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Steps towards neuro-excellence

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ABSTRACT
Between September 28 and October 1, 2022, took place the 47th National Congress of the Romanian Society of Neurosurgery. It was organized in Iasi, at the Palace of Culture. On this occasion, the 26th Francophone Course and the 4th National Congress of Modern Neuroscience were held. These three events represent the quintessence of all current modern neurosurgical problems. Extremely important topics were disputed which helped to grow the passion in the hearts of young enthusiasts and their mentors.

Keywords
47th National Congress of the Romanian Society of Neurosurgery,
26th Francophone Course,
4th National Congress of Modern Neuroscience

The entire organization of this very special event was realized with the help of DIMAS Events represented by Mr. Sebastian Draghici together with the Management of the Romanian Society of Neurosurgery (President - Assoc. Prof. Dr. Hab. Horia Ples). A major role had the current management of the Emergency Clinical Hospital "Prof. Dr. Nicolae Oblu" Iasi – Manager – Conf. Univ. Dr. Lucian Eva.

The event was fully supported by the Mayor of Iasi – Mihai Chirica and by the Management of the County Council – President: Costel Alexe, Vice-President Marius Sorin Danga, Sorin Alexandru Afloarei, but also by the Prefect of Iasi – Petru Bogdan Cojocaru. This year, the National Congress of the Romanian Society of Neurosurgery managed to gather an important number of 47 guest speakers from the country and abroad, 110 primary physicians and specialists in the field of Neurosurgery, including also an important number of resident physicians and students from various years of general medicine.

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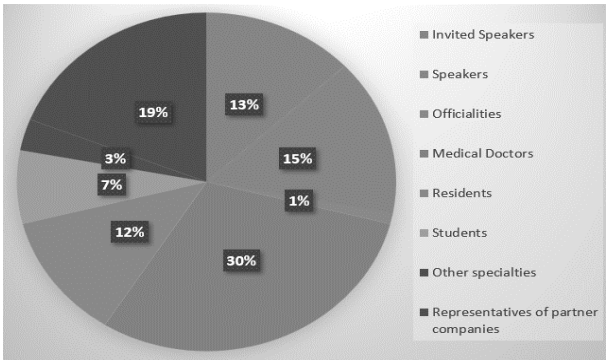

Figure 1. The structure of participants

The entire congress was organized and held in English, and the presentations were held in the famous halls of the Palace of Culture (UNESCO Monument), Henri Coanda Hall and the Voivodes' Hall. The halls presented exceptional architectural aspects, with historical significance such as "bois cement", a material imitating wood, invented by Henri Coanda, but also modern aspects, which made the audience feel in a world of science and discoveries. A very relevant element was the 26th French course of neurosurgery, quite exceptional, in which Prof. Carmine Mottolese and Prof. Olivier Klein from France, revealed modern and current aspects of pediatric neurosurgical pathology.

For the 47th Congress of the Romanian Society of Neurosurgery, we note that an important number of personalities of the world participated directly or online.

Among the international personalities we mention Prof. Amir Samii – Germany, Prof. Samy Youssef – Usa of America, Prof. Michael Buchfelder – Germany, Prof. Marcos Tatagiba – Germany, Prof. Ihsan Solaroglu – Turkey, Prof. Franco Servadei – Italy, Prof. Virendra Deo Sinha – India, Prof. Grigore Zapuhlic – Moldova, Prof. Sorin Aldea – France, Prof. Marcel Ivanov – England etc. The foreign guests through the special works and the interventions constituted an element of major lifting of the neurosurgical quality of the Congress.

Among the works and university centers in Romania we notice the presence of Prof. Horia Ples – Timisoara, Prof. Stefan Florian – Cluj, Prof. Mircea Gorgan – Bucharest, Conf. Corneliu Toader – Bucharest, Conf. Balasa Adrian – Tg. Mures, Prof. Aurel Mohan – Oradea etc. We also consider the major progress in intracerebral vascular pathology through the multiple works allocated to endovascular treatment, works presented in a totally fantastic and didactic manner by Dr. Cristian Mihalea (Paris) and Dr. Nicolae Dobrin (Iasi).

