancet. 2005;366(9488):809–817. doi: 10.1016/S0140-6736(05)67214-5.
60. Suzuki H, Taki W. Effect of aneurysm treatment modalities on cerebral vasospasm after aneurysmal subarachnoid hemorrhage 2013:115 99-105. 10.1007/978-3-7091-1192-5_22.
61. McDougall C, Spetzler R, Zabramski J, Partovi S, Hills N, Nakaji P, Albuquerque F. et al. The Barrow Ruptured Aneurysm T. doi: 10.3171/2011.8.JNS101767. Epub 2011 Nov 4.
62. Peng C, Yu-hang D, Shi-fei C, Xin-yu Y. Endovascular coiling versus microsurgical clipping for ruptured i. 2022 Jul. PMID: 35879784 doi: 10.1186/s41016-022-00283-3
63. Backes D, Vergouwen M, Velthuis BK, van der Schaaf IC, A. Bor SE, Algra A,. Rinkel GJE. Et al. Difference in Aneurysm Characteristics Between Ruptured and Unruptured Aneurysms. 2014https://doi.org/10.1161/STROKEAHA.113.004421
64. van der Kamp LT, Rinkel GJ, Verbaan D. Risk of Rupture After Intracranial Aneurysm G. JAMA Neurol. 2021;78(10):1228-1235. doi:10.1001/jamaneurol.2021.2915
65. Yamanouchi M, Arimura H, Kodama T, Urakami K. Prediction of Intracranial Aneurysm Rupture Risk Using Non-Invasive Radiomics Analysis Based on Follow-Up Magnetic Resonance. Appl. Sci. 2022, 12(17), 8615; https://doi.org/10.3390/app12178615
66. Rinaldo L,. Nesvick CL, Rabinstein AA, Lanzino G. Differences in Size Between Unruptured and Ruptured Saccular Intracranial Aneurysms. January 2020, Pages e828-e834 https://doi.org/10.1016/j.wneu.2019.10.027.
67. Hishikawa T, Date I, Tokunaga K, Tominari S, Nozaki K, Shiokawa, Y. et al. Risk of rupture of unruptured cerebral aneurysms. 2015 issue. 85 (21) 1879-1885. https://doi.org/10.1212/WNL.0000000000002149
68. Tanioka S, Ishida F, Yamamoto A, Shimizu S, Sakaida H,Toyoda M, Kashiwagi N, Suzuki H. et al. Machine Learning Classification of Cerebral Aneurysm Rupture Status with Morphologic Variables.January. 15 2020https://doi.org/10.1148/ryai.2019190077
69. Hurth H, Birkenhauer U, Steiner J, Schlak D, Hennersdorf F, Ebner FH. Delayed Cerebral Ischemia in Patients with Aneurysmal Subarachnoid Hemorrhage - Serum D-dimer and C-reactive Protein as Early Markers. J Stroke Cerebrovasc Dis. 2020 Mar;29(3):104558. doi: 10.1016/j.jstrokecerebrovasdis.2019.104558. Epub 2019 Dec 28. PMID: 31889655.

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Initial ASIA impairment scale and its association with improvement in cervical spinal cord injury. Insights from a five-year retrospective study

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ABSTRACT

Background: Cervical spinal cord injuries (SCI) are a severe subset of trauma cases, with important impacts on functional abilities and quality of life. Effective management strategies are crucial for improving outcomes.

Objective: This study evaluates the impact of initial ASIA impairment scale (AIS) grades on recovery and outcomes in cervical SCI.

Methods: A retrospective analysis of 565 patients with cervical SCI was conducted. Variables included age, gender, mode of injury, the timing of intervention, injury levels, management strategies, and outcomes based on initial and discharge AIS scores were analysed.

Results: The cohort comprised 565 patients, with age distribution as follows: 1-20 years (12.9%, n=73), 21-40 years (47.6%, n=269), 41-60 years (31.4%, n=177), and over 60 years (8.1%, n=46). Males predominated (86.9%, n=491). Age did not significantly affect outcomes (p=0.42), and while males had a 28.5% good outcome rate, females had a 39.2% rate (p=0.06). Road traffic accidents were the leading cause of injury (41.8%, n=236) but had a lower good outcome rate (22.9%) compared to falls (34.7%, n=196) with a higher good outcome rate (38.3%). Animal attacks showed the highest good outcome rate (66.7%, n=20). Timing of intervention did not significantly impact outcomes (p=0.16 for injury-to-admission and p=0.793 for timing of surgery). Subaxial cervical injuries were the most common (93.9%). Among 247 surgical patients, discectomy was most frequently performed. Complications occurred in 19.65% of patients, primarily pressure sores. The in-hospital mortality rate was 8.67%, with 79.47% discharged and 11.86% leaving against medical advice. Recovery was most pronounced in ASIA C (93.7%) and ASIA D (94.3%) patients. ASIA B patients showed a significant improvement rate (74.1%), while ASIA A patients had the lowest improvement (34.8%) (p<0.0001).

Conclusion: Initial ASIA grades are strong predictors of neurological recovery in cervical SCI, with incomplete injuries (ASIA C and D) showing good outcomes. Management strategies, including early intervention and surgical approaches, play a crucial role in recovery. Despite some variability in outcomes based on injury cause and management, ASIA grading remains a critical tool for assessing prognosis and guiding treatment.

Keywords
cervical spinal cord injuries,
ASIA scale,
outcomes,
surgical management

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Introduction

Trauma remains a leading cause of hospitalization worldwide, with spinal injuries representing a significant subset of trauma-related cases [1]. Cervical spinal cord injuries (SCI), though less frequent compared to other trauma types, are particularly severe due to their potential to cause profound and lasting disability [2]. Approximately 2.0–3.0% of all trauma patients sustain cervical SCI, and these injuries are responsible for about 8.2% of trauma-related mortalities. The severity of cervical SCI can lead to major functional impairments, affecting quality of life and survival of patients [3].

Effective emergency management of cervical SCI is crucial for optimizing outcomes. Key interventions include immediate immobilization of the cervical spine to prevent further injury, maintenance of adequate blood pressure and oxygenation to support spinal cord function, and rapid clinical and radiological assessment to identify the extent of the injury. Realignment of the spinal column is also critical to stabilize the injury and prevent secondary damage.

Definitive care of cervical SCI involves several important considerations. Recognizing the specific fracture patterns and assessing the level of spinal instability are essential for determining the appropriate treatment strategy [4]. Evaluating neurological deficits and considering other patient-specific factors, such as comorbid conditions or additional injuries, further guide the management approach [5]. The goals of surgical intervention typically include spinal realignment, decompression of neural structures, and stabilization through instrumentation to support healing and function.

Imaging plays a vital role throughout the management process. Initial and follow-up imaging are used to assess fracture healing and ensure that the spine remains stable following external immobilization, which typically lasts 8 to 12 weeks [6]. The imaging findings help guide decisions about whether surgical intervention is necessary and how to proceed with surgical planning.

The outcomes of cervical SCI are influenced by various factors, including the patient's age, Glasgow Coma Scale (GCS) score at the time of presentation, the extent of neurological impairment, and the presence of concomitant injuries or head trauma [7]. Despite advancements in treatment, many patients experience residual impairments, such as chronic pain, limited range of motion, or other functional limitations.

This retrospective study aims to provide a comprehensive analysis of the presentation, radiological features, and management strategies for cervical spine injuries in trauma patients. Additionally, it explores the relationship between the initial ASIA (American Spinal Injury Association) grade at admission and patient outcomes over a five-year period. By examining these factors, the study seeks to enhance understanding of how initial neurological status correlates with long-term recovery and overall prognosis in cervical SCI cases.

METHOD

Study design and participants

This study reviewed medical records that met the predefined inclusion and exclusion criteria. Consent was obtained telephonically from patients or their legal guardians/caregivers. Data collected included socio-demographic details, clinical presentations, radiological findings, and ASIA Impairment Scale (AIS) scores at both admission and discharge, using a semi-structured data collection tool. The ASIA Impairment Scale (AIS) categorizes spinal cord injury severity into five grades:

AIS A (Complete): No sensory or motor function is preserved in the sacral segments S4-S5.

AIS B (Incomplete): Sensory function is preserved below the neurological level, including sacral segments S4-S5, but motor function is absent.

AIS C (Incomplete): Motor function is preserved below the neurological level, but more than half of the muscles below the injury have a muscle grade < 3.

AIS D (Incomplete): Motor function is preserved below the neurological level with at least half of the muscles showing a muscle grade of ≥3 .

AIS E (Normal): Sensory and motor functions are normal with no evidence of SCI.

Clinical management

Patients with stable bony spinal injuries or cord contusions received conservative management. In contrast, those with unstable bony fractures, with or without cord compression, were treated surgically. Post-operative complications and outcomes, including survival and mortality, were documented. Improvement in AIS scores was assessed by noting

any increase in AIS grades from admission to discharge.

Outcome measures

The primary outcome measure was the change in AIS score from admission to discharge. Secondary outcomes included post-operative complications, survival, and mortality (at home by telephonic).

Data collection

Data were entered into Microsoft Excel spreadsheets, maintaining confidentiality for each participant. The dataset included variables such as socio-demographic information, clinical presentations, radiological findings, and AIS scores.

Statistical analysis

Data analysis was conducted using SPSS version 21.0. Descriptive statistics, including frequencies, percentages, means, and standard deviations, summarized the data. The Kolmogorov-Smirnov test assessed the normality of data distribution. Categorical variables were analyzed using the chi-square test, while continuous variables were compared using the independent t-test or Mann-Whitney U test, depending on data distribution. Statistical significance was set at a 5% significance level ($p < 0.05$).

Ethics

The study was approved by the Institutional Ethical Committee and adhered to ethical standards throughout.

Results

Study population characteristics and outcomes

The study included 565 participants with mean age 37.46 (±16.84 and range 4-68) categorized by age as follows: 0-20 years (12.9%, n=73), 21-40 years (47.6%, n=269), 41-60 years (31.4%, n=177), and over 60 years (8.1%, n=46). There were no significant differences in outcomes across these age groups (p=0.42). The sex distribution showed that 86.9% (n=491) of the participants were male. Among these males, 28.5% (n=140) had a good outcome, while 71.5% (n=351) experienced a poor outcome. In contrast, 13.1% (n=74) of the participants were female, with 39.2% (n=29) achieving a good outcome and 60.8% (n=45) a poor outcome (p=0.06). The mode of injury had a significant impact on outcomes (p<0.0001). Road traffic accidents (RTA) represented 41.8% (n=236) of cases, with only 22.9% (n=54) showing a good outcome. Falls from height, accounting for 34.7% (n=196) of cases, had a good outcome in 38.3% (n=75) of cases. Injuries from animal attacks (5.3%, n=30) had the highest proportion of good outcomes (66.7%, n=20), while assaults (2.8%, n=16) and other causes (15.4%, n=87) had poorer outcomes (Table-1).

Impact of injury to admission and surgery intervals on outcome

The interval between injury and admission did not significantly affect outcomes (p=0.16). Good outcomes were observed in 40.8% (n=20) of those admitted within a day, 26.4% (n=61) within 2-3 days, 33.1% (n=58) within 4-7 days, 23.5% (n=16) within 8-15 days, and 33.3% (n=14) after more than 15 days. Similarly, the interval from injury to surgery had no significant effect on outcomes (p=0.793). Surgery performed within 6-24 hours resulted in a good outcome in 25.0% (n=1) of cases, within 24-72 hours in 38.5% (n=5), within 3-7 days in 34.8% (n=16), and beyond 7 days in 41.3% (n=76) (Table-2).

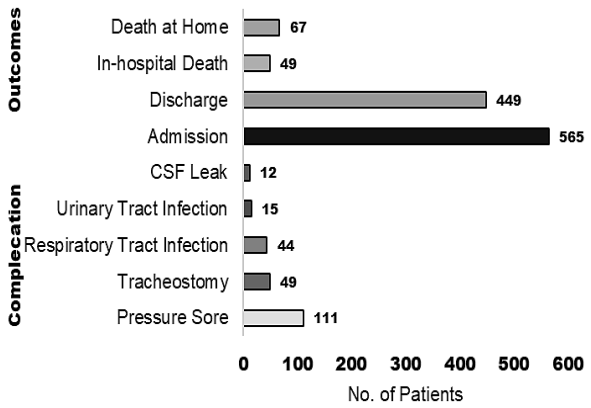

Figure 1. Distribution of cervical SCI patients on the basis of complications and outcomes.

Level of injuries and type of management

The distribution of injuries among participants was as follows: 93.9% (n=531) had subaxial cervical injuries, 4.4% (n=25) had C1-C2 injuries, and 1.7% (n=9) had Hangman's fractures(Fig 2A-C). Of the 247 operated patients, 45% (n=239) had subaxial cervical injuries, 24.0% (n=6) had C1-C2 injuries, and 22.3% (n=2) had Hangman's fractures. Among the 318 non-operated patients, 55% (n=292) had subaxial cervical injuries, 76.0% (n=19) had C1-C2 injuries, and 77.7%

(n=7) had Hangman's fractures. The distribution of injuries by management type was significant (p=0.049) (Table-3).

Figure 2A. Patient (17yr/M) with RTA with ASIA grade A involving subaxial (C4-C5 Listhesis) cervical spine injury.

Figure 2B. Patient (24 yr/M), ASIA grade E injury status with type 3 odontoid(C1-C2 type) fracture.

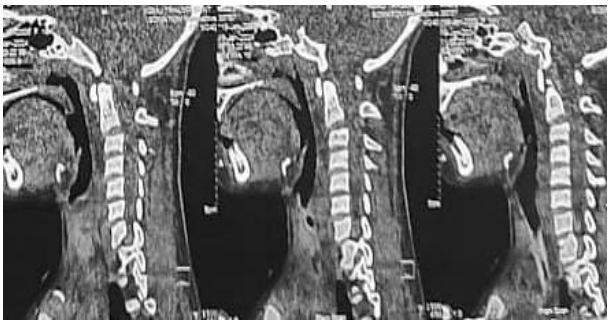

Figure 2C. Patient (16yr F) with fall from height, ASIA grade A injury with C2-C3 listhesis (Hangman)

Complications and outcomes

Complications occurred in 19.65% (n=111) of patients, including pressure sores (19.65%), tracheostomy (8.67%), respiratory tract infections (7.79%), urinary tract infections (5.65%), and cerebrospinal fluid (CSF) leaks (2.12%). Regarding outcomes, 79.47% (n=449) of participants were discharged, 8.67% (n=49) died in-hospital, and 11.86% (n=67) died at home (Fig.1).

Neurological outcome by ASIA grade

At admission, neurological status was categorized as ASIA A (36.1%, n=204), ASIA B (23.9%, n=135), ASIA C (25.3%, n=143), ASIA D (12.6%, n=71), and ASIA E (2.1%, n=12). By discharge, improvements were noted in 27.6% (n=124) of ASIA A patients, 24.7% (n=111) of ASIA B patients, 30.1% (n=135) of ASIA C patients, 15.1% (n=68) of ASIA D patients, and 2.5% (n=11) of ASIA E patients. The improvement in neurological status was highly significant (p<0.0001) (Table-4).

Status of improvement based on asia grade at admission

For ASIA A at admission, 34.8% (n=71) improved, 25.9% (n=53) remained static, and 39.3% (n=80) expired or left against medical advice. Among ASIA B patients, 74.1% (n=100) improved, 8.2% (n=11) remained static, and 17.7% (n=24) expired or left against medical advice. In the ASIA C group, 93.7% (n=134) improved, 0.7% (n=1) remained static, and 5.6% (n=8) expired or left against medical advice. For ASIA D, 94.3% (n=67) improved, 1.4% (n=1) remained static, and 4.3% (n=3) expired or left against medical advice. Among ASIA E patients, 91.7% (n=11) remained static, and 1 left against medical advice. The association between ASIA grade at admission and improvement was highly significant (p<0.0001) (Table-5).

Discussion

Spinal cord injury (SCI) is a debilitating condition that presents significant challenges, particularly in resource-limited settings. As noted in the literature, cervical spinal cord injuries (SCI) are among the most severe trauma-related injuries, often leading to substantial long-term disability or mortality [8]. The cervical spine is involved in approximately 50% of all spinal cord injuries, and injuries at or above the C3 level are particularly critical, often leading to severe impairment or death [9, 10].

In our study, which included 565 patients, the demographic and clinical characteristics were broadly consistent with previous research. The predominant age group was 21-40 years (47.6%), aligning with findings by Srinivas BH et al. [11], who

observed a similar age distribution in their study. The male predominance (86.9%) in our cohort mirrors patterns seen in other studies, highlighting the higher incidence of spinal cord injuries among males [12].

The mode of injury was a crucial factor influencing outcomes. Road traffic accidents (RTA) were the most common cause (41.8%), and these injuries were associated with poorer outcomes (22.9% good outcome). This is consistent with findings from other studies, which suggest that RTAs often involve severe trauma with complex injury patterns [13]. Falls, which accounted for 34.7% of cases, had a better outcome (38.3%), suggesting that these injuries may be less severe or more effectively managed [14]. Conversely, injuries from animal attacks showed the highest proportion of good outcomes (66.7%), potentially indicating less severe spinal involvement or more localized injuries.

Our analysis found no significant impact of the interval between injury and admission or the timing of surgery on outcomes (p=0.16 and p=0.793, respectively). This is in line with some studies that suggest while timely intervention is crucial, its impact on outcomes may be less straightforward [15,16]. This might be due to variations in injury severity, patient health status, or the nature of the intervention.

In terms of injury levels and management, subaxial cervical injuries were the most common (93.9%), and there was a significant difference in management strategies (p=0.049). Of those who underwent surgery, a majority had subaxial injuries, with discectomy being the most common procedure. This is consistent with Shah G et al. [12], who reported a similar prevalence of surgical interventions for cervical injuries. The preference for anterior discectomy over posterior approaches, despite its benefits, reflects current surgical trends and practices [14].

Complications were observed in 19.65% of patients, with pressure sores being the most frequent (19.65%). This finding underscores the need for effective prevention strategies in SCI patients, as pressure sores can significantly impact recovery and quality of life [17]. The in-hospital mortality rate of 8.67% was slightly higher than in some studies but lower than others [18]. This variation could be attributed to differences in patient demographics, injury severity, and the presence of additional comorbidities.

Neurological outcomes were significantly influenced by the ASIA grade at admission. Patients with ASIA grades C and D showed considerable improvements, with 93.7% and 94.3% improving, respectively. This aligns with findings from Coleman and Geisler [17], who emphasized that incomplete injuries generally have a better prognosis than complete injuries. The significant recovery observed in ASIA B patients (74.1%) compared to ASIA A (34.8%) further supports the notion that the initial neurological status is a key predictor of recovery [18].

The study's limitations include its retrospective nature, which may introduce recall bias or misclassification errors. Additionally, the findings may not be generalizable beyond the specific tertiary care setting of the study. Prospective and longitudinal studies are needed to better assess predictors of recovery and long-term outcomes for cervical SCI patients.

Conclusion

In summary, acute traumatic spinal cord injuries frequently affect young individuals and are primarily caused by falls and road traffic accidents, with cervical spine involvement being common. Delays in presentation and intervention can significantly impact outcomes. The severity of the injury and the appropriateness of intervention are crucial determinants of morbidity and mortality. Incomplete cervical injuries (ASIA Grades C and D) and injuries in the lower cervical regions (C5-C7) generally show better improvement compared to complete and upper cervical injuries (C4 and above). Effective management includes early immobilization, maintaining blood pressure and oxygenation, and prompt clinical assessment to optimize outcomes.

Table 1. General characteristics of study population.

Variables		Total Patients (n=565) N (%)	Good outcome (n=169) N (%)	Bad outcome (n=396) N (%)	p-value
Age (Years)	04-20	73(12.9)	18(24.7)	55(75.3)	0.420
	21-40	269(47.6)	76(28.3)	193(71.7)	
	41-60	177(31.4)	60(33.9)	117(66.1)	
	>60	46(8.1)	15(32.6)	31(67.4)	
Gender	Male	491(86.9)	140(28.5)	351(71.5)	0.061
	Female	74(13.1)	29(39.2)	45(60.8)	
Mode of Injury	RTA	236(41.8)	54(22.9)	182(77.1)	<0.0001*
	Fall	196(34.7)	75(38.3)	121(61.7)	
	Animal hit	30(5.3)	20(66.7)	10(33.3)	
	Assault	16(2.8)	6(37.5)	10(62.5)	
	#Others	87(15.4)	36(41.4)	51(58.6)	

#Fall On Ground – 22; Fall From Bed – 42; Fall Of Heavy Object On Head-15; Sports Injury-1; Machinery Injury-2. RTA; Road Traffic Accident. *p<0.05 is statistically significant

Table 2. Association of injury to admission and surgery interval with outcomes

Variable		Patients N (%)	Good outcome (n=169) N (%)	Poor outcome (n=396) N (%)	p-value
Injury to admission interval (N=565)	< 1 Day	49(8.7)	20(40.8)	29(59.2)	0.161
	2-3 Days	231(40.8)	61(26.4)	170(73.6)	
	4-7 Days	175(30.9)	58(33.1)	117(66.9)	
	8-15 Days	68(12.1)	16(23.5)	52(76.5)	
	>15 Days	42(7.5)	14(33.3)	28(66.7)	
Injury to Surgery interval (N=247)	6-24 Hours	4(1.6)	1(25.0)	3(75.0)	0.793
	24-72 Hours	13(5.3)	5(38.5)	8(61.5)	
	3-7 Days	46(18.6)	16(34.8)	30(65.2)	
	>7 Days	184(74.5)	76(41.3)	108(58.7)	

Table 3. Type of injuries and management.

Type of Injury	Total patients n(%) (n=565)	Operated n(%) (n=247)	Non-operated n(%) (n=318)	p- value
Subaxial Cervical Injury	531 (93.9)	239 (45)	292 (55)	0.049
C1-C2 Injury	25 (4.4)	6 (24.0)	19 (76.0)	
Hangman's Fracture	9 (1.7)	2 (22.3)	7 (77.7)	

Table 4. Association of ASIA grades with (patients admission, discharge and death) outcomes.