One of the works that impressed was that of Prof. Marcos Tatagiba, who presented "Surgical Treatment of Vestibular Schwannomas in the Era of Radiosurgery" bringing a new vision about evolution of pathology and treatment in neurosurgical field. Cristian Mihalea, an expert in radiological field, kept the audience focused when started to present the neuro-vascular pathologies from his point of view. His works and those of Nicolaie Dobrin gave to this congress a special value due to their endovascular method used in neuro-vascular pathologies.

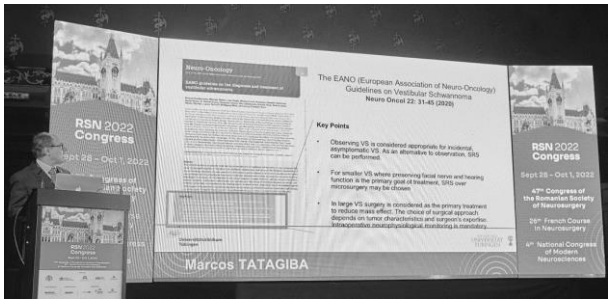

Figure 2. Prof. Marcos Tatagiba presenting his works at the 47th National Congress of the Romanian Society of Neurosurgery

The young neurosurgeons had a number of sections of development (Young Neurosurgeon Corner) where they had the opportunity to present their surgical and scientific work, carried out with so much devotion and enthusiasm. In these sessions, some of the bravest students presented papers through which they brought to the attention of the entire audience about the dreams and young hopes in the neurosurgical field.

An important section was dedicated to the 4th Congress of Neuroscience in which a whole series of topical elements in neuroscience were reviewed: The Accumbens Nucleus, The Evolution of Neural Theory, The Management of the Covid-19 Pandemic and many other very impressive papers.

At the end of the Congress, it was possible to outline as an idea that the entire Romanian neurosurgery has made important steps for the European integration, and the future of a Center of Excellence in Neuroscience belongs entirely to the Emergency Hospital "Prof. Dr. Nicolae Oblu" which in these moments possesses elements of robotic neurosurgery, Gamma Knife Surgery and Department of Neuroscience.

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Therapeutic advances in treatment of patients with neurofibromatosis type 1 and type 2. 7 years clinical experience of a single centre and literature review

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Keywords
neurofibromatosis, tumoral suppressor syndromes, lesions of the nervous system

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ABSTRACT

Background: Neurofibromatosis type 1 (NF1) and neurofibromatosis type 2 (NF2) are rare tumoral suppressor syndromes, triggered by an abnormal mutation in a tumour suppressor gene (TSG) (1). Each of these syndromes represents an orphan disease (by itself), but the tumours encountered in these patients are the most frequent lesions of the nervous system. Between the two of these diseases, NF1 presents a greater risk of malignancy, hence the importance of an accurate diagnosis and distinction between the two pathological entities. The purpose of this paper is to describe our department's practice protocol with neurofibromatosis and review the current literature regarding clinical diagnosis and management of these complex diseases.

Methods: Our paper is a retrospective study that comprehends 25 patients with neurofibromatosis treated in our clinic between 2011 and 2018.

Results: Our study included 16 female patients (64%) and 9 male patients (36%). The mean age at presentation was 48,7 (range 14-72 years). There were 7 cases (28%) of NF1 and 18 cases (72%) of NF2. Seven cases (28%) had a positive family history and 18 patients did not (72%). The most common symptoms at presentation were hearing loss, vertigo, and headache.

Conclusions: Neurofibromatosis is a very complex disease in which the tumours may have an unforeseeable growth pattern. New tumours can grow over the years and the symptoms are unpredictable. Surgical treatment is best to be reserved for symptomatic tumours. Non-surgical procedures are also an important step of the treatment, but further studies are required to decide their effectiveness.