ASIA Grades	Admission n(%)	Discharge n(%)	Hospital Death n(%)	Home Death n(%)
ASIA A	204 (36.1)	124(27.6)	42 (85.7)	38 (56.7)
ASIA B	135(23.9)	111 (24.7)	6(12.2)	18 (26.9)
ASIA C	143(25.3)	135(30.1)	1(2.1)	7(10.5)

ASIA D	71(12.6)	68 (15.1)	0 (0.0)	3 (4.5)
ASIA E	12(2.1)	11(2.5)	0 (0.0)	1 (1.5)
p-value	<0.0001*		na	

Table 5. Association of ASIA grade with status of patients.

ASIA grade at Admission	ASIA grade status at Discharge			p-value
	Improved	**Stable**	**Expired**	
A (N=204)	71 (34.8)	53 (25.9)	80 (39.3)	**<0.0001**
B (N=135)	100 (74.1)	11 (8.2)	24 (17.7)	
C (N=143)	134 (93.7)	1 (0.7)	8 (5.6)	
D (N=71)	67 (94.3)	1 (1.4)	3 (4.3)	

REFERENCES

1. DiMaggio C, Ayoung-Chee P, Shinseki M, Wilson C, Marshall G, Lee DC, Wall S, Maulana S, Pachter HL, Frangos S. Traumatic injury in the United States: in-patient epidemiology 2000–2011. Injury. 2016 Jul 1;47(7):1393-403.
2. Eckert MJ, Martin MJ. Trauma: spinal cord injury. Surgical Clinics. 2017 Oct 1;97(5):1031-45.
3. Elachi IC, Yongu WT, Kotor JN, Edem BE, Ahachi CN, Mue DD. The Nature and Complications of Acute Traumatic Cervical Spinal Cord Injury in a University Hospital in Nigeria.
4. Vaccaro AR, Kim DH, Brodke DS, Harris M, Chapman J, Schildhauer T, Routt MC, Sasso RC. Diagnosis and management of thoracolumbar spine fractures. JBJS. 2003 Dec 1;85(12):2456-70.
5. Yue JK, Cnossen MC, Winkler EA, Deng H, Phelps RR, Coss NA, Sharma S, Robinson CK, Suen CG, Vassar MJ, Schnyer DM. Pre-injury comorbidities are associated with functional impairment and post-concussive symptoms at 3-and 6-months after mild traumatic brain injury: a TRACK-TBI study. Frontiers in neurology. 2019 Apr 9;10:343.
6. Eiff MP, Hatch RL. Fracture Management for Primary Care E-Book. Elsevier Health Sciences; 2011 Jul 6.
7. Aarabi B, Albrecht JS, Simard JM, Chryssikos T, Schwartzbauer G, Sansur CA, Crandall K, Gertner M, Howie B, Wessell A, Cannarsa G. Trends in demographics and markers of injury severity in traumatic cervical spinal cord injury. Journal of neurotrauma. 2021 Mar 15;38(6):756-64.
8. American Spinal Injury Association. (2019). "International Standards for Neurological and Functional Classification of Spinal Cord Injury." Journal of Spinal Disorders & Techniques, 32(2), 100-108. doi:10.1097/BSD.0000000000000980
9. Jiang, J., & Zhang, J. (2016). "Clinical and Radiological Factors Predicting Outcomes in Cervical Spinal Cord Injury." Journal of Orthopaedic Research, 34(2), 271-277. doi:10.1002/jor.22980
10. Doulgeris, J. J., & Arora, S. (2018). "Outcomes Following Surgical Management of Cervical Spinal Cord Injuries: A Review of Current Evidence." Global Spine Journal, 8(4), 425-431. doi:10.1177/2192568218758533
11. Dvorak, M. F., & Roffey, D. M. (2016). "Spinal Cord Injury Management: A Review of Acute and Chronic Care." Journal of Orthopaedic Trauma, 30(1), 20-26. doi:10.1097/BOT.0000000000000516
12. Tetreault, L. A., & Kwon, B. K. (2015). "Comparative Analysis of Surgical and Non-Surgical Treatments for Cervical Spinal Cord Injury." Journal of Neurosurgery, 123(4), 999-1008. doi:10.3171/2015.3.JNS142303
13. Yoon, S. T., & Wang, J. C. (2011). "Management of Cervical Spinal Cord Injuries: A Review of Contemporary Practices." *Orthopedic Clinics of North America*, 42(3), 357-369. doi:10.1016/j.ocl.2011.03.001
14. Fehlings, M. G., & Rizvi, S. A. (2016). "Outcomes of Surgical Intervention for Acute Cervical Spinal Cord Injury." Neurosurgery, 79(2), 287-295. doi:10.1227/NEU.0000000000001263
15. Koski, T., & Korhonen, H. (2013). "Statistical Analysis in Spinal Cord Injury Research: Best Practices and Methodologies." Spinal Cord, 51(10), 740-746. doi:10.1038/sc.2013.47
16. Goel, A., & Laheri, V. (2018). "Surgical Techniques and Outcomes for Cervical Spinal Cord Injury." Neurosurgical Focus, 44(6), E12. doi:10.3171/2018.4.FOCUS1842
17. Hurlbert, R. J., & Furlan, J. C. (2012). "The Impact of Delayed Treatment on Spinal Cord Injury Outcomes." Journal of Neurotrauma, 29(8), 1453-1460. doi:10.1089/neu.2011.2094
18. Boffeli, T. J., & Kim, K. D. (2015). "Age and Gender Differences in Cervical Spinal Cord Injury Outcomes." Spinal Cord, 53(4), 277-282. doi:10.1038/sc.2014.207.

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One year follow up of a child with clinico-radiologically diagnosed left Thalomopeduncular Glioma

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Keywords
paediatric thalamic tumours, VP shunt insertion, temozolomide, shunt series, low resource settings

ABSTRACT

Background Absence of or poor facility and equipment have been the bane of management of thalamic tumours in low-resource settings.

Case presentation We present a case of a 3-year-old with clinico-radiologically diagnosed thalamopeduncular-cerebellar glioma, treatments and outcome.

Conclusion In low-resource settings with high reliance on clinico-radiologic data, arriving at a diagnosis requires a high index of suspicion. Early institutions of basic definitive care could give a chance for a good outcome.

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INTRODUCTION

Thalamic tumours make up approximately 5% of paediatric brain tumours [1–5], low-grade glioma (LGG) accounts for the highest percentage of thalamic glioma [6]. Thalamic high-grade glioma is not infrequent [7]. With the advancement in technology, the once dreaded location which was associated with high operative morbidity and mortality can now be accessed with minimal or no morbidity. However, this is not the case in low resource settings, where basic imaging tools such as cranial computed tomography (CT) is located more than 260-560 km away (i.e. approximately 4-8 hours' drive northwest-ward from the location of the facility- Modibbo Adama University Yola, in northeast Nigeria) [8,9]. More so, many patients are financially constrained and

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cannot do basic blood workup, purchase the cheapest available chemotherapeutic agent, or afford referral to private facilities in faraway southwestern Nigeria. These facilities have some of the modern imaging equipment (such as tractography) and intraoperative neuronavigation. Hence, the reliance on basic facilities to give the patients optimal care.

Modibbo Adama University Teaching Yola, is a new tertiary health institution in northeast Nigeria, approved by the Federal government of Nigeria 2 years ago, with a nascent stable Neurosurgery Unit which serves both its host and neighbouring states.

Herein, we present a child with clinico-radiologically diagnosed left Thalomopeduncular-cerebellar glioma, who had ventriculoperitoneal shunt and 3 courses of temozolomide with excellent outcome at the time of writing this article.

CASE PRESENTATION

A 3-year old right-handed Nigerian female child was admitted to our facility with a 4-month history of progressive sequential right hemi-body weakness, ataxic gait, inability to sit, and loss of neck control. There was associated recurrent headache, three episodes of vomiting and aphasia. At presentation, the child was found to have differential spastic quadriparesis, (Medical Research Council (MRC) power grade zero on the right and 3-4 on the left) with a GCS of 10/15 (E-4, V-2, M-4), truncal ataxia, and bilateral papilledema but could fixate and track light.

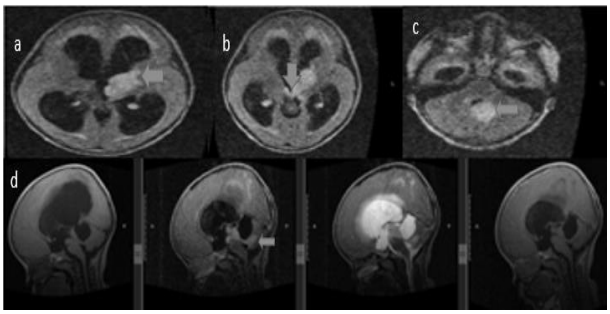

Figure 1. Brain MRI of the 3-year old with clinico-radiologically diagnosed left thalamopeduncular-cerebellar glioma- upper row (a)-(b) shows craniocaudal extension of the tumour highlighted by the brown arrows. (a) tumour epicentred in left thalamus, (b) tumour in the cerebral peduncles (left>>right) and (c) tumour involving the left superior, middle and inferior cerebellar peduncle. The lower row (d) shows extension of the tumour from the cerebral peduncle via the midbrain to the cerebellar peduncles on different intensities.

Brain magnetic resonance image (MRI) at presentation, revealed a non-contrast enhancing, isointense on T1W and hyperintense on T2W left thalamic mass, differentially involving the cerebral peduncle (left>>right), extending via the midbrain tectum to involve the left superior, middle and inferior cerebellar peduncles, with effacement of the fourth ventricle. There is tri ventriculomegaly (with transependymal seepage) and cerebrospinal fluid (CSF) in the suprapineal space displacing the cerebellum posteriorly. We made a clinico-radiological diagnosis of Obstructed Hydrocephalus due to a left Thalamic Peduncle-cerebellar low-grade glioma (Figure 1).

Patient was planned for a right occipito-parietal ventriculoperitoneal (VP) shunt insertion (via Keen's point) with post-op administration of temozolomide 200 mg daily for 5 days every 28-day cycle for 12 courses or when patient has clinical recovery and or radiologic regression of tumour. She was also placed on dexamethasone tablets pre-operatively.

Figure 2. Shunt series of the 3-year old with left thalamopeduncular-cerebellar glioma.

Right occipito-parietal VP shunt was successfully done 2 days after presentation (Figure 2) and patient was placed on IV Ceftazidime and IV Paracetamol post-op. She started chemotherapy treatment on 14th postoperative day, based on Temozolomide 200 mg daily, alongside 0.5 mg of tabs Dexamethasone and IV Ondansetron 2 mg over 15 minutes, 30 minutes before temozolomide, then at 4 hours and 8 hours after first dose of Ondansetron daily for 5 days, to avoid chemotherapy induced vomiting. The CSF cytology returned negative; however, we continued the chemotherapy based on the clinico-radiologic diagnosis of left thalamopeduncular-cerebellar glioma.

Patient was later discharged on 19th postoperative day after completing the first course of temozolomide chemotherapy. She showed

satisfactory improvement with a GCS of 15/15, modified Rankin score (mRS) of 4 (achieved neck control, sits unsupported and walked with "*clumsy and drunken*" ataxic gait with maximum support) and Glasgow coma scale extended (GOSE) lower moderate.

She had only 3 of the 12 planned courses of chemotherapy due to financial constraints, following which the mother could not present her for follow-up. We however, contacted the mother via mobile phone who revealed that they could not afford the transport fare from the state where they reside (about 185 km, i.e. 3 hours 30 minutes' drive), more so the chemotherapy and the first post chemotherapy MRI. She however responded that the child had greatly improved and played around with steady gait (which was confirmed on WhatsApp video call). The child also answered every question intelligently over the phone conversation. She is currently doing well with mRS of 1 and GOSE upper normal and is doing well in school 6 months post-operation. Mother has, however, declined physical follow up and further postoperative radio imaging due to financial constraints.

During the course of chemotherapy, she had clinico-haematological evidence of anaemia and had to be transfused with whole blood on three occasions. She also had left otitis externa that warranted otorhinolaryngology consultation after the first course of chemotherapy. Furthermore, she was admitted for severe diarrhoeal disease after the third course of chemotherapy. Throughout the period, her white cell and platelet count were within normal limits.

Discussion

Functional anatomy of the thalamus

The thalamus is a paired ovoid deep brain structure composed mainly of grey matter, each measuring 3.5 cm long and connected by grey matter "massa intermedia". Medially, it forms the upper two-third of the lateral wall of the third ventricle (with the hypothalamus forming the inferior third); laterally it is delineated by the internal capsule, cranially it shapes the floor of part of the lateral ventricle, inferiorly it is separated by the subthalamus from the midbrain and anteriorly it forms the posterior border of the foramen of Munro. The pulvinar, is the posterior part of the thalamus, which communicates with the superior and inferior colliculi via its metathalamic (geniculate) bodies. The pulvinar is grooved superiorly by the fornixes [10].

The thalamus is divided into several nuclei. Most anteriorly, is the anterior nucleus whose affectation could lead to diencephalic amnesia. Medially, are the large dorsal and small ventral nuclei. Laterally, are the dorsal and ventral tier of nuclei. The dorsal tier is divided into the lateral and posterior (which includes the pulvinar and its geniculate bodies) nuclei. The ventral tier is divided into ventral posteromedial (VPM) and ventral posterolateral (VPL) nuclei. Furthermore, additional nuclei include intrathalamic, midline and reticular nuclei [10].

Functionally, only the lateral ventral tier nuclei (VPM and VPL) and geniculate bodies are assigned specific functions [10]. The medial geniculate forms part of the auditory pathway between the inferior colliculus and the auditory cortex, whilst the lateral geniculate body plays a role in the visual pathway and its affectation will cause homonymous hemianopsia or quadrantanopia. The VPM receives sensory information from the head and face through the trigeminal lemniscus and tastes information through the solitary tract. The VPL receives exteroceptive sensory information (pain, touch, temperature) from the contralateral side of the body by the ascending spinothalamic tract (spinal lemniscus) and proprioceptive information (sense of the relative position of body parts and of muscle strength) through the medial lemniscus (cuneate and gracile nuclei). Motor information is also received from the cerebellum (via the superior cerebellar peduncle to the ventral lateral nucleus) and the corpora striata. Affectation of the pulvinar could lead to varying sensory deficits, weakness, memory impairment, aphasia, hand tremor, and dystonia.

Clinico-radiologic findings

The thalamus is a location for several pathologies. The pathological entities includes glioma [11] (viz LGG are hypointense, non-contrast enhancing and HGG are contrast enhancing with necrotic core [12]), lymphoma [13] (especially the primary CNS type is hyperattenuating contrast enhancing on CT and isointense with restricted diffusion, however homogeneously contrast enhancing in the immunocompetent, but ring-enhancing with necrotic core in the immunocompromised occurring more in the cerebral hemisphere, but could occur in the periventricular white matter, corpus callosum,

basal ganglia and thalamus), metabolic disease (namely Wilson's disease presents with dysarthria, dystonia and tremor and copper deposit seen lentiform nucleus and thalamus as hypointense on T1W and gradient echo, but hyperintense in the outer rim of putamen on T2W and FLAIR; Fahr's disease- calcium deposit involving the basal ganglia symmetrically, seen as hyperdense on CT, but variable intensity on MRI; and Wernicke's encephalopathy seen in thiamine deficiency, commonly in alcoholics), congenital anomalies such as Neurofibromatosis type 1 (seen as focal areas of signal intensity, non-contrast enhancing with no mass effect), vascular lesions (such as arteriovenous malformation presenting with flow voids, described as "bag of worms" on MRI. Other vascular abnormalities are haemorrhage, hypoxia or ischemia from arterial or venous pathology), infections (namely thalamic abscess, which could be confused with subacute haematoma and Creutzfeldt-Jakob disease presenting with hyperintensity involving the pulvinar and dorsomedial nuclei bilaterally known as "hockey stick sign" or "pulvinar sign") and metastasis which should be suspected in a patient with confirmed primary and multiple intracranial lesions [10].

The index patient presented with clinico-radiologic features of an LGG epicentre in the left thalamus and progressively involved the cerebral peduncles (worse on the left), the midbrain and the ipsilateral superior, middle and inferior cerebellar peduncles with tri ventriculomegaly, which to the best of our knowledge is the first account of thalamic peduncle-cerebellar glioma in the literature. Hence the child presented with speech impairment, differential quadriparesis (dense on the right), truncal ataxia resulting in loss of neck control, and depressed consciousness. Similarly, in the study of 60 children with thalamic tumours by Bernstein et al [14], 75% had hemiplegia, 68% had headache, 47% had vomiting, 22% had altered sensorium and 7% had speech dysfunction; however, none had truncal ataxia, since they had no cerebellar involvement. However, in another study by Kim et al [15], only 22% had hemiparesis and 2.7% had gait imbalance, dizziness and rigidity. 19.4% had thalamic-peduncle-midbrain involvement. Furthermore, in a study of 8 children by D'Amico et al [3], 75% had hemiparetic and 12.5% had ataxia. In a study of 27 children by Cinalli et al, 77.8% had thalamopeduncular tumours of various histologic types, though majorly glioma and 7.4% of the bilateral thalamopeduncular tumour being high grade tumours [6]. In a study of 33 children by Nayel et al, 36.4% had hemiparesis, of which 6.1% were bilateral [1]. Unilateral thalamic tumours like in this patient have the propensity to grow inferiorly [18,19].

Management and outcome

In the past, the diagnosis and treatment of thalamic gliomas relied solely on imaging due to the deep location of the thalamus. However, with the advancement in both technology and surgical techniques, various approaches to the thalamus have been developed with reduced morbidity and mortality. In the area of technology, 3-Tesla MRI have made the study of the lesion and its relation to white matter (diffusion tensor image (DTI) or tractography) very clear for preoperative planning as regards the approach to be made [3,15]. Furthermore, intraoperative neuronavigation also contributes to the precise localization of the lesion [3,15]. More so, if biopsy is the sole goal of surgery, except in the situation where the tissue may be considered inadequate, stereotactic biopsy could be deployed with utmost precision. Also, for tumours that meet the criteria of radiosurgery, stereotactic radiosurgery without the benefit of tissue biopsy is available. These are not easily available in low resource settings like ours where the highest form of MRI is 1.5T in the whole country, and the closest from our facility is 260 km away, coupled with the dilapidated road network to access the service. Although it is cheaper (approximately 32 United States dollars-price is halved for paediatric age group-, when compared to 95 US dollars elsewhere in southwest Nigeria), most patients and relatives are unable to afford it. However, for those under the National Health Insurance Scheme (NHIS), 2/3 of the payment is covered by the scheme. Unfortunately, most patients are not under the scheme.

In the patient who had hydrocephalus and met the criteria for CSF diversion, endoscopic third ventriculostomy with or without choroid plexus cauterization and biopsy of the lesion if possible is done. If the option of VP shunt is preferred, it is done under endoscopic guidance to insert both the ventricular and abdominal catheters [6]. While endoscopic guided VP shunt placement is not currently available in Nigeria, only about five centres

spread across the northwest, southeast, southwest and north central of Nigeria have facilities for endoscopic third ventriculostomy [8,9]. This patient however, had occipito-parietal VP shunt insertion via the Keen's point which is approximately 3 cm above and behind the highest point of the pinna. Other commonly used points include Dandy's point which is 3 cm above the inion and 3 cm away from the midline; Frazier's point which is 6 cm above the inion and 3 cm away from the midline and Kocher's point which 1 cm anterior to the coronal suture and 2-3 cm away from the midline [21]. Post-operatively, the tip of the ventricular catheter above the location of the sphenoid sinus (approximate location of the foramen of Munro) and the intraperitoneal location of the abdominal catheter in a "shunt series" was adjudged by the first author to be adequately placed catheter.

The strategy of management of thalamic gliomas include radiologic diagnosis, biopsy (open or stereotactic), tumour excision (subtotal or gross), radiosurgery (with or without biopsy), radiotherapy and or chemotherapy [1,17]. Different combinations of chemotherapeutic agents have been used and still in use [16], however with the advent of temozolomide an alkylating agent, a single chemotherapeutic agent can be used with good outcome. Temozolomide, although proven to be effective for both LGG and HGG in the thalamus, is not without adverse effects which include aplastic anaemia from myelosuppression, severe infection and death. However, our patient only had severe anaemia necessitating transfusion, otitis externa and severe diarrhoea that was promptly managed. The cost of the 5-day course was 43 US dollars and this was pretty difficult for the relatives to afford during the course of therapy, since chemotherapeutic drugs are not covered by the NHIS and this patient is not registered in the NHIS.

Fortunately, the patient had clinical recovery after the third course of chemotherapy. Khaw et al, in their study of 13 children with LGG, 6 of which had only radiologic diagnosis found out that temozolomide is effective as a second line agent in the treatment of paediatric LGG [16]. However, Badejo et al in their case report of bithalamic LGG (diffuse astrocytoma), who had several courses of chemotherapeutic agents with poor quality of life until demise one-year post biopsy [18]. Bithalamic tumours because of their mostly diffuse histologic nature are usually of poorer prognosis [19]. In the Canadian study, duration of symptoms greater than 3 months and tumour grade rather than extent of resection are the important prognostic factors in unilateral thalamic tumours [19], although Puget et al previously found that duration of symptoms, size of tumour, extent of resection and tumour grade are the factors impacting overall survival [20]. In the study of 20 patients by Eissa et al in which tumour grade was evenly distributed, and 15 (including 5 with LGG) had chemotherapy, while 11 (including one with LGG) had radiotherapy, patients with biopsy alone had better overall survival than their counterparts who had tumour debulking; and tumour size was the determinant for overall survival [17].

This patient with thalamopeduncular-cerebellar tumour (to the best of our knowledge is the first case of thalamopeduncular tumour with cerebellar extension in the literature) is a candidate for stereotactic biopsy and CSF diversion, if the equipment were available. However, in the absence of the necessary equipment, we relied on the radiologic features, which was suggestive of LGG and has been previously shown to respond to chemotherapeutic agent like temozolomide and opted for the safest available care, which was CSF diversion with anatomic landmark-guided, ventriculoperitoneal shunt placement, confirmed post-operatively with "shunt series" and single chemotherapeutic agent- temozolomide.

Conclusion

In a low resource setting, high index of suspicion is required to make radiologic diagnosis of thalamopeduncular glioma and early institution of chemotherapeutic agent could be the only chance to good outcome in children under 3-years of age, despite the general poor prognosis of thalamic gliomas irrespective of their grade. In the absence of endoscopic guidance for catheter insertion, anatomic landmarks and shunt series are respectively greatly relied upon for intra-operative catheter insertion and post-operative confirmation of adequate placement of VP shunt in low resource settings. Once radiologic diagnosis of glioma can be made, chemotherapy can be commenced with an expectant favourable outcome.

References

1. Nayel MH, Ibrahim IM, Elbeltagy MA, Abdelmoneam AS, Ismail AR. Recent Trends in Management of Thalamic Tumours in Pediatric Age Group [Internet]. Med. J. Cairo Univ., Vol. 89, No. 3, June: 1207-1213, 2021 www.medicaljournalofcairouniversity.net
2. Lee RP, Foster KA, Lillard JC, Klimo P Jr, Ellison DW, Orr B, Boop FA. Surgical and molecular considerations in the treatment of pediatric thalamopeduncular tumors. J Neurosurg Pediatr. 2017 Sep;20(3):247-255. doi: 10.3171/2017.4.PEDS16668. Epub 2017 Jul 7. PMID: 28686121; PMCID: PMC5839469.
3. D'Amico, Alberto, Giulia Melinda Furlanis, Valentina Baro, Luca Sartori, Andrea Landi, Domenico d'Avella, Francesco Sala, and Luca Denaro. 2023. "Thalamopeduncular Tumors in Pediatric Age: Advanced Preoperative Imaging to Define Safe Surgical Planning: A Multicentric Experience" Journal of Clinical Medicine 12, no. 17: 5521. https://doi.org/10.3390/jcm121755214.
4. Chiba K, Aihara Y, Masui K, Abe K, Komori T, Kawamata T. Pulvinar Locus is Highly Relevant to Patients' Outcomes in Surgically Resected Thalamic Gliomas in Children. World Neurosurg. 2020 Feb;134:e530-e539. doi: 10.1016/j.wneu.2019.10.116. Epub 2019 Nov 5. PMID: 31704359.
5. JH, Phi JH, Lee JY, Kim KH, Park SH, Choi YH, Cho BK, Kim SK. Surgical Outcomes of Thalamic Tumors in Children: The Importance of Diffusion Tensor Imaging, Neuro-Navigation and Intraoperative Neurophysiological Monitoring. Brain Tumor Res Treat. 2018 Oct;6(2):60-67. doi: 10.14791/btrt.2018.6.e14. PMID: 30381918; PMCID: PMC6212692.
6. Cinalli G, Aguirre DT, Mirone G, Ruggiero C, Cascone D, Quaglietta L, Aliberti F, Santi SD, Buonocore MC, Nastro A, Spennato P. Surgical treatment of thalamic tumors in children. J Neurosurg Pediatr. 2018 Mar;21(3):247-257. doi: 10.3171/2017.7.PEDS16463. Epub 2017 Dec 22. PMID: 29271729.7.
7. Kramm CM, Butenhoff S, Rausche U, Warmuth-Metz M, Kortmann RD, Pietsch T, et al. Thalamic high-grade gliomas in children: A distinct clinical subset? Neuro Oncol. 2011 Jun;13(6):680–9.
8. Ukachukwu AK, Njeru PN, Ayodele OA, Ahmad MH, Onyia CU, Morgan E, Ekweogwu OC, Usman B, Badejo OA, Dawang Y, Orhorhoro OI, Oyemolade TA, Okere OE, Abu-Bonsrah N, Petitt Z, Oboh EC, Otun A, Nischal SA, Deng DD, Mahmud MR, Mezue WC, Malomo AO, Shehu BB, Shokunbi MT, Ohaegbulam SC, Fuller AT, Haglund MM, Chikani MC, Adeolu AA, Adeleye AO; DGNN-NCAP Survey Collaborators. A Geospatial Analysis of the Availability, Distribution, and Accessibility of Neurosurgical Facilities, Workforce, and Infrastructure in Nigeria; and Projection Towards 2050. World Neurosurg. 2024 May;185:e16-e29. doi: 10.1016/j.wneu.2023.10.146. PMID: 38741324.
9. Ukachukwu AK, Oyemolade TA, Nischal SA, Onyia CU, Morgan E, Ekweogwu OC, Orhorhoro OI, Ahmad MH, Ayodele OA, Usman B, Badejo OA, Dawang Y, Okere OE, Abu-Bonsrah N, Deng DD, Petitt Z, Njeru PN, Oboh EC, Otun A, Still MEH, Haglund MM, Fuller AT, Chikani MC, Adeleye AO, Adeolu AA; Duke Global Neurosurgery and Neurology-Nigeria Neurosurgery Capacity Assessment Project (NCAP) Survey Collaborators. Assessing the Neurosurgical Capacity in Nigeria Using the Modified Neuro-PIPES Tool. World Neurosurg. 2024 May;185:e30-e43. doi: 10.1016/j.wneu.2023.12.104. PMID: 38741328.
10. Tuttle C, Boto J, Martin S, Barnaure I, Korchi AM, Scheffler M, Vargas MI. Neuroimaging of acute and chronic unilateral and bilateral thalamic lesions. Insights Imaging. 2019 Feb 22;10(1):24. doi: 10.1186/s13244-019-0700-3. PMID: 30796553; PMCID: PMC6386756.
11. Smith AB, Smirniotopoulos JG, Rushing EJ, Goldstein SJ. Bilateral thalamic lesions. AJR Am J Roentgenol. 2009 Feb;192(2):W53-62. doi: 10.2214/AJR.08.1585. PMID: 19155381.
12. Al-Okaili RN, Krejza J, Wang S, Woo JH, Melhem ER. Advanced MR imaging techniques in the diagnosis of intraaxial brain tumors in adults. Radiographics. 2006 Oct;26 Suppl 1:S173-89. doi: 10.1148/rg.26si065513. PMID: 17050514.
13. Jahnke K, Schilling A, Heidenreich J, Stein H, Brock M, Thiel E, Korfel A. Radiologic morphology of low-grade primary central nervous system lymphoma in immunocompetent patients. AJNR Am J Neuroradiol. 2005 Nov-Dec;26(10):2446-54. PMID: 16286384; PMCID: PMC7976218.
14. Bernstein M, Hoffman HJ, Halliday WC, Bruce Hendrick E, Humphreys RP. Thalamic tumors in children Long-term follow-up and treatment guidelines.J. Neurosurg. 1984. 649–656. 61(4). DOI link: https://doi.org/10.3171/jns.1984.61.4.0649.
15. Kim JH, Phi JH, Lee JY, Kim KH, Park SH, Choi YH, Cho BK, Kim SK. Surgical Outcomes of Thalamic Tumors in Children: The Importance of Diffusion Tensor Imaging, Neuro-Navigation and Intraoperative Neurophysiological Monitoring. Brain Tumor Res Treat. 2018 Oct;6(2):60-67. doi: 10.14791/btrt.2018.6.e14. PMID: 30381918; PMCID: PMC6212692.
16. Khaw SL, Coleman LT, Downie PA, Heath JA, Ashley DM. Temozolomide in pediatric low-grade glioma. Pediatr Blood Cancer. 2007 Nov;49(6):808-11. doi: 10.1002/pbc.21270. PMID: 17588234.
17. Eissa, Mohamed Khaled; Elbeltagy, Mohamed; Abou-Rahma, Hesham; Negm, Hazem Mohamed; Mansour, Ahmed Said; and Elsisi, Yasser Bahgat (2024) "Role of Surgery in the Prognosis of Pediatric Thalamic Tumors," Menoufia Medical Journal: Vol. 37: Iss. 1, Article 6. DOI: https://doi.org/10.59204/2314-6788.1118.
18. Badejo, O. A., Osobu, B. E., Salami, A. A., Adeyinka, A. O., & Shokunbi, M. T. (2019). Paediatric bilateral thalamic glioma: Case report and literature review. Interdisciplinary Neurosurgery: Advanced Techniques and Case Management, 18. https://doi.org/10.1016/j.inat.2019.100499.
19. Steinbok, P., Gopalakrishnan, C. V., Hengel, A. R., Vitali, A.

M., Poskitt, K., Hawkins, C., Drake, J., Lamberti-Pasculli, M., Ajani, O., Hader, W., Mehta, V., McNeely, P. D., McDonald, P. J., Ranger, A., Vassilyadi, M., Atkinson, J., Ryall, S., Eisenstat, D. D., & Hukin, J. (2016). Pediatric thalamic tumors in the MRI era: a Canadian perspective. Child's Nervous System, 32(2), 269–280. https://doi.org/10.1007/s00381-015-2968-z.

20. Puget S, Crimmins DW, Garnett MR, Grill J, Oliveira R, Boddaert N, Wray A, Lelouch-Tubiana A, Roujeau T, Di Rocco F, Zerah M, Sainte-Rose C. Thalamic tumors in children: a reappraisal. J Neurosurg. 2007 May;106(5 Suppl):354-62. doi: 10.3171/ped.2007.106.5.354. PMID: 17566201.
21. Baregzai Y, Al-Salihi MM, Al Hajali A, Hammadi F, Ayyad A. Ventriculoperitoneal shunt entry points in patients undergoing shunt placement: A single-center study. World Neurosurg X. 2024 Mar 2;23:100337. doi: 10.1016/j.wnsx.2024.100337. PMID: 38497063; PMCID: PMC10937944.

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Intracranial gas containing epidural abscess in a closed traumatic head injury

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ABSTRACT

This paper is intended as an illustrative teaching case. It presents a prototype of a closed traumatic head injury with left frontal convexity extra-axial gas containing abscess, not conclusive on CT scan. The diagnosis was, however, made intra-operatively. It went further to discuss the diagnostic challenges and management pearls of such patients and concluded with a few pertinent take-home messages..

Keywords
aerocele,
non-foul smelly culture negative abscess,
traditional practice

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CASE PRESENTATION

A 17-year-old right-handed immunocompetent Nigerian male, who hit his head against a hanging rail while playing with his friends 7 days prior to presentation, sustained injury to the scalp which was dressed with traditional concoction. He had no loss of consciousness, bleeding from craniofacial orifices or features of raised intracranial pressure (ICP). He however, presented with a 3-day history of altered sensorium, progressive right hemi-body weakness and right focal tonic-clonic seizure lasting 3-10 minutes, averaging 5 episodes per day, with subsequent increasing frequency, necessitating admission. No history of fever.

At presentation to Modibbo Adama University Teaching Hospital Yola, in northeast Nigeria, he was drowsy with Glasgow coma scale score (GCS) of 10 (E3, V2, M5), sluggishly reactive equal pupils, right supranuclear facioparesis and right spastic hemiparesis (with Medical Research Council -MRC- power grade 0). He had a 2x3cm irregular shaped contaminated left frontal scalp wound. However, his vital signs were within normal limits. We made a clinical diagnosis of moderate head injury (GCS 10), with right extra-axial collection likely subacute extradural haematoma.

Cranial computed tomography (CT) scan revealed left frontal scalp soft tissue swelling and aerocele, with no underlying calvarial fracture. There was no evidence of sinus or otologic infection. There was however, a left frontal convexity biconvex ring enhancing air-fluid 6.06

cm mass, abutting on the calvarium, with perilesional oedema, 8.55mm ipsilateral subfalcine herniation and some effacement of the lateral ventricles. We made a diagnosis of left frontal convexity subacute haematoma and aerocele (Figure 1a to c) and the patient was scheduled for urgent left frontal mini-craniectomy and evacuation of left frontal epidural subacute hematoma.

However intraoperatively we found a left frontal scalp wound with purulent discharge, an underlying intact calvarium and egress of approximately 30 millilitres of non-foul-smelling yellowish purulent effluent under pressure following the craniectomy, which was evacuated. The cavity was irrigated with warm saline containing antibiotics until there was egress of clear fluid containing minimal debris. The wound was copiously irrigated and closed with interrupted mattress sutures. He was thereafter, placed empirically on triple parenteral antibiotics consisting of ceftazidime, vancomycin and flagyl for 4 weeks despite the culture yielding no growth and did well. He regained some power in the right lower limb (MRC of at least 3) on the second postoperative day and sat out of bed by himself on the third postoperative day. He was discharged upon completion of parenteral antibiotics on 2 weeks of oral antibiotics, with Glasgow coma scale extended (GOSE) of upper normal and modified Rankin score (mRS) of zero. The post-operative CT scan done at discharge revealed complete resolution of the abscess, with normal brain parenchyma and ventricles (Figure 1d to f). He was seen at 3 months post-discharge with no sequelae.

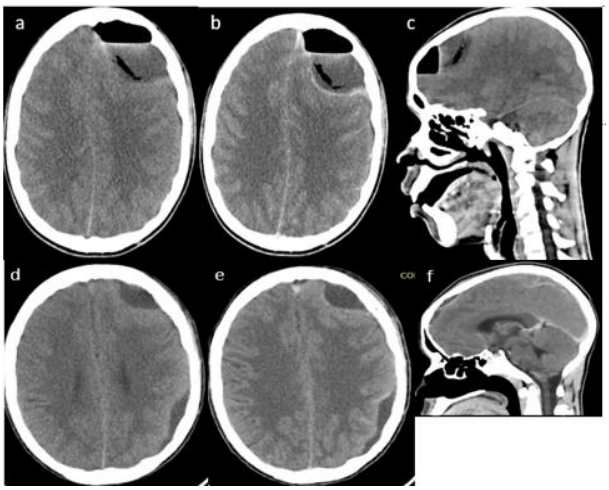

Figure 1. (pre-operative image-a to c)- Cranial CT of a 17-year old with moderate head injury, early focal right tonic-clonic seizure, right supranuclear facioparesis and right spastic hemiparesis showing ring enhancing right frontal air-fluid mass with midline shift. (a) axial pre-contrast, (b) axial post contrast, (c) sagittal pre-contrast. (2-weeks post-operative images-d to f) shows complete replacement of lesion with normal saline- (d) axial pre-contrast. (e) axial post-contrast and (f) sagittal pre-contrast.

Discussion

Intracranial abscess is a focal empyesis surrounded by a vascular capsule [1,2]. Intracranial abscess can be classified [1] based on location (such as frontal, parietal, temporal, occipital, cerebellar abscess, with frontal being the most common followed by cerebellar abscesses [2]), presence or absence of membrane or medullary covering (such as epidural - as seen in our patient-, subdural or intraparenchymal), mechanism (such as contiguous spread from otolaryngologic infection, paranasal sinus infection, mastoid sinus infection, or hematogenous spread from lung abscess, bacterial endocarditis, sequelae of cyanotic congenital heart disease, or iatrogenic or traumatic -as seen in our patient), volume (small <20 mls, medium 21 to 40 mls, large 41 to 60 mls and giant >60 mls), clinical phase (compensation, sub decompensation, moderate decompensation, severe decompensation and terminal phase), loculations (single or multiple), flow phase (acute, subacute or chronic) and number (single or multiple).

Before the advent of third generation cephalosporins and brain imaging, the risk factors for brain abscess are otitis media, paranasal sinus infection, trans mastoid, trauma and distant infection from hematogenous spread especially in children. However, with the advent of third generation cephalosporins and availability of radio imaging tools, there has been reversal of the risk factors [2–4]. The surgical risk factors for intracranial abscess [1] include poor surgical wound debridement following open head injury, late diagnosis of post-traumatic or iatrogenic cerebrospinal fistula, incomplete evacuation of intracranial haematoma or intracranial haematoma managed nonoperatively [5] and foreign body left in the wound (such as sponges or implants). However, in our patient the likely cause was contiguous spread from the overlying obvious scalp infection following traditional concoction application. It can also occur following acute bacterial meningitis [4].

Following the inoculation of the organism, there is initiation of vasculitis associated with arterial thrombosis leading to area of central necrosis [1], surrounded sequentially by zone of inflammatory cells, macrophages and fibroblasts, area of dense collagen capsule, an area of neovascularization in continuity with the outer area of cerebritis and reactive astrocytes, gliosis and area of oedema external to the capsule [2]. Classically, brain abscess evolves through the following stages viz: early cerebritis (1-3 days), late cerebritis (4-9 days), early encapsulation (9-14 days) and late encapsulation (>14 days) stage [2]. Due to the thinness of the capsules in the early stages, especially in the presence of immunosuppression, the abscess could easily spread to distant sites, making it present with multiple intracranial abscesses especially in the setting of brain abscess or subdural empyema.

Intracranial epidural abscess however, is an extramedullary (extra axial) focal empyesis occurring in the space between the periosteum and the periosteal dura. Furthermore, because of the firm attachment of the periosteal dura to the sutural line, the spread of an epidural abscess, similar to extradural haematoma is limited as seen in this patient.

The limiting nature of the epidural abscess, in the absence of subdural or deeper involvement, makes the presentation insidious in onset. However, our patient presented with acute onset of altered mentation, aphasia and right hemiplegia. Other common presentations which were absent in our patient are periorbital cellulitis and frontal oedema [3,6,7]. Most intracranial abscess occur in the second [2] to third decade [8], as seen occurring in the second decade in this patient. The absence of fever and normal white cell count which further confounded the diagnosis of an abscess, could be explained by the thick wall of the abscess seen on the CT scan.

Cranial CT is a cost-effective tool for diagnosing intracranial epidural abscess [6,7]. It usually will show a biconvex extra-axial mass either at the convexity, interhemispheric or skull base, with a thickened underlying dura which is visible following contrast infusion. It may reveal the focus of the infection if it is intracranial and either brain oedema and herniation as seen in our patient. Furthermore, in the case of open traumatic head injury as the risk factor, it can also reveal the overlying skull fracture and intracranial aerocele [9]. However, in our patient although there was obvious intralesional aerocele, there was no obvious calvarial or skull base fracture or intracranial focus of infection on cranial CT scan. Brain magnetic resonance image (MRI) also has a role in delineating the brain lesion interface and revealing thickened dura following gadolinium infusion [6,7]. Diffusion weighted imaging restriction could confirm the diagnosis [7].

Although it has been established that intracranial extradural abscess is insidious in onset, gas containing intracranial abscess can cause rapid clinical deterioration and even death [9]. This explains the rapidity in onset of symptoms (occurring within 3 days) in this patient. Gas containing abscess following trauma is usually as a result of skull base fracture resulting in a potential fistulous tract communicating with the intracranial space [10]. Therefore, the location of the abscess is often in the frontal skull base [9].

However, in our patient it was located in the frontal convexity with no overlying calvarial or skull base fracture. Furthermore, gas containing abscesses are also associated with various gas producing organisms in the brain [10]. The reported causative microorganisms of gas-containing intracranial abscess include Clostridium perfringens, Klebsiella pneumoniae, Pepto streptococcus species, and Fusobacterium nucleatum [9]. Whilst Klebsiella pneumoniae is seen commonly in diabetic and immunosuppressed elderly patients following hematogenous spread, Clostridium perfringens are seen following traumatic inoculation of the pathogen in the young [9]. In order for Clostridium perfringens to multiply, they require exacting conditions of decreased oxidation reduction potential, thereby making them less frequently isolated from intracranial abscess, since the intracranial space has good arterial oxygenation [10]. This might explain the culture of negative abscess in this patient. The only recorded case of contiguous, non-fistulous and non-haematogenous gas containing abscess to the best of our knowledge was due to frontal sinusitis following sinus surgery [9]. This patient however, had no paranasal sinusitis, otitis media or mastoid sinusitis. Furthermore, posttraumatic fungal inoculation has also been recorded in a 21-month old child [11].

Different colours of the intracranial abscess such as white, yellow, green and red have been found to

be associated with causative organisms [8,10]. Grey coloured materials have been found in necrosis of malignant brain tumours and radio necrosis [8]. Reddish materials were associated with Clostridium perfringens in a child with open traumatic head injury, presenting with fever and operated within 48 hours of trauma [10]. However, our patient with gas containing yellowish abscess, had no organism seen nor cultured. Similarly, the study of 400 patients with brain abscesses by Yang et al revealed 171 patients without fever, 121 with normal white cell count and 116 with negative culture abscesses [12].

Because of the rapidity in deterioration and even death in patients with intracranial epidural gas containing abscess, surgery (consisting of either craniotomy and excision of abscess wall or burr hole and drainage of the abscess), microbiological and/ or histological analysis of aspirate and/ or abscess wall biopsy and extended empirical antibiotics of 4-6 weeks (consisting of at least 2 weeks of parenteral antibiotics) which could be reviewed following release of aspirate or biopsy results is usually the strategy of treatment, in all patients presenting with neurologic symptoms [9]. All empirical antibiotics are generally stopped before surgery to boost the yield of microbiology or histology results [2]. Although antibiotics were stopped in our patient, his aspirate culture returned negative and antibiotics were continued empirically since he responded well to the regimen. The type of surgery depends on the associated pathology seen on preoperative imaging [9]. Therefore, craniotomy will be decided when there is an identified fistulous tract needing excision, or frontal sinusitis as the likely aetiology of the abscess needing cranialization of its posterior wall [9]. However, when there are no additional indications necessitating craniotomy, it has been found that the outcome of burr hole drainage is better than that of craniotomy and excision [2]. Our patient however, since he had no identifiable frontal sinusitis and/ or fistulous tract, had mini-craniectomy and evacuation of abscess and did well on empirical antibiotics. Furthermore, in patients with paranasal sinusitis otolaryngologist collaboration should always be sought for a better outcome [8–10,12].

This case is unique in that it is the first case with gas containing abscess diagnosed intra-operatively in a patient with closed head injury and localised infected scalp injury, with no other known clinico-radiological risk factor. Although, a non-gas containing brain abscess has been reported in a diabetic patient with intraparenchymal haematoma following closed head injury and no discernible focus of infection, managed nonoperatively, resulting in abscess and subsequently needing craniotomy and excision of the abscess [5].

Conclusion

In a patient with previously reported lucid interval following trauma, presenting with acute onset of neurologic deterioration and an evidence as little as infected scalp injury and radiologic evidence of extra-axial air-fluid level lesion, a gas containing extra-axial traumatic abscess should always be considered as a differential diagnosis in the management of such patient. To achieve a good outcome, expedited surgical intervention and extended duration of antibiotics should be initiated.