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Background

Neurofibromatosis type 1 (NF1) and neurofibromatosis type 2 (NF2) are rare tumoral suppressor syndromes, triggered by an abdormal mutation in a tumor suppressor gene (TSG) (1). Each of these syndromes represents an orphan disease (by itself) (2) (3), but the tumors encountered in these patients are most frequent lesions of the nervous system (1). Between the two of these diseases, NF1 presents a greater risk of malignancy (4), hence the importance of an accurate diagnosis and distinction between the two pathological entities. The purpouse of this paper is to describe our department`s practice`s protocol with neurofibromatosis and review the current literature regarding clinical diagnosis and management of these complex diseases.

Materials and methods

We performed a retrospective study that comprehends cases from 4th Neurosurgical Department of the "Bagdasar-Arseni" Clinical Emergency Hospital. We retrospectively reviewed the charts of 25 patients with neurofibromatosis treated in our clinic between 2011 and 2018. We only included patients who fulfilled the known clinical indicators for of NF1 or NF2. Eleven patients, who didn't fulfill all the other criteria for NF1 or NF2, were therefore excluded from our study.

Results

Our study comprehends 16 female patients (64%) and nine male patients (36%). The average age at admission was 48,7 (range 14-72 years). The distribution of the patient sample based on the age group is shown in Figure 1. There were 7 cases (28%) of NF1 and 18 cases (72%) of NF2. Seven cases (28%) had a positive family history and 18 patients did not (72%). The most common symptoms at presentation were hearing loss, vertigo, and headache (Figure 2). Other signs and symptoms were seizures, lumbar pain, frontal lobe syndrome, or intracranial hypertension syndrome.

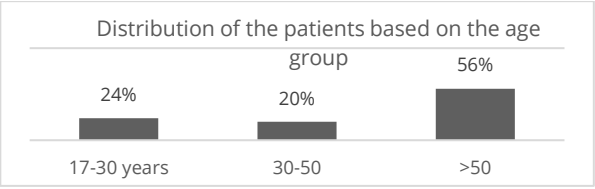

Figure 1. Age groups distribution.

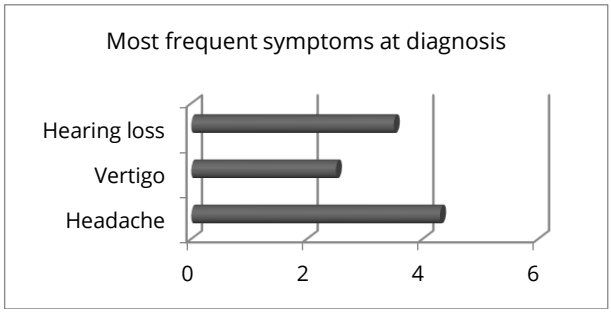

Figure 2. Most frequent symptoms at diagnosis.

In 6 cases (24%) Gamma knife radiosurgery was chosen as the first treatment option. The distribution of the tumors based on their location is illustrated in Fig. 3.

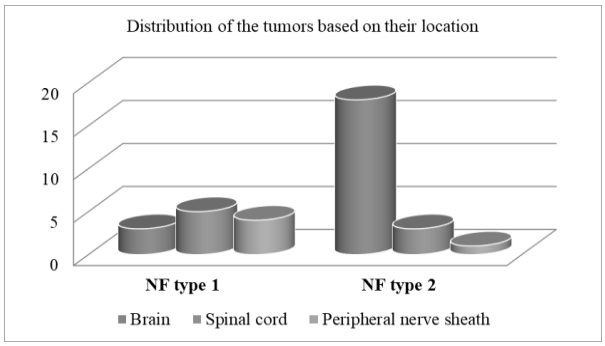

Figure 3. Distribution of the tumours based on their location in the neuroaxis.

The distribution of the patients based on whether they did, or did not, undergo surgical procedures is illustrated in Fig. 4.