References

1. Byvaltsev V.A, Kalinin A.A, KhachiKyan A.F, Zhdanovich G.S, Egorov A.V, Panasenkov S.Y, et al. THE NEW ARMENIAN MEDICAL JOURNAL A Case of Successful Treatment of Post-traumatic Frontal Lobe Brain Abscess in Patient During Subacute Period of Penetrating Craniocerebral Trauma. 2015.
2. Singh, Y. , Gupta, T. , Jaiswal, G. and Lodha, K. (2020) Intracranial Abscesses: An Institutional Study. Open Journal of Modern Neurosurgery, 10, 297-306. doi: 10.4236/ojmn.2020.102032.
3. Belden, Katherine; Jallo, Jack; and Mwamuka, Linda (2020) "Epidural Abscess of the Central Nervous System," JHN Journal: Vol. 15: Iss. 1, Article 4. DOI:https://doi.org/10.29046/JHNJ.015.1.003 Available at: https://jdc.jefferson.edu/jhnj/vol15/iss1/4
4. Lisandra SD, Carlos Jaime de AF, Eveline FNV, Roberto da JPN (2014) Cranial Epidural Abscess Successfully Treated with Conservative Measures: Case Report. J Neuroinfect Dis 5: 154. doi:10.4172/ 2314-7326.1000154
5. Thomas SG, Moorthy RK, Rajshekhar V. Brain abscess in a non-penetrating traumatic intracerebral hematoma: case report and review of literature. Neurol India. 2009 Jan-Feb;57(1):73-5. doi: 10.4103/0028-3886.48812. PMID: 19305084.
6. Fountas KN, Duwayri Y, Kapsalaki E, Dimopoulos VG, Johnston KW, Peppard SB, Robinson JS. Epidural intracranial abscess as a complication of frontal sinusitis: case report and review of the literature. South Med J.

2004 Mar;97(3):279-82; quiz 283. doi: 10.1097/01.SMJ.0000117331.31320.83. PMID: 15043336.
7. Pradilla G, Ardila GP, Hsu W, Rigamonti D. Epidural abscesses of the CNS. Lancet Neurol. 2009 Mar;8(3):292-300. doi: 10.1016/S1474-4422(09)70044-4. PMID: 19233039.
8. Kural C, Kırmızıgoz S, Ezgu MC, Bedir O, Kutlay M, Izci Y. Intracranial infections: lessons learned from 52 surgically treated cases. Neurosurg Focus. 2019 Aug 1;47(2):E10. doi: 10.3171/2019.5.FOCUS19238. PMID: 31370013.
9. Su TM, Lan CM, Lee TH, Hsu SW. Gas-containing brain abscess: etiology, clinical characteristics, and outcome. Kaohsiung J Med Sci. 2014 Dec;30(12):619-24. doi: 10.1016/j.kjms.2014.10.003. Epub 2014 Nov 15. PMID: 25476100.
10. Young RF, Frazee J. Gas within intracranial abscess cavities: an indication for surgical excision. Ann Neurol. 1984 Jul;16(1):35-9. doi: 10.1002/ana.410160108. PMID: 6147117.
11. Tekkök IH, Higgins MJ, Ventureyra EC. Posttraumatic gas-containing brain abscess caused by Clostridium perfringens with unique simultaneous fungal suppuration by Myceliophthora thermophila: case report. Neurosurgery. 1996 Dec;39(6):1247-51. doi: 10.1097/00006123-199612000-00039. PMID: 8938783.
12. Yang SY. Brain abscess: a review of 400 cases. J Neurosurg. 1981 Nov;55(5):794-9. doi: 10.3171/jns.1981.55.5.0794. PMID: 7310502.

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Drains vs. no drains following burr-hole evacuation of chronic subdural hematoma

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Abstract

Objectives: The purpose of this study was to examine the recurrence of chronic subdural hematomas after burr hole evacuation with and without the use of a subdural drain. The study was designed as a randomised control study. Setting: UPUMS SAIFAI Department of Neurosurgery. Duration: The research lasted from August 2022 to December 2023. Inclusion Criteria Male and female 18-80 years old with persistent subdural hematoma with a midline displacement of more than 5mm on CT scan**.**

Exclusion Criteria: Bilateral chronic subdural haemorrhage on CT scan, recurrent CSDH, patients with shunt in-situ, patients with bleeding-related conditions (INR > 2.5, BT > 7 min, count of platelets < 60000) or on anticoagulant drugs, patients with severe systemic ailment such as renal failure (Serum Creatinine > 2.5), chronic liver disease (ultrasound shows liver cirrhosis and splenomegaly) and known ischemic heart disease were excluded from this study

Materials and Methods: In this study, 100 participants were randomly assigned to two equal groups. Persons who met the inclusion criteria were enrolled in the trial through the emergency room and OPD. All patients were prepared for surgery, and their informed permission was obtained. All patients were treated identically as per usual ward regular practice, with the exception that the treatment choice (whether to use the drain or not) was determined by randomization; Group A with drain and Group B without drain. All patients were discharged on the third postoperative day and were observed for 6 months.

Results: Recurrence occurred in just 19 (19%) of the individuals. Four of these 19 patients are in the drain group, whereas the remaining 15 are no drain. While no recurrence was detected in 81 (81%) of the patients [group A: 46 (92%) vs. group B: 35 (70%)]. The difference between the two groups was statistically insignificant.

Conclusion: Based on the findings of this study, it was concluded that there is no significant difference between the two groups and that recurrence will occur whether a drain is placed or not; however, it was also discovered that the rate of recurrence was lower with a subdural drain than without a drain after burr hole evacuation of chronic subdural hematoma. Some additional component may be involved in recurrence, necessitating a lengthy investigation to make a solid judgement.

Keywords
chronic subdural haemorrhage, burr-hole craniostomy, drain, recurrence

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Introduction

Globally, the elderly population is growing significantly. 1 Elderly trauma patients encounter distinct problems and suffer more barriers to healing than their younger counterparts. 2 Chronic subdural hematoma (CSDH) is one of the pathological sequelae of old brain

injury as a result of mild head trauma, which accounts for roughly 20% of cases in one geriatric research. 3 The average duration between injury and development of symptoms was six weeks.

Clinical symptoms include reduced level of awareness, headache, difficulties with walking or balance, cognitive dysfunction or memory loss, motor deficiency, headache, or aphasia.5 Chronic subdural haematomas develop from the liquefaction of an acute subdural haematoma, especially if it is silent. In a recent assessment of over 800 non-operatively treated acute SDHs, hematomas less than 10 mm in maximal thickness invariably cleared spontaneously, but those higher than 10 mm in maximal thickness progressed into chronic SDHs.26

Chronic subdural haemorrhage developed from ASDH may develop membranes between the dura mater and the haematoma after one week and membranes between the brain and the haematoma after three weeks. New weak vessels may develop into these membranes and, if not resorbed, might continually haemorrhage, increasing the hematoma. 5 Another mechanism contributing to CSDH growth is the stretching of crossing veins, which are securely attached at their pial and dural ends, by the decreasing brain in the old, until enough momentum may be created by only a modest force to trigger rupture by stretching or shearing.5

Patients with no apparent mass effect on imaging studies and no neurologic symptoms or signs other than moderate headache should be monitored with successive CT scans of the brain to evaluate if they stay stable or resolve. Although hematoma resolution has been documented, it cannot be anticipated with any certainty, and no medical therapy has been found to be useful in hastening the clearance of acute or chronic subdural hematomas. A stand-alone treatment with dexamethasone is plausible for multi-morbid individuals at high surgical risk.23 Based on the existing evidence, no official recommendations for the use of preventive anticonvulsants in patients with persistent subdural hematoma can be given.24 Drainage through 1 or 2 burr holes is routinely used to treat liquefied chronic subdural hematomas (CSDHs). The burr holes are strategically positioned so that conversion to a craniotomy may be possible. Sometimes a closed drainage system is left in the subdural space for 24 to 72 hours after surgery.14 Chronic subdural hematoma is a frequent neurosurgical problem, and surgical treatment options include twist drill craniotomy, bur hole drainage, and more radical craniotomy and membranectomy. However, with adequate therapy, the prognosis is often favourable.22 The technique is chosen based on the location, size, and thickness of the haematoma, the patient's general medical state, and the choice of the on-call surgeon. Despite these therapeutic options, the recurrence rate for CSDHs is between 5% and 33%.15. The recurrence of CSDH following the initial drainage treatment is between 5 and 30%.

At 6 months, death rates for patients with and without drains were (86% and 181%, respectively). 5 According to Weigel et al's meta-analysis, there was no significant difference in mortality between the three approaches. Morbidity was much greater in the craniotomy series (12.3%) than in the twist drill (3%) or burr hole (3.8%) craniostomies. Twist drill craniostomy showed a lower recurrence rate than burr hole craniostomy and craniotomy. 6 Hong-Joon Han et al. conclude that CSDH can be effectively evacuated using a single burr hole craniostomy, which is a less invasive method that takes less time and has a lower recurrence rate. 7 In a recent Pakistani study of 60 persons of Chronic SDH, in the majority of patients i.e. 46 (76.7%), drain was removed in 4 days or less. 8

Convulsions, intracerebral bleeding, and subdural empyema are well-known consequences after surgical removal of a persistent subdural haemorrhage. 9 According to Taussky P et al, treating CSDH with a single burr hole is linked with a considerably greater postoperative recurrence rate, longer admission period, and greater wound infection rate. If subdural drains are implanted after CSDH evacuation via a burr hole, patients had a decreased risk of recurring procedures. 11 Although there is a trend to reduce surgical treatments for persistent subdural haemorrhages there is no consensus on the best management.21

So far, there has been debate on the need of drains following burr hole evacuation for chronic subdural haemorrhage.The purpose of this study was to document the incidence of recurrence following the use of a drain after burr hole evacuation for chronic subdural hematoma in order to reduce the number of procedures in elderly patients. Our findings will aid in the development of recommendations for the surgical therapy of patients with chronic subdural haemorrhage.

Material and methods

This randomised controlled study was carried out at the UPUMS SAIFAI Department of Neurosurgery. The research was done between August 2022 and December 2023.Using probability purposive sampling, the sample size was set at 100 cases (50 in Group A and 50 in Group B). A sample size of 100 patients (50 in each group) was estimated using 80% power of test, 7.5% margin of error, and the predicted proportion of recurrence following burr hole evacuation of chronic subdural haemorrhage which was 8% and 30%, respectively.

We recruited individuals of both sexes with CSDH requiring burr hole evacuation and Chronic Subdural haemorrhage with a midline displacement of more than 5mm on CT scan. Patients with chronic subdural haemorrhage symptoms and signs verified by CT scan were also taken. Patients with CSDH requiring surgical treatment other than burr hole evacuation, patients with bilateral chronic subdural haemorrhage on CT scan, patients who had an operation for drainage of an ipsilateral CSDH within six months prior to admission confirmed from patient record, patients with CSF shunt in-situ confirmed from patient record and CT scan, patients with bleeding disorders (INR > 2.5, BT > 7 min, platelet count 60000), patients on anticoagulant drugs confirmed from availability CKD (Serum Creatinine > 2.5), chronic liver disease (ultrasound shows liver cirrhosis and splenomegaly) and uncontrolled DM (BSF > 126) and known IHD were excluded from this study

Procedure for Data Collection Patients who met the inclusion criteria were enrolled in the emergency and outdoor settings. Before surgical intervention, the patient/next of kin provided informed written permission. Name, age, gender, and address were among the demographic details recorded. There was no ethical dilemma. The thickness and midline displacement induced by the haemorrhage were assessed using the available CT image of the patient site. Bur hole evacuation was used to operate on all of the patients. Patients were treated exactly as per usual ward regular practice, with the exception that the treatment choice (whether to utilise the drain or not) was determined by randomization using a random # Table, Group A with drain and Group B without drain. After the procedure, the patient was admitted to the hospital and placed in the intensive care unit (ICU). Each patient was followed for recurrence at 15th day then finally at 01 month.

SPSS 20 was used for data analysis to compare variables of interest between two groups. The recurrence at one month was an interesting variable. The frequency distribution table and percentages were used to show qualitative data [sex (male/female), recurrence]. Age was reported quantitatively as a mean and standard deviation. The primary outcome metric was recurrence, which was represented as a frequency distribution. Fisher's exact test was used to compare the result of chronic subdural haematoma recurrence following burr hole evacuation in both groups. P <0.05 was regarded as significant. The date was stratified based on the age of the patients (<65 years, more than 75 years).

Results

In this study, the mean age of all the patients was calculated as 67.02 ±8.30 years with minimum and maximum age as 31 and 85 years respectively .The mean ages of patients in group A and B was69.7 ±11.30 year and 64.40 ±10.45 years respectively. There were 32 (32%) female and 68 (68%) male patients. So the most of the patients were male and male-to-female ratio was observed as 2:1.

Results of this study showed that there were 47 (47%) patients who had hematoma on right side out of which 20 were randomized into with drain group and 27 were randomized into without drain group. Similarly, there were 53 (53%) patients who had hematoma on left side, out of which 30 were randomized into with drain group and 23 were randomized into without drain group. It was revealed from analysis of the data that all the patients had Fronto-parietal location of hematoma.

Descriptive analysis of the data showed that the mean midline shift was 10.40 ± 1.03 mm with minimum and maximum midline shift as 5 and 20mm respectively. 7 The mean midline shift of patients in group A and B was10.10 ± 2.13 mm and 10.80 ± 1.12 mm respectively . There was insignificant difference between both groups for mean midline shift.

It was revealed that there were only 19 (19%) patients who develop hematoma again or simply say recurrence occurred. Out of these 19 patients 4 belong to group A; in which drain was placed while 15 belong to without drain group. While in 81(81%) patients no recurrence was observed [group A: 46

(92%) vs. group B: 35 (70%)]. The difference between both groups was seemed to be insignificant

Table 1. (pre-operative image

		Drain 50	No Drain 50	Total 100	P-vaule
	Age (years) (mean ± S.D	69.7 ±11.30	64.40 ±10.45	67.02 ±8.30	NS [1]
	Midline shift (mean ± S.D)	10.10 ± 2.13	10.80 ± 1.12	10.40 ± 1.03	NS [1]
Gender	Male	35 70%	33 66%	68	NS [2]
	Female	15 30%	17 34%	32	
Anatomical side	Right	20 40%	27 54%	47	NS [2]
	Left	30 60%	23 46%	53	
Recurrence of hematoma	Yes	4 8%	15 30%	19	NS [3]
	NO	46 92%	35 70%	81	

1. p-value was calculated using independent sample t-test
2. P-value was calculated using chi-square test
3. P-value was calculated using Fisher's exact test

Discussion

In our study, individuals with CSDH who were not treated with subdural drainage had a greater recurrence rate than those who were treated with subdural drainage, however this didn't reach statistical significance. Patients with and without subdural drains showed comparable functional status and GOS at discharge. Our findings (recurrence of 8% for drainage and 30% for no drainage) are consistent with those of previous studies published in the literature. In comparison to our study (10% vs. 30%), Wakai and colleagues found recurrence rates of 5% for drain and 33% for no drain. Tsutsumi et al. reported 3.1% and 17% rates, respectively.20 We also found recurrence rates that are quite comparable to those reported in the Lind et al retrospective research, which revealed recurrence rates of 10% for drain and and 19% for no drain.11 Santarius et al., on the other hand, observed recurrence in 10 of 108 (93%) patients with a drain and 26 of 107 (24%) patients without a drain, which was statistically significant (p = 003).5 They discovered that medical and surgical complications were comparable across research groups.

We considered 100 patients in this investigation. The average age of all patients with CSDH was 67.02 8.30 years, with more than half of the cases being older than 60 years. Chronic subdural haemorrhage appears to be most common in the fifth to seventh years of life. According to reports, 56% of patients in their fifth and sixth decades had CSDH. Adults aged 70-79 years have the greatest incidence (7.35 occurrences per 100,000 population).12,13,16

There were 32 female patients and 68 male patients. As a result, the majority of the patients were male, with a male to female ratio of 2:1. These findings were consistent with previous research. Subdural hematomas are more prevalent in males than in women, with a roughly 3:1 male to female ratio. Men are also more likely than women to develop persistent subdural hematoma. According to reports, the male to female ratio is 2:1. These are implausible coincidences, given males are more likely than women to get a head injury.13,16

There were 47 (47%) patients with CSDH on the right side and 53 (53%) patients with CSDH on the left side, and the site of CSDH was fronto-parietal in all patients. Mori's research, which similarly found a high proportion of CSDH on the left side (69.6%), concurred that there were more patients with CSDH on the left side.16

This investigation also detected the midline shift, with the mean midline shift being 10.40 1.03mm. The significant finding of this study was the recurrence of hematoma one month following the operation. Recurrence occurred in just 19 (19%) of the individuals. Four of these 19 patients are in the drainage group, whereas the other 15 are not. While the remainder of the individuals showed no signs or symptoms, there was no recurrence on CT scan. The difference between the two groups was minor, but the increased frequency of recurrence in group B (without drain) demonstrated that drain is favourable when compared to no drain. CSDH recurrence a after burr hole craniostomy is not rare, incidence is 7% – 18%.18-21 Our findings were similarly comparable to those of a previous research done by A and published by Shameem et al, in which symptomatic recurrence was identified in 16% and

23% of patients, respectively, compared to 10% and 30% in our investigation. 25 The rate of recurrence was lower in individuals who received a subdural drain than in those who did not. However, no statistically significant difference existed between the two groups.25 Several studies now suggest leaving a closed-system drainage following CSDH irrigation to enhance outcomes and reduce the likelihood of recurrence. However, the use of a drainage system is still debatable.19,13 The insertion of the drain, it is thought, can greatly reduce the risk of symptomatic recurrence and therefore the necessity for re-operation. Despite the fact that some writers support drainage there have been only a few attempts to clarify this question with prospective studies. 19-20

Wakai et al. provide a prospective comparative analysis of 38 patients who were randomly randomised to burr-hole irrigation with closed-system drainage or irrigation without closed-system drainage. According to the findings of this study, closed-system drainage following burr-hole irrigation greatly lowers the recurrence rate of CSDHs.

Closed system drainage dramatically decreased the risk of symptomatic recurrence of CSDHs in a larger, better planned, more recent prospective randomised research. In this study, the investigators randomly allocated 257 consecutive adult patients with CSDHs to one of two surgical groups: group 1 received one burr-hole irrigation of the hematoma cavity with closed-system drainage, while group 2 had just one burr-hole irrigation with no drainage. The rates of recurrence after irrigation with and without closed system drainage were considerably different: 3.1% with closed system drainage and 17% with burr-hole irrigation alone.20 Most neurosurgeons avoid using drains due to concerns about increased surgical risk. We also discovered that the CD group had higher surgical problems. Some neurosurgeons insert a subdural drain for a day or two to avoid recurrences; others do not for fear of puncturing the cortex and creating an intracerebral or subdural haemorrhage or the creation of a bacterial subdural empyema.23.

Conclusion

The majority of the participants (81%) recovered from burrhole craniostomy, and no recurrences were recorded. However, some individuals (19%) experience haemorrhage recurrence. According to the findings of this study, there is no significant difference between the two groups, and recurrence will occur whether the drain is placed or not. However, the rate of recurring was lower with subdural drain than without drain after burr hole evacuation of chronic subdural haemorrhage More research with a bigger sample size is needed to answer the puzzle of dispute. Furthermore, it is critical to discover characteristics that contribute to a high or low recurrence rate in the treatment of CSDHs since this may aid in the selection of suitable surgical methods and postoperative therapy.

References

1. Le Roux A, Nadvi S. Acute extradural haematoma in the elderly. British journal of neurosurgery, 2007; 21 (1): 16-20.
2. Callaway DW, Wolfe R. Geriatric trauma. Emer Med Clin N Amer. 2007; 25: 857-60.
3. Sinha V, Gupta V, Singh DK, Chopra S, Gupta P, Bagaria H. Geriatric head injuries—Experience and expectations. The Indian Journal of Neurotrauma, 2008; 5 (2): 69-73.
4. Soto-Granados M. Treatment of chronic subdural haematoma through a burr hole. Cir Cir. 2010; 78 (3): 203-7.
5. Santarius T, Kirkpatrick PJ, Ganesan D. Use of drains versus no drains after burr-hole evacuation of chronic subdural haematoma: a randomized controlled trial. The Lancet, 2009; 374 (9695): 1067-1073.
6. Weigel R, Schmiedek P, Krauss JK. Outcome of contemporary surgery for chronic subdural haematoma: evidence based review. Journal of Neurology, Neurosurgery & Psychiatry, 2003; 74 (7): 937-43.
7. Han HJ, Park CW, Kim EY, Yoo CJ, Kim YB and Kim WK. One vs. Two Burr Hole Craniostomy in Surgical Treatment of Chronic Subdural Haematoma. J Korean Neurosurg Soc. 2009; 46 (2): 87–92.
8. Ishfaq A, Ahmed I, Bhatti SH .Effect of head positioning on outcome after burr hole craniostomy for chronic subdural haematoma. Journal of the College of Physicians and Surgeons Pakistan, 2009; 19 (8): 492-495.
9. Yi-hui Ma, Zhou Fei. Management of chronic subdural haematoma. The Lancet, 2010; 375 (9710): 195.
10. Taussky P, Fandino J, Landolt H. Number of burr holes as independent predictor of postoperative recurrence in chronic subdural haematoma. Br J Neurosurg. 2008; 22 (2): 279-82.
11. Lind CR, Lind CJ, Mee EW. Reduction in the number of repeated operations for the treatment of subacute and chronic subdural haematoma by placement of subdural drains. J Neurosurg. 2004; 100 (1): 169-70.
12. Hackney D. Radiologic imaging procedures. In: Goldman L, Ausiello D, eds. Cecil Medicine. 23rd ed. Philadelphia,

Pa: Saunders Elsevier; 2007: chap 419.
13. Cohen M, Scheimberg I. Subdural haemorrhage and child maltreatment. Lancet, 2009; 373 (9670): 1173.
14. Muzii VF, Bistazzoni S, Zalaffi A, Carangelo B, Mariottini A, Palma L. Chronic subdural hematoma: comparison of two surgical techniques. Preliminary results of a prospective randomized study. J Neurosurg Sci. 2005; 49 (2): 41-6.
15. Sambasivan M. An overview of chronic subdural hematoma: Experience with 2300 cases. Surg Neurol. 1997; 47: 418-22.
16. Mori K, Maeda M. Surgical treatment of chronic subdural hematoma in 500 consecutive cases: clinical characteristics, surgical outcome, complication and recurrence rate. Neurol Med Chir (Tokyo), 2001; 41: 371-81.
17. Ernestus RI, Beldzinski P, Lanfermann H, Klug N. Chronic subdural hematoma: Surgical treatment and outcome in 104 patients. Surg Neurol. 1997; 48: 220-5.
18. Matsumoto K, Akagi K, Abekura M, Ryujin H, Ohkawa M, Iwase N, et al. Recurrence factors for chronic subdural hematomas after burr-hole craniostomy and closed system drainage. Neurol Res. 1999; 21: 277-80.
19. Mellergard O, Wisten O. Operations and re-operations for chronic subdural hematomas during a 25 – year period in a well defined population. Acta Neurochir (Wein), 1996; 138: 708-13.
20. Tsutsumi K, Maeda K, Iijima A, Usui M, Okada Y, Kirino T. The relationship of preoperative magnetic resonance imaging findings and closed system drainage in the recurrence of chronic subdural hematoma. J Neurosurg. 1997; 87: 870-5.
21. Khadka NK, Sharma GR, Roka YB, Kumar P, Bista P, Adhikari D, Devkota UP. Nepal Med Coll J. Single burr hole drainage for chronic subdural hematoma, 2008 Dec; 10 (4): 254-7.
22. Gökmen M, Sucu HK, Ergin A, Gökmen A, Bezircio Lu H. Randomized comparative study of burr-hole craniostomy versus twist drill craniostomy; surgical management of unilateral hemispheric chronic subdural hematomas. Zentralbl Neurochir. 2008 Aug; 69 (3): 129-33. Doi: 10.1055/s-2007-1004587. Epub 2008 Jul 29.
23. Stephan Emich1*, Bernd Richling2, Marc R McCoy3 , Rahman Abdul Al-Schameri1 , Feng Ling4 , Liyong Sun4 , Yabing Wang4 and Wolfgang Hitzl2 . The efficacy of dexamethasone on reduction in the reoperation rate of chronic subdural hematoma – the DRESH study: straightforward study protocol for a randomized controlled trial. Trials, 2014, 15: 6. Doi: 10.1186/1745-6215-15-6.
24. Anticonvulsants for preventing seizures in patients with chronic subdural haematoma. Ratilal BO1 , Pappamikail L, Costa J, Sampaio C. Cochrane Database Syst Rev. 2013 Jun. 6; 6: CD004893. Doi: 10.1002/14651858.CD004893.pub3.
25. A Shameem .MS, Agrawal D .M Ch, Kale SS M Ch et al, Department of Neurosurgery, JPN Apex Trauma Centre, All India Institute of Medical Sciences, New Delhi, India. A comparative study of treatment of chronic subdural hematoma – burr hole drainage versus continuous closed drainage ..Indian Journal of Neurotrauma (IJNT1), 2011; Vol. 8, No. 1: pp. 17-24.
26. Z J. Chris. H Leo. B M Ross. Surgical Management of Traumatic Brain Injury. Youmans Neurological Surgery, 2011, Vol. 4: pp. 3447-3448.

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Comparison between minimally invasive percutaneous pedicle screw fixation versus open pedicle screw fixation for geriatric osteoporotic spine fracture in a rural hospital

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Abstract

Background: Research aimed to see if minimally invasive percutaneous pedicle screw fixation (MIPPS)or open pedicle screw fixation (OPS) worked effectively for geriatric osteoporotic fractures (#) of the spine.

Methods: In the department of neurosurgery at the tertiary care centre, 60 cases of geriatric osteoporotic vertebral # were divided into a MIPPS set (n=30 MIPPS) and an OPS set (n=30, conventional OPS).

Results: The experimental set surgical time, surgical bleeding, incision size, days of hospital stay, and incidence of postoperative complications were smaller than those in the control set (all P <0.05). Both sets' Visual Analogue Scale (VAS) and Oswestry Disability Index (ODI) improved 6 months following surgery, with the experimental set showing the most improvement (all P<0.05).

Conclusions: Both sets of MIPPS and OPS may accomplish adequate internal fixation, with the former having reduced trauma, a less surgical duration, a quicker recovery, fewer postsurgical problems, and less post-surgical discomfort.

Keywords
minimally invasive spine surgery, osteoporotic fracture

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Introduction

Osteoporosis is a frequent condition among the aged, particularly among women. Because of loss of bone density and failure of bone microarchitecture in patients, osteoporotic # can be readily caused by little external force; this is typical in wrists, spines, and hips [1]. One of the leading causes of disability and mortality in the elderly is osteoporotic vertebral fracture # (OVF) [2]. The question of how to enhance the therapy of geriatric OVF has become a research hotspot as well as a tough issue. Geriatric OVF treatment aims to promote fracture healing, decrease operative problems, improve immediate and long-term postoperative life quality, and avoid secondary fracture. conservative and surgical therapy options are available. Bed rest, lower back functional exercise, and medication therapy are the most common noninvasive treatments. Conservative therapy can help to avoid operation morbidity, but it can also cause bedsores, hypostatic

pneumonia, and unpleasant symptoms including low back discomfort due to its inability to maintain vertebral height [2]. At the moment, geriatric OVF is generally treated surgically, with OPS as the standard operational approach. Pedicle screws have high biological stability and can offer effective fixation [3]. An open procedure, on the other hand, entails a vast operating region and may result in surgical trauma as well as several postoperative problems [4]. Although MIPPS is a relatively new surgical option, its clinical efficacy is still debated. The effectiveness of MIPPS was investigated in this study.

Methods

From August 2022 to December 2023, 60 peoples with geriatric OVF were treated in the department of neurosurgery at a tertiary care center, with 42 males and 18 females ranging in age from 60 to 81 years.

Criteria for inclusion: 1) people aged 60 years; 2) people diagnosed with osteoporosis in bone density examination (t value of -2.5 or more) and compression fracture of the spine with fracture time not exceeding 1 month by imaging examination [4]; 3) people diagnosed with single vertebral fracture; 4) people without nerve injury; 5) people who signed an informed consent form.

Criteria for exclusion: 1) people with numerous vertebral body fractures; 2) people complicated by serious internal medicine disorders or organ failure; 3) people with old injuries; This study was approved by the Ethics Committee of Affiliated Hospital The people and their families were informed and gave their consent and the research conformed to the provisions of the Declaration of Helsinki.

Operative methods

Each patient was given GA and tracheal intubation before being positioned in the prone posture with their abdomen in the air. The same set of doctors treated all of the patients. The OPS set received traditional open reduction and internal fixation. The location of the injured vertebra was found using a C-arm X-ray machine, and the injured vertebra was used as the center point for a spinal posterior longitudinal incision, on which the incision was created conventionally, and the position of the wounded vertebra was exposed. Two pedicle screws were inserted into the upper and lower vertebrae and secured with connecting rods until adequate reduction was achieved. To avoid infection, patients were frequently given perioperative antibiotics [5]. The MIPPS set had treatment with percutaneous pedicle screw fixation, which was less invasive. A C-arm x-ray machine was used for anteroposterior fluoroscopy, and the entry point of pedicle screws was identified by the junction of four 2.0 Kirschner wire projection lines. Then, a 1.5-2.0 cm longitudinal incision was made at the entrance point of the pedicles to bluntly separate the surrounding muscles, clear exposed joints, and introduce a location pin (notice that the angle of pin insertion should be abducted by 10-15 degrees). Under fluoroscopy, an expanding duct was introduced along the pin, a functioning channel was installed, and pedicle screws were fastened in. A curved fixe bar was introduced from top to bottom through subcutaneous muscle tissue, and the screw is tightened the C-arm x-ray equipment was used to guide the reduction and fixing procedures. After washing the incision, the skin was sutured [5]. (Figure 1)

Complications were treated as follows. 1) Active exercise for patients with deep venous thrombosis to help exercise ankles, knees, and hip joints following surgery, as well as to apply medications that block thrombosis in the meanwhile. 2) For delayed union, we appropriately treated the union, observed whether or not the union could be effective, performed internal fixation when the union was unsuccessful, and added external fixation as needed.

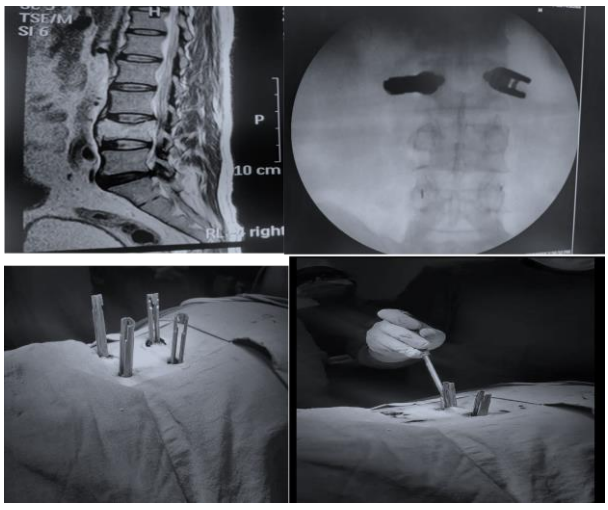

Figure 1. Minimally invasive percutaneous pedicle screw fixation

Outcome measures

The following were the primary outcome measures.

1) Imaging diagnostic indexes: Pre- and post-surgery percentages of vertebral height, kyphotic angle, and disc height. The percentage of vertebral body height equals the front height of the damaged vertebra/the average height of the front of the upper and inferior vertebral bodies multiplied by 100%. In the damaged vertebra, the kyphotic angle is the angle formed between the upper endplate of the upper vertebral body and the lower endplate of the inferior vertebral body. The gap between the damaged vertebra and the lower vertebral body is referred to as disc height. 2) Clinical effect: 6 months after surgery, VAS and ODI [6, 7]. The patients judged their pain based on their own emotions. The greater the VAS score, the more critical the pain. The ODI addressed ten different facets of pain, including pain degree, daily self-care, sitting, standing, walking, carrying things, sexual life, social life, sleep problems, and tourism. The more serious the malfunction, the higher the ODI score.

Secondary outcome measures include: Variables during surgery: The surgery time, intraoperative blood loss, incision length, and days of hospitalization of the two sets were examined and compared. Postoperative problems (such as delayed union, deep vein thrombosis, and so on) were compared between the two groups. Indicator of discharge: The wound healed quickly. There were no problems or they were addressed.

Statistical analysis the data were statistically analyzed with SPSS 19.0. Measurement data was expressed as mean ± standard deviation. Independent sample t test was used for comparison between the two groups. The enumeration data were processed with $\chi 2$ test and expressed in $\chi 2$. $P<0.05$ is statistically significant.

Results

In the OPS sets 30 patients (20 males and 10 females) received OPS, and 30 patients (22 males and 8 females) in the MIPPS set received MIPPS. There were no significant differences in gender or age between the two groups (both $P>0.05$). Refer Table 1. Evaluation of perioperative factors between the two groups surgical time in the MIPPS set was lesser than that in the OPS set (81.75±11.58minutes vs. 108.62±17.34 minutes respectively, $P<0.05$). surgical bleeding in the MIPPS set was significantly lower than that in the OPS set (70.48±15.86mL vs. 278.20±44.13 mL respectively, $P<0.05$). Incision size in the MIPPS set was significantly smaller than that in the OPS set (5.34±2.52 cm vs. 13.89±1.43cm respectively, $P<0.05$). The surgical time, surgical bleeding, incision size and hospitalization days in the MIPPS set were all significantly decreased than those in the OPS set

Table 1. Evaluation of perioperative variables.

	OPS set	MIPPS set	P value
Case	30	30	
Age	71.22±9.41	72.22±8.50	NS
Gender M/F	20/10	22/8	NS
Surgical time (min)	108.62±17.34	81.75±11.58	**<0.05**
Surgical bleeding (mL)	278.20±44.13	70.48±15.86	**<0.05**
Incision size (cm)	13.89±1.43	5.34±2.52	**<0.05**
Days of hospital stay (day)	15.15±4.41	7.85±1.23	**<0.05**

Imaging diagnostic indicators were compared between the two sets before and after internal fixation. Before surgery, there was no significant difference in the percentage of vertebral size, kyphotic angle, or disc size between sets (all $P>0.05$). One week and six months after surgery, the percentage of vertebral size and disc size rose in the MIPPS and OPS sets, but the kyphotic angle reduced in the MIPPS set (all $P<0.05$).

VAS scores were compared between the two sets before and after surgery. Before surgery, there was no significant difference in VAS across sets ($P>0.05$). Six months after surgery, both groups' VAS ratings were reduced (both $P<0.05$).

ODI comparison between the two sets before and after surgery There was no significant difference in ODI between sets before internal fixation ($P>0.05$). ODI of the two sets reduced significantly six months after surgery (both $P<0.05$),

Table 2. Evaluation of outcome and imaging diagnostic Indexes.

	OPS set	MIPPS set
VAS		
Before SURGERY	8.2±1.12	8.8±1.01
6 months after fixation	5.2±1.03*	3.7±1.04*
ODI		
Before SURGERY	42.2±2.45	44.2±2.06
6 months after fixation	18.2±2.08*	10.2±1.98*

Percentage of vertebral height (%)		
Before fixation	58.11±17.08	55.13±20.33
1 week after fixation	88.41±10.11*	89.37±9.07*
6 months after fixation	86.38±9.59*	87.93±9.35*
Kyphotic angle (°)		
Before SURGERY	15.92±4.61	16.05±5.37
1 week after fixation	5.66±1.24*	4.60±1.36*
6 months after fixation	6.41±1.90*	5.93±1.07*
Disc height (mm)		
Before SURGERY	6.32±1.07	6.90±1.85
1 week after fixation	23.11±4.03*	22.32±5.07*
6 months after fixation	21.97±5.39*	21.15±5.81*

Compared with before internal fixation in the same set, *P<0.05.

In the comparison of postoperative complications between the two sets, there was one instance of screw position errors, one case of deep venous thrombosis, one case of soft tissue infection, and two cases of delayed union in the OPS set (30 cases). There was only one occurrence of delayed union in the MIPPS set. There was no screw loosening in either set. The MIPPS set had fewer postoperative complications than the OPS set, although there was no statistical difference.

Table 3. Evaluation of postoperative complications

	OPS set 30	MIPPS set 30	P value
Screw position error	1	0	
Deep venous thrombosis	1	0	
Soft tissue infection	1	0	
Delayed union	2	1	
Total (n, %)	5 (16.66%)	1(3.33%)	NS

Discussion

One of the most frequent disorders among the elderly is osteoporosis [8]. geriatric OVF is a common and dangerous osteoporosis consequence. In the clinic, conservative and surgical therapies for geriatric OVF are primarily used. Conservative therapy may result in an array of problems with no clear impact [9]. As a result, when their conditions may be fulfilled, patients frequently choose surgical therapy. The fundamental goal of surgical therapy is to alleviate pain, enhance fracture healing, prevent postoperative complications, and improve a people's standard of life [10]. Its surgical methods include OPS and MIPPS.

Traditional OPS fixation can provide good correction effects and contribute to spinal stabilization, but it requires a more than 10 cm long incision along the patient's back and the removal of an extensive portion of paravertebral muscles, which harms surrounding soft tissue, causes reduce postsurgical recovery, and may also cause paraspinal muscle destruction and leave complications such as chronic low back problems and pain [11-13].

With the advancement, MIPPS has steadily gained acceptance in clinical practice. Gelb et al. demonstrated that, when compared to traditional OPS , MIPPS can protect paraspinal muscles and has the advantages of smaller intraoperative blood loss, fewer normal structural trauma, quick postsurgical recovery, and fewer side effects such as postsurgical backache [14]. The study included 60 patients with geriatric OVF to assess the clinical outcomes of MIPPS against OPS. (1) Following surgery, the percentage of vertebral height and disc height in the MIPPS set and those in the OPS set increased. In contrast, the kyphotic angle in the MIPPS set and those in the OPS set decreased, indicating that both operation types can effectively restore spinal height and disc height.

After surgery, there was no significant difference in the percentage of vertebral height, disc height, or kyphotic angle between the two sets, indicating that both surgery types had the same therapeutic effect (Table 2). The findings were congruent with those of Li et al. [7]. (2) The MIPPS sets surgical time, surgical bleeding, incision size, and days of hospitalization were shorter than those in the OPS set, and no screw breaking was observed in either set, indicating that MIPPS has effective outcomes, little trauma, few hospital stay days, quickly postoperative recovery, just a few postoperative complications, and can provide patients with better postoperative life quality (Tables 2 and 3)Chen et al.'s investigation was also compatible with the findings of this study (15). Some researchers argue that there is no substantial difference in surgical time between the two types of operations, which might be attributed to early reporting time and mediocre surgical procedures [16]. (3) The VAS score and ODI of the two groups were substantially lower 6 months after internal fixation than before internal fixation, and the VAS

score and ODI of the people treated with MIPPS reduced more significantly, indicating that both operation types can decrease pain and relieve disorder, but MIPPS can provide greater advantages than OPS. (Figures 1).

In the end, both OPS and MIPPS are effective for the treatment of geriatric OVF, with the latter offering smaller trauma, less surgical time, a faster recovery, and a higher post-surgical standard of living for patients. Most experts agree with this study that MIPPS can produce good surgical results with fewer complications and faster recovery [17-20]. However, there are certain drawbacks to MIPPS:(1) It is ineffective for upper and middle thoracic #, as well as fractures with nerve damage [4]; (2) the number of X-ray exposures is increased, as is the duration [21]. As a result, in order to do MIPPS, surgeons must be knowledgeable and familiar with the spine, as well as confident in their surgical indications.

(1) Fresh unstable spinal #; (2) # with no stenosis of the spinal canal along with no hematoma and foreign body in spinal canal; (3) Spinal # with no nerve injury; and (4) # with no interlocking of facet joints were indications for MIPPS in the treatment of geriatric OVF. (1) A C-arm is necessary to precisely detect damaged vertebrae and pedicles before internal fixation; (2) The pin end should be abducted by 15 degrees in the direction of inserting the pin, and the pin can be inserted immediately when the pin reaches facet joint.

Limitations of this study

Because it is hard to catch up on older patients in both sets, the follow-up period in postoperative imaging, VAS score, and ODI is rather short. Thus, while it may be demonstrated that MIPPS is better than OPS in a short period, long-term follow-up data are still required to assess the two procedures' long-term consequences. Furthermore, it only included patients with spinal # who required just internal fixation treatment, not patients with large # spaces who required both internal fixation and vertebroplasty surgery. Thus, in future tests, it will be necessary to determine whether treatments are superior in patients with large # spaces

Conclusion

In conclusion, OPS fixation, as well as MIPPS fixation, are both successful treatments for geriatric OVF. In comparison to conventional OPS fixation, MIPPS fixation results in fewer surgical bleeding, a quicker surgical time, smaller muscle and soft tissue injuries, quicker postsurgical recovery, a smaller incision scar, fewer days of hospitalisation, less pain, fewer postsurgical complications, and a better standard of life; however, MIPPS is more difficult in terms of surgical tools and technical aspects. If the patient's economic circumstances and surgical indications permit, MIPPS is worthy of therapeutic advancement.

Abbreviations

MIPPS - minimally invasive percutaneous pedicle screw fixation
OPS- open pedicle screw fixation
OVF - osteoporotic vertebral fracture
VAS- visual analogue scale
ODI - Oswestry Disability Index
-fractures

References

1. Kanis JA. Diagnosis of osteoporosis and assessment of fracture risk. Lancet 2002; 359: 1929-1936.
2. Scheer JK, Bakhsheshian J, Fakurnejad S, Oh T, Dahdaleh NS and Smith ZA. Evidence-based medicine of traumatic thoracolumbar burst fractures: a systematic review of operative management across 20 years. Global Spine J 2015; 5: 73-82.
3. Papanastassiou ID, Setzer M and Eleraky M. Minimally invasive sacroiliac fixation in oncologic patients with sacral insufficiency fractures using a fluoroscopy-based navigation system. J Spinal Disord Tech 2011; 24: 76-82.
4. Payer M. "Minimally invasive" lumbar spine surgery: a critical review. Acta Neurochir (Wien) 2011; 153: 1455-1459.
5. Wang XB and Zeng QC. Percutaneous minimally invasive pedicle screw technique and open reduction internal fixation for thoracolumbar fracture. Journal of Mudanjiang Medical College 2018; 39: 81-83.
6. Mei X and Yan LJ. Clinical effect of sextant minimally invasive percutaneous internal fixation system in senile osteoporotic vertebral fractures. Journal of Clinical and Experimental Medicine 2016; 15: 1926-1928.
7. Li Z, Shen XZ, Ma JW, Shan ZS and Cao ZY. Minimally invasive percutaneous pedicle screw fixation with Sextant for the treatment of osteoporotic spinal fractures in the elderly. Chinese Journal of Gerontology 2017; 37: 1977-1979.
8. Ruiz Santiago F, Tomas Munoz P, Moya Sanchez E, Revelles Paniza M, Martínez Martínez A and Pérez Abela AL. Classifying thoracolumbar fractures: role of quantitative imaging. Quant Imaging Med Surg 2016; 6: 772-784.
9. Bakhsheshian J, Dahdaleh NS, Patwardhan AG and Smith

ZA. Comment on the biomechanical analysis of four- versus six-screw constructs for short-segment pedicle screw and rod instrumentation of unstable thoracolumbar fractures. Spine J 2014; 14: 1810-1811.
10. Dahdaleh NS, Smith ZA and Hitchon PW. Percutaneous pedicle screw fixation fumbar fractures. Neurosurg Clin N Am 2014; 25: 337-346.
11. Takata Y, Sakai T and Higashino K. State of the art: intraoperative neuromonitoring in spinal deformity surgery. J Med Invest 2015; 62: 103- 108.
12. Lyu J, Chen K, Tang Z, Chen Y, Li M and Zhang Q. A comparison of three different surgical procedures in the treatment of type A thoracolumbar fractures: a randomized controlled trial. Int Orthop 2016; 40: 1233-1238.
13. Roussy JP, Bessette L, Bernatsky S, Rahme E and Lachaine J. Biologic disease-modifying anti-rheumatic drugs and the risk of non-vertebral osteoporotic fractures in patients with rheumatoid arthritis aged 50 years and over. Osteoporos Int 2013; 24: 2483-2492.
14. Gelb D, Ludwig S and Karp JE. Successful treatment of thoracolumbar fractures with short-segment pedicle instrumentation. J Spinal Disord Tech 2010; 23: 293-301.
15. Chen Z, Zhao JQ, Fu JW, Yang XM and Chen Q. Modified minimally invasive percutaneous pedicle screws osteosynthesis for the treatment of thoracolumbar fracture without neural impairment. Natl Med J China 2010; 90: 1491- 1493.
16. Luo CS, Li B and Tian XB. A comparative study of the open and percutaneous operation for thoracolumbar fractures respectively. Orthopedic Journal of China 2009; 17: 1692-1694.
17. Vaccaro AR, Schroeder GD and Kepler CK. The surgical algorithm for the AOSpine thoracolumbar spine injury classification system. Eur Spine J 2016; 25: 1087-1094.
18. Kepler CK, Vaccaro AR and Schroeder GD. The thoracolumbar AOSpine injury score. Global Spine J 2016; 6: 329-334.
19. Chen L, Qin JP, Wu FJ, Liao WB and Ao J. Minimally invasive passage in posterior laminotomy decompression and intervertebral bone grafting combined with percutaneous pedicle screw fixation for treatment of Denis type B thoracolumbar burst fractures. Chin J Repar Reconst Surg 2016; 30: 985-991.
20. Barbagallo GMV, Raudino G and Visocchi M. Restoration of Thoracolumbar Spine Stability and Alignment in Elderly Patients Using Minimally Invasive Spine Surgery (MISS). A Safe and Feasible Option in Degenerative and Traumatic Spine Diseases. In: Visocchi M, Mehdorn HM, Katayama Y, von Wild KRH, edtors. Trends in Reconstructive Neurosurgery 2017. pp. 69- 74.
21. Li C, Pan J, Gu Y and Dong J. Minimally invasive pedicle screw fixation combined with percutaneous vertebroplasty for the treatment of thoracolumbar burst fracture. Int J Surg 2016; 36: 255-260.