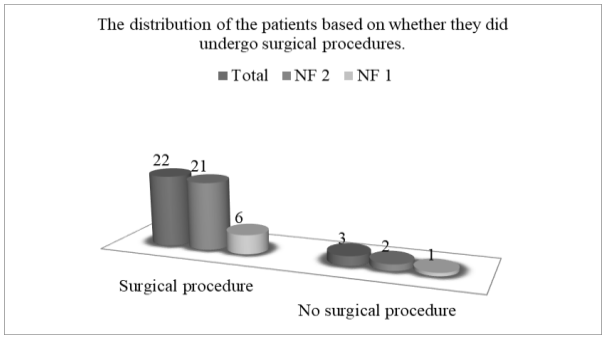

Figure 4. The distribution of the patients based on whether they did, or did not, undergo surgical procedures.

Case presentation

We present you the case of a 14 years-old child diagnosed Type II Neurofibromatosis was referred to our clinic with a 1-year history of cervical and brachial

neuralgia, hypoesthesia, and mild weakness in her left hand, as well as numbness of the fingers and left foot hypoesthesia. Her spinal cord function was evaluated to grade D on the Frankel scale. Neurological examination revealed an increased patellar reflex, no tricipital reflexes bilaterally, left ankle clonus, and bilateral positive Babinski sign. Other clinical signs were soft subcutaneous masses (neurofibromas) on the nose, frontal and temporoparietal regions and left hand, and also axillary and thoracal café-au-lait spots.

Cervical MRI investigation revealed on the left side a massive gadolinium-enhancing extramedullary spinal tumor starting at the level of C6-C7 vertebrae, expanding into the mediastinum, displacing the vertebral artery. The tumor was also in contact with the left common carotid artery, without compression. It had a scalloping effect on the left lateral wall of the C6 and C7 vertebral bodies, entered the superior thoracic aperture and extended to the T2-T3 vertebral level (Fig. 5).

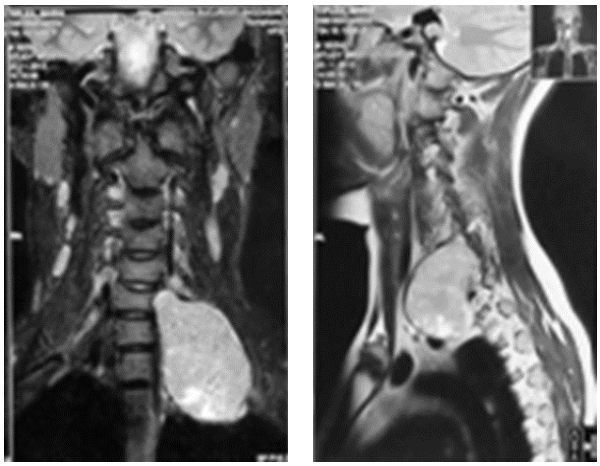

Figure 5. Gadolinium-enhanced cervical MRI, coronal and sagittal section, showing a large extramedullary spinal tumor at the level of C6-C7 vertebrae.

The patient underwent for first surgical intervention in order to excise the left medullary compressive portion of the tumor through posterior cervical approach. Six weeks later, using an anterior cervical Dartevelle approach, the extracapsular excision of the left laterocervical tumoral portion was performed. Postoperative, the patient was in good medical state, without any neurological deficit. The third intervention took place 4 weeks after and the previous one. The extracapsular excision of the tumoral process located between the right thyroid lobe, the carotid artery and the transverse processes of C2-C5.

For the vestibular schwannoma, Gamma Knife Radiosurgery was the elective treatment. Eventually, surgical excision of the subcutaneous neurofibromas was performed.

Two years later she was referred again to our clinic with complaints of dizziness, gait instability associated with visual dysfunction, more severely right side. The cerebral MRI images revealed an expansive process of the sellar and parasellar region with temporal lobe extension (Fig. 6). Surgical intervention for total removal of the lesion was the therapeutic attitude opted by the patient. Under general anesthesia, total removal of the lesion was performed, through a right pterional approach. The histopathological examination concluded a WHO grade II meningioma. Postoperative, the symptoms from the admission were improved, without dizziness or gait instability. Visual dysfunction did not improve but the patient did not accuse the worsening of the visual dysfunction.