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Peripheral nerves adjacent to spinal cord injury could help restore sensory motor regeneration in complete paralysis patients

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Abstract

Peripheral nerves adjacent to spinal cord injury could help restore sensory motor neurons regeneration

Background and objectives: In people with spinal cord injury we hypothesize that peripheral nerves in the thoracic segment and accessory nerve and supra scapula nerve branches on the back of the patient can be sacrificed to use them to stimulate regeneration in spinal cord injury due to trauma.

Method: To test this hypothesis, we establish a loop shape framework with distal end-to-end anastomosis of peripheral nerves adjacent to cord injury or anastomosis of the distal end of the accessory nerve and supra scapula nerve on the back of the patient and guide growth stimulation balance from the loop shape framework to injured side. We developed this novel technique and tested it in four individuals with complete sensory-motor paralysis as part of the ongoing clinical trial.

Result: Within 6 months time loop shape frame work stimulation novel technique mediated ASIA score improvement from A score to C score in case 1,2 and after 8 months case three can move his hand and foot, Mr. 4 sensory recovered from umbilical level to beneath of knee and the patient move proximal muscle voluntary (3/5).

Conclusion: This novel technique in neurosurgery opens a majestic path to recovery of spinal cord injury and brain regeneration.

Keywords
peripheral nerves, spinal cord injury, sensory motor regeneration

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Introduction

Traumatic spinal cord injury is a tragic event there is no effective treatment for neurological recovery the primary injury cord compression or contusion leading to secondary injury by blood flow interruption and the release of oxygen free radicals, inflammation and edema. The only intervention for improving neurological outcome is decompression and vertebral column stabilization and it doesn't change effectively ASIA score of patien[1,2] the inability of adult mammalian central neuron to regrowth in response to spinal cord injury is due to them limited intrinsic regrowth capacity due to glial scar and cystic cavities in combination with poor endogenous re myelination and axonal regrowth[2,3].

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Multiple trophic factor should be combined for a spinal cord repair therapy and any single intervention is unlikely to improve patient outcome. Peripheral nerves adjacent to spinal cord injury could help restore sensory motor axon regeneration.

In people with spinal cord injury we hypothesized that peripheral nerves in thoracic segment can be sacrificed to use them stimulate regeneration in spinal cord injury due to trauma. And similarly accessory nerve and supra scapula nerve branch on the back of patient can be used for cervical cord regeneration.

Figure 1. Case 1 T7 pair nerves.

Figure 2. Case 1 T7 pair nerves after anastomosis together.

To test this hypothesis, we establish a loop shape frame work with distal end to end anastomosis of peripheral nerves adjacent to cord injury (Fig 1,2) and anastomosis between accessory nerve and supra scapula nerve on left back side of patient which guides growth stimulation balance from the loop shape frame work to injured site. We developed this novel technique and tested it in four individual with complete sensory motor paralysis as part of ongoing clinical trial.

Within six-month time loop shape frame work stimulation novel technique mediated ASIA score improvement from A score to C score in case1,2. and case 3 could move his hand and foot after 8 months. In 3 months Mr. 4 sensory recovered from umbilical level to beneath of knee and the patient move proximal muscle voluntary (3/5).

This novel technique in neurosurgery opens a majestic path to recovery of spinal cord injury.

METHOD

This research approved by ethic committee in research and consent form completed by patients.

Figure 3. Case 1 CT.

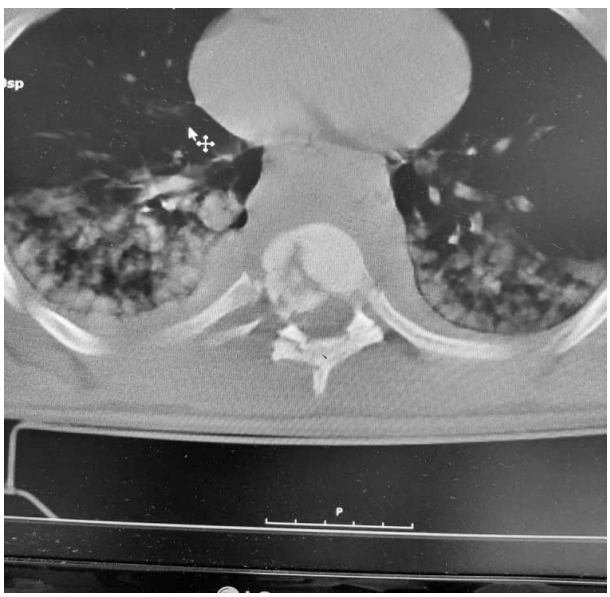

Figure 4. Case 1 T2 MRI.

Case 1

Mr. 1, age 14 had traumatic spinal cord injury his leg motion strength was zero and has not any sensory function below T8 lesion level.

Mr. 1 sent for CT, MRI and finding showed burst fracture of T8 vertebra (fig 3,4) the patient was taken for neurosurgical vertebral stabilization and fusion 6th day after incidence and we established a loop shape frame work with distal end to end anastomosis of T7 peripheral nerves adjacent to cord injury (Fig 1,2).

Case 2

Mr.2 age 36 years old man became paraplegic after trauma to lumbar spine. after the incident his bilateral lower limb showed no muscle contraction with sensory loss. A CT, MRI scan revealed a L1 burst fracture (FIG 5,6) the patient underwent surgery 2th day after incidence and we established a loop shape frame work with distal end to end anastomosis of T11 peripheral nerves adjacent to cord injury.

Figure 5. Case 2 CT.

Figure 6. Case T2 MRI

Case 3

Mr.3 age 53 old man became quadriplegic after trauma to cervical spine A MRI scan revealed C3-C4 segment lesion (fig 7) the patient underwent surgery 30th day after incidence and we established a loop shape frame work with distal end to end anastomosis between accessory neve and supra scapula nerve on the left side back of patient (8,9).

Figure 7. Case 3 T2 MRI

Case 4

Mr.4 age 38 old man became paraplegic after trauma to thoracolumbar spine MRI revealed T11-T12 dislocation (fig 10) the patient underwent surgery 3 day after incidence and after correction of dislocation we cut distal and ligate of T10 pair nerves.

Figure 8. Suprascapula and accessory nerves before anastomosis.

Figure 9. Suprascapula and accessory nerves after anastomosis.

RESULT

Flow chart

Patient selection, surgery for fusion, nerve anastomosis proximal to spinal injury, clinical response consideration.

Figure 10. Case 4/

Case 1

On the 90th day after peripheral nerve anastomosis Mr.1 sensation down to T8 segment recovered. On 180th day after anastomosis sitting balance recovered and the patient adduct and abduct knee and flex foot finger and ASIA score improved from A to C Mr.1 step with walker and orthosis brace.

Case 2

On the 90th day after peripheral nerve anastomosis Mr.2 sensation down to L1 Segment beneath the knee and sitting balance recovered and the patient adduct and abduct knee. On the 180 day after anastomosis Mr.2 step with walker and orthosis brace.

Case 3

8 months after anastomosis Mr.3 move his foot and hand on the left side and we don't see any movement at right side as control and we did anastomosis in right side after 9 months of first left anastomosis and see better sensation in right side but no movement.

Case 4

3 months after distal cutting and ligation of T10 pair nerves proximal to spine lesion Mr. 4 sensory recovered from umbilical level to beneath of knee and the patient move proximal muscle voluntary (3/5).

Discussion

In neuroscience effort for spinal cord regeneration has been unsuccessful. Why axons cannot grow. Three theories dominate the field the first theory hypothesized protein that inhibit axons growth and the second describe a glial scar forms at the injury site, the third theory say neurons is genetically shut off after birth [5].

Most scientist believe that many factors modulate spinal axons growth and combination therapies will be necessary to achieve functional regeneration of spinal cord 4. but what happens in peripheral nerve regeneration. It comprises the formation of axonal sprouts and re innervation of original targets.

It has been accepted that CSF flows from subarachnoid spaces along all brain nerves and all peripheral nerve into the respective tissues. CSF has been found to have an important signaling function and there is interaction between CSF and peripheral nerves. CSF flow along lumbar nerves in distal direction at a speed of 10 cm /per hour6

Base on CSF interaction with nerves and its circulation we establish a loop shape frame work with distal end to end anastomosis of peripheral nerves adjacent to cord injury (FIG 1,2) and guided CSF and growth stimulation balance from the loop shape frame work to injured side.

It is possible improve result with more using of nerves proximal to lesion or with using of granulocyte colony stimulant factor (GCSF) and successful trial open way for treatment of chronic patients and maybe help to treatment of brain neural cells in cortical spinal tract and basal ganglia due to observation in case 3 which show specific effect on left side of patient. on the other hand C2 nerve pair can be used to help regeneration of cervical spine alongside using of accessory nerve on the back of patient also vestibular neve can help to medulla regeneration and cochlea, facial nerve treatment using of some drugs such as riluzole and refanezumab may be help to treatment and result

References

1. Ahuja, C., Wilson, J., Nori, S. et al. Traumatic spinal cord injury. Nat Rev Dis Primers 3, 17018 (2017).
2. Fitch MT, Silver J. CNS injury, glial scars, and

inflammation: Inhibitory extracellular matrices and regeneration failure. Exp Neurol 2008;209:294–301.
3. Tuszynski MH. Growth-factor gene therapy for neurodegenerative disorders. Lancet Neurol. 2002;1:51–7.
4. Griffin JM, Bradke F. Therapeutic repair for spinal cord injury: combinatory approaches to address a multifaceted problem. EMBO Mol Med. 2020 Mar 6;12(3):e11505. doi: 10.15252/emmm.201911505. Epub 2020 Feb 24. PMID: 32090481; PMCID: PMC7059014.
5. Young W. Spinal Cord Regeneration. Cell Transplantation. 2014;23(4-5):573-611.
6. Bechter K, Schmitz B. Cerebrospinal fluid outflow along lumbar nerves and possible relevance for pain research: case report and review. Croat Med J. 2014 Aug 28;55(4):399-404.

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Factors affecting visual outcomes of pituitary macroadenoma following transsphenoidal surgery

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ABSTRACT

Objective: 1. To provide quantitative objective measurement of the efficacy of surgery for pituitary macroadenoma. 2. To discuss different factors that could affect visual outcomes of pituitary macroadenoma

Method: This is a single centre prospective study, conducted at DEPARTMENT OF NEUROSURGERY SMS MEDICAL COLLEGE AND HOSPITAL JAIPUR over one year (May 2021-May 2022), 50 cases of sellar, suprasellar tumours were included were treated with surgery. Our study excluded pituitary apoplexy and included both functioning and non-functioning pituitary adenomas. We analyzed how various factors impacted vision outcomes, including post-surgical tumour height reduction (vertical decompression) and changes in Knosp grade (lateral decompression). Vision results were assessed using the Visual Impairment Score (VIS), combining visual acuity and visual field deficits.

Results: Preoperative tumour height and supracarotid height significantly affect VIS ($p < 0.005$) and Knosp grading also showed a significant correlation with VA ($p = 0.03$) and VF ($p=0.03$). Our study found significant impact of tumour height reduction on VIS improvement. Change in supracarotid height showed a trend towards correlation with VIS change ($p = 0.054$). Additionally, there were no significant differences in complications between groups, with a marginal trend observed in diabetes insipidus ($p = .372$)

Conclusion: The research highlights that the degree of optic nerve compression, particularly measured from the bend of the internal carotid artery, is crucial for predicting vision outcomes. Endoscopic surgery is preferred for treating these tumours because it allows for better sideways decompression, which is essential for relieving nerve pressure in both vertical and horizontal directions. This approach is pivotal in achieving optimal vision recovery and maximizing vision improvement compared to other surgical methods.

Keywords
visual outcomes,
transsphenoidal surgery,
pituitary macroadenoma

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INTRODUCTION

Benign pituitary tumors, originating from the pituitary gland, can exert pressure on the optic nerves and optic chiasm as they grow, leading to visual impairment. Transsphenoidal surgeries, either performed microscopically or endoscopically, are effective in decompressing the

optic apparatus and restoring visual function. [1,2] The advancements in endoscopic technology have improved the ability to achieve complete tumor removal and enhanced visual outcomes. Visual improvement can occur immediately after surgery, at three months, and even over several years. [2,3] Multiple factors, including age, the extent of tumor removal, Knosp grading, the duration of preoperative visual field defects, and the thickness of the peripapillary retinal nerve fiber layer, have been identified as influencing visual outcomes. [4] Despite this, there is a need for more quantitative studies to investigate the impact of tumor compression and surgical methods on visual outcomes.

OBJECTIVES

Aims

To Study visual outcomes of Transsphenoidal surgery for pituitary macroadenoma.

Objectives

1. To provide quantitative objective measurement of the efficacy of surgery for pituitary macroadenoma.
2. To discuss different factors that could affect visual outcomes of pituitary macroadenoma.

STUDY DESIGN

This study is a prospective analysis and a sample of 50 patients on 1st come 1st basis was included in the study with cases of pituitary macroadenomas that underwent surgical intervention at a tertiary neurosurgical referral center between May 2021 and May 2022.

Inclusion criteria

Cases of pituitary macroadenomas that were functioning or nonfunctioning and without apoplexy at initial presentation who will undergo surgery will be included.

Exclusion criteria

Patients will be excluded if:

1. Patients with recurrent tumors to avoid confounding bias.
2. Patients without preoperative magnetic resonance imaging (MRI) or with PAs lacking SSE
3. Patient having pituitary apoplexy

Methodology

Patient demographics including age, sex, percentage of apoplexy on presentation, excision methods, percentage of gross total excision, and cerebrospinal fluid (CSF) leak rate will be recorded. Preoperative magnetic resonance imaging (MRI) scans of the pituitary gland will be done and studied. The extent of vertical compression, both absolute height and supracarotid height, will be recorded, signifying chiasmal compression (Fig. 1). The absolute height of the tumor will be defined as the distance from the most caudal portion to the most cranial portion of the tumor. In contrast, the supracarotid height will be the distance measured from the midpoint joining both genu of the cavernous internal carotid artery to the most cranial portion of the tumor [17]. On the other hand, the extent of lateral compression, measured by Knosp grading, was recorded, signifying optic nerve compression [18]. Postoperative visual outcomes were assessed with visual acuity (VA), VF, and visual impairment scale (VIS). Visual impairment scale is a quantitative tool, ranging from 0 to 100, commonly employed by ophthalmologists to assess visual function. The scale combined VA and VF defect of both eyes quantitatively. The values of VIS correlate with the severity of visual function impairment. [19,20]

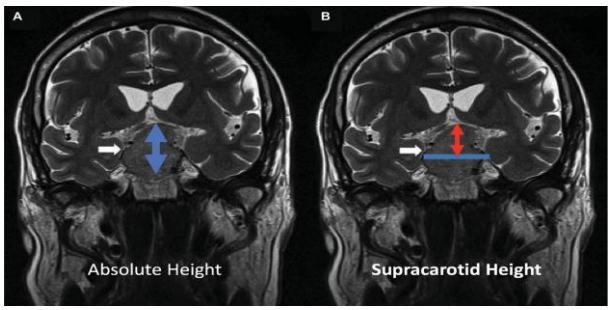

Figure 1. (A and B) Measurement for the vertical compression representing chiasmal compression. **(A)** The absolute height that is measured from the most caudal to the most cranial part of the tumor. White arrow indicates the tumor whereas the blue arrow indicates the absolute tumor height. **(B)** The supracarotid height that is measured from the most cranial part of the tumor to the midpoint joining both genu of internal carotid artery. The white arrow indicates the tumor whereas the blue line indicates the midpoint joining both genu of internal carotid artery. The red arrow indicates the supracarotid height.

METHODS AND STATISTICS

Data analysis was performed using Statistical Product and Service Solutions (SPSS) version 15. To investigate the relationships between visual acuity (VA), visual impairment score (VIS), tumor height, and Knosp grading, linear regression analysis was employed. Additionally, independent sample t-tests and chi-square tests were utilized to examine the effects of Knosp grading, surgical modes, VA, visual fields (VF), and VIS.

RESULTS

Basic Demographics

Table 1. Basic demographics

Variables	N	Mean	Std. Deviation	Present	Not present
Age	50	43.0	1.119		
Sex	50	1.58	.499	42 % male	58% female
Sinusitis	50	2.00	.000		100%
Rhinorrhea	50	1.72	.454	28%	72%
Meningitis	50	1.96	.198	4%	96%
Diabetes insipidus	50	1.78	.418	22%	78%
Bleeding	50	1.94	.240	6%	94%

The sample comprised 50 participants, with a mean age of 43 years (standard deviation = 1.119). The gender distribution had a mean score of 1.58 with a standard deviation of 0.499. The complications analysis revealed that none of the individuals (100.0%) had sinusitis. Out of the total participants, 14 individuals (28.0%) had rhinorrhea, while 36 individuals (72.0%) did not encounter this problem. Meningitis was detected in 2 participants, accounting for 4.0% of the total, while the remaining 48 subjects, or 96.0%, did not have meningitis. 11 participants, or 22.0% of the total, had diabetes insipidus, while 39 participants, or 78.0% of the total, did not have it. Ultimately, 3 people (6.0%) experienced bleeding as a problem, while 47 participants (94.0%) did not. The average values for these problems were as follows: sinusitis (mean = 2.00, standard deviation = 0.000), rhinorrhea (mean = 1.72, standard deviation = 0.454), meningitis (mean = 1.96, standard deviation = 0.198), diabetes insipidus (mean = 1.78, standard deviation = 0.418), and bleeding (mean = 1.94, standard deviation = 0.240).

Vertical compression

The linear regression analysis aimed to examine the correlation between the independent variables, supracarotid and tumour height, and the dependent variable, VIS. The results showed that the intercept is significantly different from zero, with a t-value of 1.217 and a p-value of 0.005. The coefficient for supracarotid is -0.450, with a beta value of -0.032, indicating significant impact on VIS. The coefficient for tumour height is -0.546, with a beta value of -0.056, and the coefficient for tumour height is statistically significant (p<.005), indicating substantial impact on VIS. Thus tumour height has significant impact on VIS.

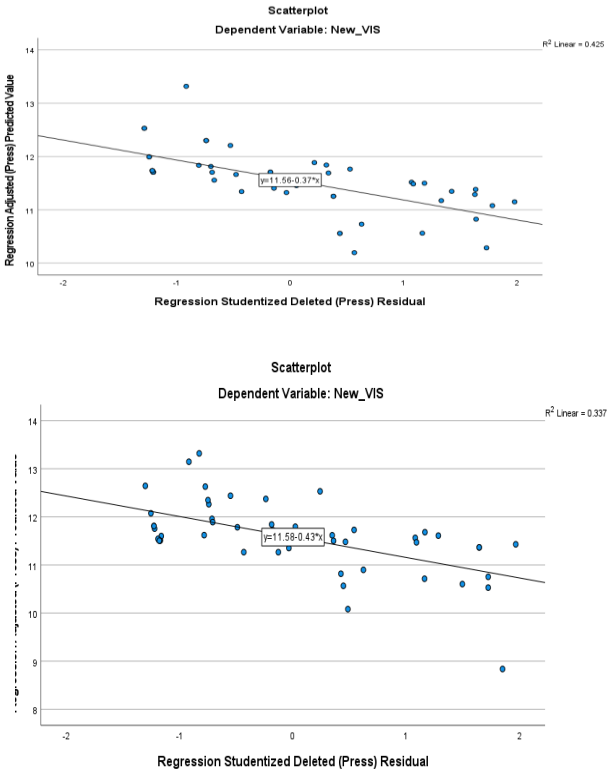

Figure 3. (A) The linear relationship between supra carotid height and visual impairment scale (VIS). **(B)** The linear relationship between tumor height and VIS.

Lateral compression

The study conducted two Chi-Square tests to examine the associations between knosp grading and VF and VA. The results showed a strong correlation between knosp grading, VF and VA. The chi-square test showed significant relationship between VA and knosp grading, with a test statistic of 40.273, with a p-value of 0.03.The independent samples t-tests were used to evaluate the disparities in complications between two distinct groups,

specifically groups 1.00 and 2.00. There were no statistically significant differences between the groups in terms of mean scores for complications such as sinusitis, meningitis, and bleeding, assuming equal variances ($p > .05$). However, when considering rhinorrhea and diabetes insipidus, there were no significant differences assuming equal variances. However, when variances were not presumed equal, there was a marginally significant difference in diabetes insipidus ($p = .372$), indicating a possible trend. In general, apart from diabetes insipidus, there is little evidence to support significant variations in the severity of complications among different groups.

Modes of surgeries

In terms of lateral decompression, endoscopic surgical method is effective in relieving pressure on the optic chiasm.

Discussion

Our study aligns with prior research, demonstrating endoscopic transsphenoidal surgery's effectiveness for visual outcomes in pituitary adenoma patients. [9,10,11,12,13,14]. Consistent with Guo et al.'s meta-analysis, the endoscopic approach achieved superior gross total resection and visual improvement rates. Preoperative MRI findings correlated with visual impairment, with absolute and supracarotid height impacting visual impairment scores (VIS). [16] Knosp grading further aided in understanding visual dysfunction. [16] Notably, vertical compression (optic chiasm) and lateral compression (optic nerve) require separate evaluation, and both were crucial for optimal outcomes in our study. While both microscopes and endoscopes facilitated chiasmal decompression, the endoscope achieved superior lateral decompression and visual improvement. This likely reflects technological advancements offering broader visualization and manipulation angles. [16]

This study's limitations include its retrospective, single-center design with multiple surgeons, potentially introducing variability. [17] Additionally, the chronicity of optic nerve compression lacked standardization, and objective measures of optic nerve dysfunction (e.g., optical coherence tomography) were absent. Future studies incorporating these elements can further refine visual outcome prediction. [18]

Conclusion

The extent of both vertical and lateral decompression of pituitary macroadenoma is essential for achieving better visual outcomes. Height of tumor measured from genu of cavernous ICA correlates better with the visual outcome than the absolute tumor height. As the endoscopic approach can achieve a greater degree of lateral decompression, it is preferred in pituitary surgery to achieve a better visual outcome.

References

1. Guo S, Wang Z, Kang X, Xin W, Li X. A meta-analysis of endoscopic vs. microscopic transsphenoidal surgery for non-functioning and functioning pituitary adenomas: comparisons of efficacy and safety. Front Neurol. 2021; 12:614382. doi: 10.3389/fneur.2021.614382. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
2. Møller M W, Andersen M S, Glintborg D. Endoscopic vs. microscopic transsphenoidal pituitary surgery: a single centre study. Sci Rep. 2020;10(01):21942. doi: 10.1038/s41598-020-78823-z. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
3. Gnanalingham K K, Bhattacharjee S, Pennington R, Ng J, Mendoza N. The time course of visual field recovery following transphenoidal surgery for pituitary adenomas: predictive factors for a good outcome. J Neurol Neurosurg Psychiatry. 2005;76(03):415–419. [PMC free article] [PubMed] [Google Scholar]
4. Sun M, Zhang Z Q, Ma C Y, Chen S H, Chen X J.Predictive factors of. visual function recovery after pituitary adenoma resection: a literature review and meta-analysis Int J Ophthalmol 2017. Published. 10.18240/ijo.2017.11.17 [PMC free article] [PubMed] [CrossRef] [Google Scholar]
5. Yang Y, Bao Y, Xie S. Identification of the extradural and intradural extension of pituitary adenomas to the suprasellar region: classification, surgical strategies, and outcomes. Front Oncol. 2021;11:723513. doi: 10.3389/fonc.2021.723513. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
6. Knosp E, Kitz K, Steiner E, Matula C. Pituitary adenomas with parasellar invasion. Acta Neurochir Suppl (Wien) 1991;53:65–71. [PubMed] [Google Scholar]
7. Yu F, Afifi A A. Descriptive statistics in ophthalmic research. Am J Ophthalmol. 2009;147(03):389–391. [PubMed] [Google Scholar]
8. Fahlbusch R, Schott W. Pterional surgery of meningiomas of the tuberculum sellae and planum sphenoidale: surgical results with special consideration of ophthalmological and endocrinological outcomes. J Neurosurg. 2002;96(02):235–243. [PubMed] [Google Scholar]
9. Cohen A R, Cooper P R, Kupersmith M J, Flamm E S,

Ransohoff J. Visual recovery after transsphenoidal removal of pituitary adenomas. Neurosurgery. 1985;17(03):446–452. [PubMed] [Google Scholar]
10. Lee G I, Park K A, Oh S Y, Kong D S. Parafoveal and peripapillary perfusion predict visual field recovery in chiasmal compression due to pituitary tumors. J Clin Med. 2020;9(03):697. doi: 10.3390/jcm9030697. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
11. Lachowicz E, Lubiński W. The importance of the electrophysiological tests in the early diagnosis of ganglion cells and/or optic nerve dysfunction coexisting with pituitary adenoma: an overview. Doc Ophthalmol. 2018;137(03):193–202. [PMC free article] [PubMed] [Google Scholar]
12. Muskens I S, Zamanipoor Najafabadi A H, Briceno V. Visual outcomes after endoscopic endonasal pituitary adenoma resection: a systematic review and meta-analysis. Pituitary. 2017;20(05):539–552. [PMC free article] [PubMed] [Google Scholar]
13. Goudakos J K, Markou K D, Georgalas C. Endoscopic versus microscopic trans-sphenoidal pituitary surgery: a systematic review and meta-analysis. Clin Otolaryngol. 2011;36(03):212–220. [PubMed] [Google Scholar]
14. Sturgess I, Rudd A G, Shilling J. Unrecognized visual problems amongst residents of Part III Homes. Age Ageing. 1994;23(01):54–56. [PubMed] [Google Scholar]
15. Barzaghi L R, Medone M, Losa M, Bianchi S, Giovanelli M, Mortini P.Prognostic factors of visual field improvement after trans-sphenoidal approach for pituitary macroadenomas: review of the literature and analysis by quantitative method Neurosurg Rev 20123503369–378., discussion 378–379 [PubMed] [Google Scholar]
16. Luomaranta T, Raappana A, Saarela V, Liinamaa M J. Factors affecting the visual outcome of pituitary adenoma patients treated with endoscopic transsphenoidal surgery. World Neurosurg. 2017;105:422–431. [PubMed] [Google Scholar]
17. Jean W, Deklotz T R.Endoscopic Endonasal Approach for Pituitary Tumor Resection CSurgeries 2016. Published. 10.17797//bdxmmtst16 [CrossRef] [Google Scholar]
18. Cennamo G, Solari D, Montorio D. Early vascular modifications after endoscopic endonasal pituitary surgery: the role of OCT-angiography. PLoS One. 2020;15(10):e0241295. doi: 10.1371/journal.pone.0241295. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

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Primary tuberculous osteomyelitis of skull presenting as scalp swelling. A rare case

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Abstract

Background: Tuberculosis in common in developing countries but involvement of skull bone is very rare Incidence of tuberculosis in skeletal system is less than 1 percentage (1, 2, 3). Out of the bone involvement most of them are weight bearing bones however flat and skull bone involvement is very rare.

Case presentation: An 18-year-old male presented with headache and swelling over the right temporal region for 15 days. MRI brain contrast was suggestive of lesion hypointense on T1 and Hyperintense on T2 with surrounding ring enhancement present and portion of lesion extending transcranial to outer surface of bone under the scalp. The patient underwent excision of the tumour along with Antitubercular therapy.

Conclusion: All patients with Scalp swelling with intracranial extension must be suspected of tuberculous osteomyelitis and related investigations and MRI should be done.

Keywords
tuberculous, osteomyelitis, skull, scalp, swelling

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Background

Tuberculosis in common in developing countries but involvement of skull bone is very rare Incidence of tuberculosis in skeletal system is less than 1 percentage (1, 2, 3). Out of the bone involvement most of them are weight bearing bones however flat and skull bone involvement is very rare. As the skull bone is deficient with lymphatic supply, lymphatic spread from primary focus is very rare which explains why calvarial tuberculosis is a rare entity.

Case report

An 18-year male patient presented in Outpatient department with complaint of swelling over right temporal region for 15 days. On examination patient was vitally stable with Glassgow Coma Score of E4 V5 M6 and rest of the neurology was normal. On local examination patient had about 6 cm × 8 cm firm, ovoid shaped, compressible, non-

fluctuant, non-trans-illuminant swelling was present over right temporal region [Fig 1] with overlying skin normal.

Figure 1. A and B showing inspection findings of the swelling from behind and right side.

On Radiological investigation, MRI brain contrast was suggestive of lesion hypointense on T1 and Hyperintense on T2 with surrounding ring enhancement [Fig 2] present and portion of lesion extending transcranial to outer surface of bone under the scalp. The chest x-ray was normal.

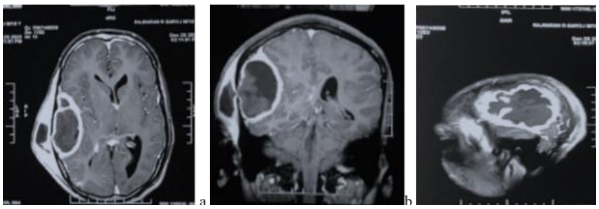

Figure 2. A, B and C shows rim enhancing lesion on MRI contrast films in axial, coronal and saggital sections respectively

Based on the radiological findings, provisional diagnosis of Meningioma was made with few other differential diagnosis kept in mind like tumors arising from the bone, epidermoid and chordoma. The Patient underwent excision of the tumor. Intraoperatively tumor was found to be extradural arising from the skull bone with solid and cystic components with cystic component containing purulent material. Whole tumor along with the involved part of the bone was excised and specimen was sent for histopathology[Fig 3]. The Purulent material was sent for microbiological examination. The Microbiological examinations and gene expert results came out to be negative. Histopathological examination showed a picture of tuberculous osteomyelitis.

Patient was started on antitubercular therapy as per the weight band. Patient was discharged and is kept on regular follow up with further plan to cover the skull defect with an exogenous graft material.

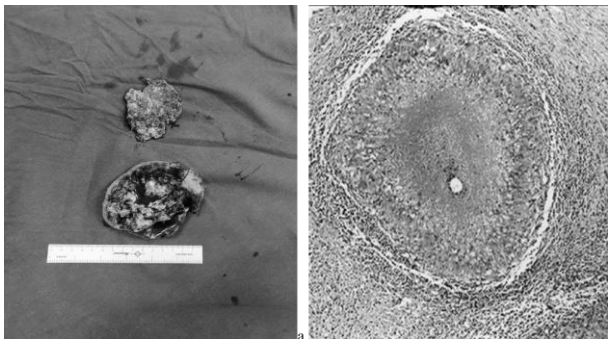

Figure 3. A and B shows gross specimen and microscopic picture on histopathological examination of the excised tumor respectively

Discussion

Tuberculosis of skull is very rare and estimated to occur in 0.01% of patient infected with mycobacterium tuberculosis (4). The incidence rate of tuberculosis skull is 0.2–1.3% among the skeletal tuberculosis (5). Isolated calvarial TB is rare and most cases are secondary to either pulmonary TB, TB osteitis in other bones or widespread Tuberculosis. The disease may present with painless scalp swelling, discharging sinuses, seizures, meningitis, headache, motor deficits, etc.

The common presentation of the skull tuberculosis is a discrete, round or oval, and solitary lesion in the frontoparietal region. Antitubercular therapy, and appropriate surgical intervention are the mainstay in the management of the calvarial tuberculosis. A few studies suggest that antitubercular treatment is alone sufficient (6). However other studies state that surgical intervention in addition to ATT is necessary because the diseased bone might be the source of bacilli and removal by surgical excision may be required to achieve a cure. (7, 8).

In our case, patient presented with only complaint of swelling over right temporal region for 15 days. The Neurological and systemic examination was found to be Normal. There were no other features suggestive of Tuberculous source elsewhere in the body. The patient underwent excision of the lesion and biopsy. Intraoperative findings were consistent with inflammatory pathology. Histopathological diagnosis of

Tuberculous Osteomyelitis of the skull was made. Patient was started on antitubercular therapy as per the weight band. Patient was discharged and is kept on regular follow up with further plan to cover the skull defect with an exogenous graft material.

Conclusion

Tuberculosis of the skull is a rare entity but is curable if presented in early symptoms. In that case the prognosis is good. TB lesions producing mass effects requires urgent surgical intervention. Post-operative ATT is a must according to RNTCP.

Abbreviations

TB- Tuberculosis;
ATT- Anti Tubercular therapy;
RNTCP- Revised National Tuberculosis control program.

References

1. Agarwal N, Jain SK. (2002). Tuberculous osteitis of skull: a case report. Br J Neurosurg, 105–6.
2. Alpysbaev, K. S., Djuraev, A. M., & Tapilov, E. A. (2021). Reconstructive and restorative interventions at the proximal end of the thigh and pelvic bones in destructive pathological dislocation of the hip in children after hematogenous osteomyelitis. International Journal of Health & Medical Sciences, 4(4), 367-372. https://doi.org/10.21744/ijhms.v4n4.1779
3. Diyora B, Kumar R, Modgi R, Sharma A. (2009). Calvarial tuberculosis: A report of eleven patients. Neurol India [Internet], 57:607. http://www.neurologyindia.com/text.asp?2009/57/5/607/57814
4. Strauss DC. Tuberculosis of flat bones of the vault of the skull. Surg Gynecol Obstet. 1933;57:384–98.
5. Unuvar E, Oguz F, Sadikoglu B, Sidal M, Ones U, Tetikkurt S. Calvarial tuberculosis. J Paediatr Child Health. 1999;35:221–2. doi: 10.1046/j.1440-1754.1999.t01-1-00309.x.
6. LeRoux PD, Griffin GE, Marsh HT, Winn HR. Tuberculosis of the skull: A rare condition. Case report and review of literature. Neurosurgery. 1990;26:851–5. doi: 10.1227/00006123-199005000-00018.
7. Mohanty S, Rao CJ, Mukherjee KC. Tuberculosis of the skull. Int Surg. 1981;66:81–3.
8. Ip M, Tsui E, Wong KL, Jones B, Pung CF, Ngan H. Disseminated skletal tuberculosis with skull involvement. Tuberc Lung Dis. 1993;74:211–4. doi: 10.1016/0962-8479(93)90015-P.

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Comparison of the neurological outcomes and infection rate in surgical and conservative management of compound depressed skull fractures

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ABSTRACT

Background: Depressed skull fractures (DSFs) constitute a significant chunk of head injuries. As per level 3 evidence of recent brain trauma foundation guidelines, depressed fracture segments greater than the thickness of the calvaria should undergo operative intervention to prevent infection and to improve neurological outcomes. This study was done to refute the Brain Trauma Foundation guidelines of level 3 evidence by non-surgical management of those depressed skull fractures in which surgical management is indicated, and we aimed to assess and compare the incidences of infection rate and neurological outcomes in patients of surgical and conservative management of depressed skull fractures.

Material and methods: This prospective interventional study included 102 patients with compound depressed fractures with a surgical indication as per "Brain Trauma Foundation Guidelines 2006 Level 3 Management" from August 2020 to December 2021. A minimum of 6 months of follow-up was done. Those who gave consent for surgery were included in the surgical group, and those who refused were included in the conservative group, and both groups were compared. In the surgical group, the method of choice recommended was the conventional method of elevation of the depressed fracture segment and debridement, and in the conservative group, simple debridement and suturing after saline and antibiotic wash followed by IV antibiotics were given. Statistical Analyses: Data were analyzed using the SPSS software (version 23.0) for Windows. Qualitative variables were analyzed using chi sq. test and quantitative data by Student's t-test.

Results: Out of 102 patients, 42 were managed surgically and 60 were managed conservatively. The majority, 44.1%, of depressed skull fractures were present over the frontal bone. The overall complication rate was 20.58% (21/102). 68.29% of patients contributed to neurological complications, and the rest (31.70% of complications) were infective. No significant difference was found in comparing the neurological outcomes and infection rate in non-surgically versus surgically managed groups.

Conclusion: Conservatively managed depressed fractures have equivalent neurological outcomes and infective complications when compared with surgical management. The results of our research will provide benefits towards more conservative management with adequate wound debridement and antibiotics so that these patients can also be managed in peripheral rural hospitals and avoid unnecessary referrals to higher tertiary centres.

Keywords
traumatic brain injury,
seizure,
surgical elevation,
hospital stay,
surgical debridement

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Introduction

Depressed skull fractures are one of the common findings among traumatic brain injuries and are most commonly dealt with by neurosurgeons in their day-to-day practice. Compound-depressed skull fractures, by definition, have a skin laceration resulting in communication between the external environment and the cranial cavity, leading to wound contamination and infections. (1) In literature, the reported overall infection rate in patients with depressed skull fractures varies from 9% to 14%. (2,3) There are specific surgical and non-surgical management indications in depressed fractures, defined as Level 3 recommendations by the Brain Trauma Foundation. (4) In patients with compound cranial fractures, depressed fracture segments greater than the thickness of the calvaria should undergo operative intervention to prevent infection. Non-surgical treatment is advocated in a compound depressed cranial fracture if there is no radiological or clinical evidence of dural penetration (CSF leak, intradural pneumocephalus on CT.), no significant intracranial hematoma, depression not more than 1 cm, no involvement of the frontal sinus, no gross cosmetic deformity, and no wound infection or gross wound contamination. (4) The surgical method of choice recommended is elevation of the depressed fracture segment and debridement. (4) It's always been a management dilemma for neurosurgeons whether the conventional method of surgery that is the elevation of the depressed fracture segment prevents the infection rate or not in all patients with compound depressed skull fractures. The primary objective of this study was to observe the effects of surgical and conservative management on the neurologic outcomes in patients with compound depressed skull fractures, and the secondary objective was to compare complications (neurologic and infections) between the treatment arms.

Aim of our study

This study was undertaken to assess and to compare the incidences of infection rate and neurological outcome in patients with surgically and conservatively managed depressed skull fractures, to find out whether surgery is really beneficial in all patients of compound depressed skull fractures to prevent the overall infection rate and to improve the neurological outcome.

Methodology

This prospective comparative interventional study was approved by the scientific and ethical committee of Pt. JNM Medical College, Raipur (C.G.) & DKS Post Graduate Institute and Research Center, Raipur. A total of 102 patients with compound depressed fractures admitted in the department of neurosurgery at Pt JNM Medical College and DKS Postgraduate and Research Institute Hospital Raipur (CG) were included from August 2020 to December 2021. This sample size was calculated according to the primary objective, with study power at 80% and an α error of 0.5. Out of 102 patients, 42 were managed surgically, and 60 patients were managed conservatively. Conservatively managed patients were considered those patients in whom surgery was indicated as per "Brain Trauma Foundation Guidelines 2006 Level 3 Management" (4), but as these patients have given negative consent for surgery, they were included under the non-surgical group or conservative group.

Inclusion criteria in our study were the following:

- Patients with compound depressed skull fractures who had indications for surgery according to Brain Trauma Foundation guidelines.
- Age group < 65 years.
- Follow-up duration: six months or more.

Exclusion criteria in our study were the following

- All depressed fractures in front of the hairline (operated for cosmetic reasons).
- Depressed fractures are operated for and associated with other intracranial injuries like sub-dural hemorrhage, extradural hemorrhage, contusion, and pneumocephalus.
- Patients who lost on the follow-up.
- Patients with skull base fractures.

In our study, there was no crossover from the conservative group to the surgical group. In all patients, a non-contrast CT scan was done to assess the exact size and depth of depressed fragments and the associated findings, such as subdural hemorrhage, extradural hemorrhage, contusions, and pneumocephalus. All patients of compound depressed fractures had accidental wounds (classified as class III/contaminated wounds as per U.S. Centers for disease control classification)26 and

received intravenously cefuroxime 1.5 gm followed by 750 mg every 8th hourly along with intravenous metronidazole 500 mg every 8 hours.

Cleaning, suturing, debridement, and local wound dressing were done in all cases in an emergency room. All those patients who indicated surgery as per the criteria of the Brain Trauma Foundation guidelines level 3 evidence underwent surgery. Elevation of the depressed fracture segment was done, and repair of the underlying dural tear, if present, was performed as the conventional surgical procedure of choice. Patients who gave negative consent for surgery were considered in the non-surgical or conservative group, and they were managed conservatively by wound cleaning, suturing, debridement, and antibiotics.

During the hospital stay, infectious complications were noted in both groups of patients. The GCS and Glasgow outcome score were recorded at the time of discharge from the hospital. We have compared the infection rate and neurological outcomes with the variables such as age group, gender, mode of injury, GCS at the time of admission, site of fracture, type of management, and onset of seizures after injury as mentioned in Table 4, separately for non-surgically and surgically managed depressed fractures. Microsoft Excel was used in creating the database and producing graphs, while the data were analyzed using the SPSS software (version 23.0) for Windows. Numerical variables were reported as the mean ± standard deviation, and qualitative variables were analyzed using chi square. test. To analyze quantitative data, a Student's t-test was used. Differences between groups were assessed with the chi-square or Fisher's exact test for categorical variables. Two-tailed p-values less than 0.05 were considered significant ($p<0.05$).

Discussion

Depressed skull fractures occur in most head injuries, requiring immediate clinical assessment and management. In this study, we have included a total of 102 patients. We have discussed the presentation of depressed skull fractures in our tertiary care hospital concerning demography, mode of injury, site of injury, clinical presentation, the incidence of infectious and neurological complications, and duration of hospital stays in surgical and conservative management.

A. Demographic characteristics

In our study, the mean age group in the surgically managed group of patients, 24.73±14.96 years, was close to the mean age group of 26.95±14.87 years reported by Sidram V et al. and 27.9±12.9 years reported by Manne S et al. in surgically managed depressed fractures.(5,6) In the non-surgically managed group, the mean age in our study was 31.23±14.02 years, close to 34±3 years reported by Robert F. Heary et al. in non-surgically managed depressed fractures. (7)

Table 1. Shows the mode of injury.

Sr. No.	Mode of injury	No of patients (N = 102)
1	Road traffic accidents	76 (74.5%)
2	Assaults	15 (14.7%)
3	Fall from height	9 (8.8%)
4	Others	2 (2.0%)

Table 2. Shows the site of the depressed fracture

Sr. No.	Site of depressed fracture	No of patients (N = 102)
1	Frontal	45 (44.1%)
2	Parietal	35 (34.3%)
3	Temporal	17 (16.7%)
4	Occipital	2 (2.0%)
5	Fronto-temporal	2 (2.0%)
6	Parieto-occipital	1 (1.0%)

Table 3. Shows the clinical presentation of depressed fracture patient.

Sr. No.	Clinical presentation	No of patients(N = 102)
1.	Loss of consciousness	78 (76.5%)
2.	Vomiting	38 (37.3%)
3.	ENT bleed	26 (25.5%)
4.	Seizures	15 (14.7%)

B. Mode of injury

Road traffic accidents were the principal mode of injury in most patients 76 (74.5%).{as shown in Table no 1}.Similar to our study, other studies by Manne S et al. (5), Jamieson et al. (8), Rotterdam and Glasgow series(9,10) have also reported RTA being the primary cause of depressed skull fractures. Manne S et al. (5) reported a maximum incidence of 66.7% of RTA in his series, and other non-RTA reasons like

assaults, falls from height, and railway accidents combined accounted for only 33.3% of cases. The increased incidence of RTA in our region was due to the increasing incidence of riding bikes under the influence of alcohol and non-wearing helmets.