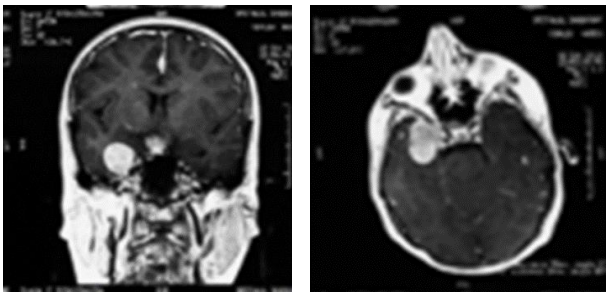

Figure 6. Cerebral gadolinium-enhanced MRI scan showing an expansive process of the sellar and parasellar region with temporal lobe extension.

The patient was strictly followed-up for early detection of new brain tumors because of their unforeseeable growth pattern. The last follow up was in February 2018 and the cerebral CT scan did not revealed any new tumour or progression of the disease.

Discussion

Surgical resection represents the gold standard of treatment for plexiform neurofibromas, but the recurrence rates are significantly high (8). Targeted therapies, such as anti-Ras therapy, seem to have promising effects (9) (10). In 2020, USA Food and Drug Administration has approved the use of selumetinib for treating inoperable plexiform

neurofibromas in pediatric NF1 patients (11). Regarding treatment strategies for NF2 patients, currently there is no consensus on the effectiveness of different approaches, because of the high regrowth rate after resection (12). Surgical resection is usually guided by the clinical symptoms and the approachability of the lesion. A close clinical and imagistic follow-up is necessary in both NF1 and NF2 syndromes.

Conclusion

Neurofibromatosis is a very complex disease in which the tumors may have an unforeseeable growth pattern. New tumors can grow over the years and the symptoms are unpredictable. Surgical treatment is best to be reserved for symptomatic tumors. Non-surgical procedures are also an important step of the treatment, but further studies are needed in order to determine their effectiveness.

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The assessment of risk factors for brainstem injuries and supratentorial brain injuries in patients with traumatic brain injury

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Keywords
brainstem injury, supratentorial brain injury, severe traumatic brain injury, imagistic data, histopathological data

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ABSTRACT

Traumatic brain injury (TBI) is an important cause of death with a significant worldwide percentage. In the United States, there are approximately 2.8 million TBIs yearly with 250,000 hospitalized patients and 50,000 TBI-related deaths. Every year, there are one million hospitalizations in the European Union, resulting in more than 50,000 deaths, most of which occur due to road traffic accidents. Needless to say, these estimations varied based on the different sources of data. The patient's outcome is determined by the context of the trauma, the type of lesion, as well as other factors.

The aim of the study was to assess variables associated with brainstem injury and supra-tentorial brain injury in patients with TBI. This cohort included 70 consecutive TBI-related deaths from the Institute of Legal Medicine Cluj-Napoca. There was a significant difference in brainstem contusion (haemorrhage contusion) in patients younger than 60. According to the computed tomography (CT) data, brain contusion and laceration were observed in association with brainstem contusion in a significant percentage of TBI-related deaths (p=0.016). Neither the meningo-cerebral blood collections nor the intraparenchymal hematomas had a significant occurrence with brainstem contusion. The diffuse axonal injuries were detected on a CT scan in a significant number of cases with brainstem contusion (p=0.011). The mass effect with brain herniation in the posterior fossa was associated with the occurrence of brainstem contusion, possibly as an extensive process (p=0.041).

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Analyzing the histopathological data, we observed the significant presence of intracranial haemorrhage in association with a hemorrhagic contusion in the brainstem (p=0.004), but not with meningeal haemorrhage. The poor neurological assessment evaluated by GCS was not an independent variable in relation with this brainstem lesion. That was probably caused by the complexity of the TBI. We did not include this variable in a multivariate analysis considering the poor outcome for all patients

Introduction

Traumatic brain injury (TBI) has an important impact regarding the overall mortality rate and the permanent disability. The brain injuries result from various mechanisms, the most common of which are related to falls (35%) and motor vehicle collisions (17%) (1). Also, the head wounds complete the high incidence of death. TBI is clinically divided into mild, moderate and severe; and the lesions are described histologically as primary and secondary brain tissue injuries. In the majority of cases the primary lesions involve the occurrence of secondary mechanisms such as brain edema, elevated intracranial pressure and brain herniation. These secondary lesions are the consequence of impaired cerebral blood flow regulation and brain metabolism alterations with upregulation of inflammatory mediators, oxidative stress, and vasospasm (2).