C. Site of depressed fracture

Our study found that most depressed skull fractures were present over the frontal region in 45 (44.1%) patients at the back of the hairline, followed by the parietal region in 35 (34.3%) patients. Other sites involved were temporal region in 17 (16.7%) patients, occipital in 2 (2%) patients, frontotemporal in 2 (2%) patients, and Parieto-occipital in 1 (1%) patient.{as shown in Table no 2} Our results are similar to the study of Vala H et al., who also reported the maximum incidence of depressed fracture in the frontal region at 35%, followed by the parietal region in 26% of patients. (11) Other sites were the temporoparietal region in 12%, the frontoparietal region in 14%, the temporal region in 7%, and the occipital region in 6% of patients reported in his study. (11) Our results were in contrast to the study of Satardey RS et al., who reported parietal bone as the commonest site in 48% of patients, followed by frontal bone in 34%, temporal in 10%, frontoparietal in 4%, and occipitotemporal in 4% of patients. (2)

D. Clinical presentation

In the clinical presentation, loss of consciousness was the common symptom and found in the majority of our patients, 78 (76.5%) patients. {as shown in Table no 3} Our results were similar to the study of Satardey RS et al. (2) and E. Shingiro et al. (12), who also reported the loss of consciousness as the most common clinical presentation in the majority of patients, 76% and 59.2%, respectively, in patients of depressed skull fractures after head injury.

E. Distribution of focal neurological deficits

In our study, focal neurological deficit occurred in 20/102 (19.60%) patients, and the incidence was close to 16% reported by Asif M et al. (13). Hemiparesis was observed to be the most common focal neurological deficit in 12 (60.0%), followed by aphasia in 5 (25%), and mono paresis in 3 (15.0%) patients. Asif M et al. also reported hemiparesis as the most common focal neurological deficit in their study in 12% of patients. (13) Like our study, C. M. van den Heever et al. and Rolekar NG et al. also reported similar types of focal neurological deficits in patients with depressed skull fractures. (14,15)

F. Severity of head injury

In our study, at the time of admission, the majority of patients had a minor type (GCS 13–15) of head injury in 75 (73.5%) patients, followed by 22 (21.6%) patients with a moderate type (GCS 9–12) of head injury, and in 5 (4.9%) patients the severe type of head injury (GCS< 8) was present.{As shown in Table no 4} Our result was similar to Venkati GS et al., who also found the majority of patients, 74%, having a minor type of head injury (GCS 13–15), followed by 14% having a moderate type of head injury (GCS 9–12), and 12% having a severe type of head injury (GCS<8) at the admission.(16)

Table 4. Shows severity of head injury.

Sr. No.	Severity of Head injury	No of patients (N = 102)	Percentage (%)
1	Minor head injury (GCS 13-15)	75	73.5%
2	Moderate head injury (GCS 9-12)	22	21.6%
3	Severe head injury (GCS < 8)	5	4.9%

Table 5. Type of management and neurological outcome in overall depressed fractures.

Sr. No.	Type of management	Total (N=102)	Good outcome (GOS =5)	Poor outcome (GOS< 5)
1.	Surgically managed (n = 42)	42	38 (90.5%)	4 (9.5%)
2.	Non surgically managed (n= 60)	60	56 (93.35%)	4 (6.7%)
P value				0.597
Chi-Square value				0.279
Degrees of freedom				1.00

G. Type of management and neurological outcomes

In, our study, in the non-surgically managed group, 93.35% of patients had good surgical outcomes (GOS>5) as compared to the surgical group having 90.5% of patients with good surgical outcomes (GOS>5), but results were not found to be statistically

significant (P > 0.05) as shown in (Table 5).Our results were similar to the study C. M. van den Heever et al. (15). They have also reported good neurological outcome of 96% of patients in non-surgically managed fractures as compared to 93% of patients in surgically managed compound depressed fractures. Damage to the underlying brain occurs on impact and, on the whole, cannot be improved by surgery. Even the simple debridement of the wound, saline, and antibiotic wash followed by suturing of the wound and keeping the patients on IV antibiotics without a conventional surgical method of elevation of a depressed fracture gives similar types of neurological outcomes. There are plausible reasons that bleeding from the injured cortex usually ceases before the conventional surgery and gets reactivated when the depressed fragments are elevated, especially in patients whose dura is torn. There seems to be a real hazard in damaging more cortex and underlying brain. Thus, we suggest the first-line management of a depressed fracture should be non-surgical.

H. Complications

The overall complication rate in our study was found to be 20.58% (21 out of 102 patients). This was close to the study of Ahmad S et al., who reported a 17.77% complication rate (16 out of 90 patients), but in contrast to Kurmi DJ et al., who reported 53.84% incidence (35 out of 65 patients). (17, 18) In our study, in surgically managed patients, the presence of complications rate was 28.57% (12 out of 42), and in non-surgically managed patients, the complication rate was 15% (9 out of 60). The total neurological complications contributed 68.29%, and the rest (31.70%) of complications were infective. Our study's results contrast to the study of Kurmi DJ et al., who reported wound infection (15.8%) as the most common overall complication, followed by seizures (13.8%). (18) In our study, in both surgically managed and non-surgically managed patients, the presence of seizures was the most common neurological complication in 28.57% and 13.33% of patients, respectively. The overall incidence of seizures was 19.60%. This was similar to the study of Kurmi DJ et al. and Ahmed J et al. (17, 18), who also reported seizures (20%) as the most common complication in the surgically managed group of patients, while it was in contrast to Sidram V et al. (2), who reported wound infection as the commonest complication in 11.3% of patients with surgically managed depressed fractures. However, in the non-surgical group of patients, seizures (13.33%), as reported in our study as the most common complication, were found to be in contrast to the study of Kurmi DJ et al. (17), who reported wound infections (17.5%) as the most common complication in the non-surgical group.

Table 6. Shows the distribution of various complications in patients with depressed skull fractures.

Sr. no	Types of complications	Surgically managed patients (n=24)	Conservatively managed patients (n=17)	Total (n=41)
1	Superficial wound infection	3	4	7
2	CSF leak	3	0	3
3	Osteomyelitis	1	0	1
4	Bacterial Meningitis	1	1	2
5	Focal neurological deficit	4	4	8
6	Seizures	12	8	20

Table 7. Overall complications in patients with surgically and non-surgically managed depressed skull fractures.

Infections	Surgically managed	Non-surgically managed	P-value	Chi-square
Present	8	5	0.11 (Not Significant)	2.55
Absent	34	55		

Table 8. Infectious complications in patients with surgically and non-surgically managed- depressed skull fractures.

Neurological complications	Surgically managed	Non-surgically managed	P-value	Chi-square
Present	16	12	0.04 (Not-Significant)	4.06
Absent	26	48		

I. Infectious complications

We found that the overall infectious morbidity in our study was 13/102 (12.74%), which is higher than in reported studies by Brisbane (7%), Glasgow (3.5%), and Rotterdam (5%). (19, 9, 10) .The most common infectious morbidity in our study was superficial wound infection in 7/13 (53.84%), followed by infected CSF leak in 3/13 (23.77%), followed by

meningitis in 2/13 (15.38%), and osteomyelitis in 1 (7.69%) patient.{as shown in Table no 6} Prakash A et al also reported that superficial wound infection was the most common infectious morbidity in 38% of patients. (19) There was no significant difference (P > 0.05) in terms of infection rate in surgically managed patients (19.04%) and non-surgically managed patients (8.33%). {as shown in Table no 7} A similar difference in the infection rates has been observed by C. M. van den Heever et al. (8% vs. 2.8%) (15) and

Table 9. Assessment of neurological outcomes with different variables.

Sr. No.	Variable	Variable	No of cases	Good outcome (GOS 5)	Poor outcome GOS (<5)	Chi- Square value	Degrees of freedom	P-value
1	Age group	< 20 years	34	33 (97.1%)	1 (2.9%)	5.034	3.00	0.169
		21-40 years	45	42 (93.3%)	3 (6.7%)			
		41-60 years	21	17 (81.0%)	4 (19.0%)			
		>61years	2	2 (100.0%)	0 (0.0%)			
2	Sex	Male	89	82 (92.1%)	7 (7.9%)	0.000	1.00	1.000
		Female	13	12 (92.3%)	1 (7.7%)			
3	Mode of injury	RTA	76	71 (93.4%)	5 (6.6%)	0.659	1.00	0.417
		Non -RTA	26	23 (88.5%)	3 (11.5%)			
4	GCS at admission	Minor(13-15)	75	73 (97.3%)	2 (2.6%)	38.845	2.00	**<0.001 (S)**
		Moderate(8-12)	22	20 (90.9%)	2 (9.1%)			
		Severe(<8)	5	1 (20.0%)	4 (80.0%)			

Hossain MZ et al. (20) reported 12% infection rates in their research of surgically managed depressed fractures. The higher incidence of infections in both groups might be due to the different sets of patients due to loco-regional factors. Our study was also in contrast to the conclusion reported by M. Z. Hossain MZ et al. that surgical treatment of contaminated depressed skull fractures decreases complications like meningitis, cerebral abscess, and osteomyelitis. (20) We found that despite surgical treatment of compound-contaminated fractures by conventional approach, infections like meningitis and osteomyelitis were still present in the surgical group of our patients. So, we conclude that even the non-surgical management of compound depressed fractures without undergoing the conventional surgical method of elevation of the depressed fracture, bedside debridement of the wound, antibiotic-saline wash, and primary closure done in an emergency room followed by IV antibiotics can prevent the infection rate. Jennet et al. also found that only debridement done bedside reduces the incidence of infection to 4.6% in their series. (21)

Early surgical management also cannot prevent the time onset of postoperative infectious complications as compared to non-surgical management. The Brain Trauma Foundation guidelines (Level III recommendation) for managing depressed skull fractures advocate surgical management of contaminated compound fractures by conventional surgical methods to reduce the rate of infection. Our study is also a level III study, but our results disagree with the above-said guidelines. There is a need for randomized control trials to clear this issue.

The average duration of treatment of complications in the conservative group for infectious complications was 26 days, while in the surgical group it was 44 days. In both groups, the bacterial meningitis and osteomyelitis had long-term treatment of 6 to 8 weeks of IV antibiotics followed by oral antibiotics for 4 to 6 weeks. Factors responsible for infected complications in both groups for compound depressed fractures were delayed onset of presentation after trauma, mostly after 72 hours, wounds soaked with dirty mud and foreign particles, and delayed treatment with prophylactic I.V. and local antibiotics for contaminated wounds.

J. Incidence of seizures and outcome in surgical and non-surgically managed patients

In our study, the overall incidence of late-onset seizures (>7 days) was 19.6%, which is near the incidence of 15% reported by Jennet B et al. in his research of depressed skull fractures. (21) The average time of onset of these seizures was 11.44

days after trauma. They concluded that the occurrence of seizures in the depressed skull is the combined effect of focal and diffuse brain damage, which predisposes to epilepsy. In our study, the incidence of late-onset seizures (>7 days) in the non-surgical group was (8/60) 13.33%, while in the surgical group, it was 28.57% (12/42). Our results are, in contrast, to the studies of Hossain MZ et al. (20) and Sidram V et al. (2), who concluded that conventional surgical treatment of elevation of depressed fracture segment decreases the seizures' incidence.

K. Assessment of neurological outcomes with different variables

On assessing neurological outcomes with different variables, we found no statistically significant ($P > 0.05$) association with age and sex, mode of injury, type of depressed fracture, site of fracture, and type of management, whether surgical or non-surgical, with neurological outcome,as shown in(Table no 9).

On the other hand, a better GCS at the time of admission and the absence of seizures have a significantly positive influence ($P<0.05$) on the neurological outcome of a depressed skull fracture. Satardey RS et al. reported that age, sex, site of fracture, and type of depressed fracture have a significant correlation with the neurological outcome. (2) Manne S et al. reported that there is no significant correlation between age and gender, site of the fracture, or type of fracture with the neurological outcome, while GCS at the time of admission has a strong correlation with neurological outcome. (5) Bidur KC et al. and Al-Haddad SA et al. reported that better GCS at admission correlated with favorable neurological outcomes. (22, 23) The poor outcomes with seizures have also been suggested by Satardey RS (2). Manne S et al. (5) suggested RTAs causing depressed skull fractures had poor outcomes compared to other injuries. We and Satardey RS et al. did not find this relevant. (18)

L. Hospital stay

Our study found a statistically significant difference ($P<0.05$) in terms of the mean duration of hospital stay. Our results were similar to the study of Katikar DB et al., who also found a shorter duration of hospital stay in non-surgically managed patients compared to surgically managed patients with depressed skull fractures.(24) Our practice of managing patients of compound depressed fractures conservatively without conventional surgery will provide an additional socioeconomic advantage, especially for poor countries, in significantly saving funds and available resources and potentially reducing transfer costs. Additionally, non-surgical management is less time-consuming and reduces the duration of hospital stay.

Strength of our study

Our study is the fourth prospective study in the history of 200 years for the treatment of compound depressed fractures. We believe that our study may open up new discussions and a quest for more powerful studies in the future.

Limitations

Randomization of patient selection was not possible because of the medicolegal nature of traumatic brain injury cases, and our sample size was also too small.

Future recommendations

Simple debridement and suturing of compound depressed fractures without conventional surgery is also equally effective management of compound depressed skull fractures, and these patients can be managed in rural peripheral hospitals.

CONCLUSION

The number of patients with head injuries in tertiary neurosurgical centres with limited beds is rapidly increasing as there is an increasing incidence of road traffic accidents. The results of our research will provide benefits towards more conservative management with adequate wound debridement and antibiotics so that these patients can also be managed in peripheral rural hospitals and avoid unnecessary referrals.

ABBREVIATIONS

TBI: traumatic brain injury,
DSFs: depressed skull fractures,
CN: cranial nerve,
GCS: Glasgow Coma Scale,
GOS: Glasgow outcome scale,
LOC: loss of consciousness,
RTA: road traffic accidents.

References

1. Shukla D. Jain M. Depressed skull fractures—case series of 100 patients. JEBMH.2018.5(48):3324-26.
2. Ritesh S. Satardey, Srikant Balasubramaniam, Jayashree S. Pandya, Rajesh C. Mahey. Asian J Neurosurgery. 2018 Apr-Jun; 13(2): 341-347.
3. Retnam KR, Jawahar G, Natarajan M. Midline depressed fractures of the skull. J Indian Med Assoc. 1986;84(9):271-2.
4. Guidelines for the Management of Severe Traumatic Brain Injury, 3rd edition. Brain Trauma Foundation: Introduction. J Neurotrauma.2007;24(1):1–2.
5. Manne S et al. Surgical outcomes in depressed skull fractures: an institutional experience. Asian J Neurosurg.2019;14:815-20.
6. Sidram V et al. A prospective study of the spectrum of a depressed fracture of the skull and its surgical outcomes. Int J Head and Neck Surgery.2015;6(4):134-138.
7. Heary RF, Hunt CD, Krieger AJ, Schulder M, Vaid C. Nonsurgical treatment of compound depressed skull fractures. J Trauma 1993;35(3):441-447.
8. Jamieson KG, Yelland JD. Depressed skull fractures in Australia. J Neurosurg.1972 Aug;37(2):150-5.
9. Miller JD, Jennett WB. Complications of depressed skull fracture. Lancet.1968;2:991–5.
10. Braakman R. Depressed skull fracture: Data, treatment, and follow-up in 225 consecutive cases. J Neurol Neurosurg Psychiatry. 1972; 35:395–402.
11. Vala H, Vaja MA. Depressed skull fracture: Prognosis of patients after conservative or surgical management. IP Indian J Anat Surg Head Neck Brain. 2020;6(1):8-13.
12. E. Shingiro et al. Clinical profile of skull fractures in Rwanda. RMJ.2017;74(3). Muhammad Asif, et al. Depressed Skull Fracture Management of 100 Cases at DHQ Teaching Hospital/Sahiwal Medical College Sahiwa Pak. J. of Neurol. Surg.2017;21(3).
13. Rolekar NG. Prospective study of the outcome of depressed skull fracture and its management. Int J Med Sci Public Health 2014; 3:1540-1544.
14. CM. van den Heever and D. J. van der Merwe. Management of depressed skull fractures. J Neurosurg 71:186-190, 1989.
15. Venkati G S, Yadav V, Shankar K B, Sikka A, Retrospective study of depressed skull fractures at a tertiary care center. IP Indian J Neuroscience.2020;6(1):55-58.
16. Kurmi DJ, Deka K, Ahmed J. A prospective clinical study of depressed skull fractures with special reference to their management. J Evid Based Med Healthc 2021;8(18):1195-1200.
17. Ahmad S, Afzal A, Rehman L, and Javed F. Impact of depressed skull fracture surgery on outcome of head injury patients. Pak J Med Sci. 2018 Jan-Feb;34(1):130-134.
18. Prakash A, Harsh V, Gupta U, Kumar J, Kumar A. Depressed Fractures of Skull: An Institutional Series of 453 Patients and Brief Review of Literature. Asian J Neurosurg. 2018 Apr-Jun;13(2):222- 226.
19. M Zahed Hossain, M S Mondle, M Monzurul Hoque. Depressed Skull Fracture: Outcome of Surgical Treatment. The Journal of Teachers Association RMC. 2008; 21(2):140-146.
20. Jennett B, Miller JD. Infection after depressed fracture of skull. Implications for management of nonmissile injuries. J Neurosurg. 1972 Mar;36(3):333-9.
21. KC Bidur, Shakya B, Thapa A. Study of Outcome of Patients Sustaining Depressed Skull Fracture Following Blunt Head Trauma. 2018;14(2):81-4.
22. Al-Haddad SA, Kirollos R. A 5-year study of the outcome of surgically treated depressed skull fractures. Annals of the Royal College of Surgeons of England. 2002;84(3):196-200.
23. Katikar D B, Jaykar R D, Rahul Ghule, Shivprasad Lakhapatre, Vikas Kumar. A prospective randomized study of operative and conservative management for compound depressed fractures of the skull. MedPulse—International Medical Journal. 2014 Oct; 1(10) 689-693.
24. K. K. Mukherjee et al. Prospective comparison of simple suturing and elevation debridement in compound depressed fractures with no significant mass effect. Acta Neurochirurgica.2015; 157:305–309.
25. Kumar S et al. A prospective comparative evaluation of surgery and conservative management treatment for compound depressed skull fractures. World Neurosurgery.2022; E1-E9.

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The learning curve: A neurosurgeon's memoir

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ABSTRACT

"The Learning Curve: A Neurosurgeon's Memoir," authored by Brigadier Harjinder Singh Bhatoe, is an autobiography of an Indian military neurosurgeon. The author invites readers on an intimate exploration of a life shaped by triumphs, tribulations, and the relentless pursuit of self-discovery as a soldier neurosurgeon. This autobiography is a poignant testament to the resilience of the human spirit and the transformative power of personal growth.

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The narrative unfolds with a refreshing and courageous honesty as the author fearlessly navigates through the highs and lows of their existence. From the early chapters, readers are drawn into the vivid tapestry of the author's past, witnessing the defining moments that have moulded their character. Dr. H.S. Bhatoe started his medical education at the prestigious Armed Force Medical College (AFMC) of Independent India. For him, surgery was a choice, but neurosurgery was a calling. Neurosurgeons are born gentlemen and leaders. A coveted military position was an icing on the cake in his case. He not only excelled as a surgeon but also as a soldier.

In the famous American movie "A Few Good Men," while being interrogated, Col. Jessup (portrayed by Jack Nicholson) counterquestions the young lawyer (portrayed by Tom Cruise), "Ever put your life in another man's hands, ask him to put his life in yours?" This situation is not only for a soldier but also a neurosurgeon as they deal with the most irreversible organ of the body. The author excelled diligently in both roles as a matter of the most responsibility and honour.

The book has certain unique attractions for any healthcare professional and regular reader alike, such as intriguing anecdotes from the literature at the beginning of every chapter, setting the tone of the ensuing pages. Foreword by his mentor and Emeritus Professor Vijay Kak MS, FRCS (End & Edin), FAMS, FIHE (London), this book also delves into the details of common and uncommon neurosurgical problems in a way any soldier analyses his enemy. His detailing of surgeries performed on those human beings is as meticulous as assembling a sniper's rifle by a blindfolded sniper. His remarkable remembrance of patients' names, colleagues' mannerisms, and surgical nuances is as fresh as today. Being regularly transferred to many military hospitals and maintaining the records in the non-digital era is no mean feat. His descriptions of neurosurgical ailments are spiritual and empathic. Summarizing within 24 chapters, he takes us on a memory lane spread over a journey of 45 years. Many of these chapters are a surgical treatise where the surgeon's emotions, frustrations, and the entire gamut of surgical conditions are illustrated by a humane neurosurgeon.

Some of his descriptions of surgical steps are detailed enough to be a chapter of any neurosurgical operative atlas. His journey from the angiogram era to 3D endoscopy fascinates seasoned and trainee neurosurgeons alike. His regular postings under challenging terrains and war zones provided him an opportunity to manage many unusual injuries and complications, especially firearm injuries. The narrative is not without its moments of humour, offering a welcome reprieve from the weightier subjects at hand. The author's wit and self-awareness shine through, creating a dynamic and engaging reading experience.

Apart from being a celebrated neurosurgeon, he was a coveted paratrooper and an honoured President's Guard. The book is a written testimony of secret and overt failures. In these chapters, he has candidly shared his moments of very aggressive, passively aggressive, and observational roles. This soldier doctor is not only a medical fraternity but a respected colleague, a teacher, a guide, a family man, and an internationally admired and acclaimed neurosurgeon.

Neatly presented in a 328-page hardbound first edition, "The Learning Curve" is enriched with coloured photographs and exciting stories of grateful patients, sleep-depriving complications, honest introspections, and lessons. As the story unfolds, the author's growth becomes palpable, showcasing the transformative power of self-reflection and the willingness to confront life's challenges head-on. The book is not merely a recollection of events but a testament to the author's journey towards self-actualization. The last chapter devoted to the family highlights the value of work-life balance and the vital role of our loved ones. It has become an engaging, inspiring, and entertaining read and would be an asset for any personal and institutional library. Readers will undoubtedly find solace, inspiration, and perhaps a reflection of their journeys within the pages of this compelling autobiography.

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