The prognostic of TBI depends on multiple factors, some of which are: the anatomical localization of the primary lesion, the type of injury, the secondary mechanisms, the proportion of damaged brain tissue, and also the accurate management for TBI. An acute hemorrhage or a contusion is clearly detected with an appropriate technique (computer tomography) or during the autopsy as morphopathology aspects. These aspects should explain the prognostic of TBI. Diffuse axonal injury (DAI) is often observed in extensive brain damage with intracranial hemorrhage, after rapid and sustained deceleration or acceleration of the brain (3). DAI occurred in up to 50% of traumatic brain injuries (TBIs), detected by magnetic resonance imaging (MRI), in the United States (4). The brainstem injury is an important cause of death, related to the anatomical and functional mechanisms of the cardio-respiratory control in the lower brainstem and spinal cord (5). Some types of posterior fossa lesions are difficult to detect on the MRI and are not completely understood. Also, the correlation between the brainstem injury and the outcome is still unclear. Of course, the researchers assumed a relationship between the brainstem lesions and other brain lesions, from the supratentorial fossa. These could be explained by secondary lesions that occurred as a consequence of the primary lesions. Brain edema is one of the most important secondary lesions that occurs almost in every TBI, including the brainstem injury or the supratentorial brain injury. Beside of the common mechanism of brain edema, cytotoxic or vasogenic, there is currently discussed about a new term "CSF(cerebrospinal fluid) - shift edema" that defined a new mechanism of brain edema occurred in traumatic subarachnoid hemorrhage, as a consequence of rapid shift of CSF from the cisterns. (6) There are many instances where the initial cortical contusion develops at the white/gray border with expansion into overlying grey matter (7). Contusion progression was found with a frequency of 63%-70% (8)(9). TBI is frecquently associated with coma status, caused by alteration of ascending arousal system, that could be observed in DAI with widespread damage white matter or mainly in bilateral brainstem injury.(10) Despite the preclinical and clinical management during hospitalization which is mainly focused on preventing the secondary lesion, the outcome of patients with brainstem injury is still discouraging.

In this study we assessed the variables associated with brainstem injury and supratentorial brain injury in patients with TBI, and to assess imagery data related to the TBI.

METHODS

The study was retrospective, longitudinal, observational, analytical, cohort type. In this study we included 70 TBI-related deaths from the Institute of Legal Medicine Cluj-Napoca, from January 2017 to December 2021. The data were noted from the reports of eligible patients for this study. This study was approved by the Clinical Ethics Committee of the ˝Iuliu Haţieganu˝ University of Medicine and Pharmacy in Cluj-Napoca.

The eligible cases for this study were: the autopsied cases with TBI who were admitted in a department of neurosurgery before death. Patients with TBI who died immediately after trauma were excluded from the study, because we considered that they had a fatal brain injury.

In the first part of the analysis, we noted the demographical information and the following clinical

data: the neurological status related to Glasgow Coma Scale (GCS) on initial evaluation, the classification of TBI (mild, moderate and severe), the comorbidities, the type of surgical intervention used, the complications developed during hospitalization, the number of days of hospitalization until death occurred. We recorded the imagistic data detected on the initial CT: the primary cerebral lesions - subdural hematoma and its maximal thickness (in millimeters, mm), intraparenchymal hematoma and its maximal thickness (mm), subarachnoid hemorrhage, contusion and laceration, diffuse axonal injuries, cranial fracture; and the secondary brain lesions – brain edema, brain herniation and the midline shift. In the next part we noted the microscopic aspects of the brain lesions from the histopathological reports. We distinguished the cases with brainstem injuries from cases without them and we established two groups on this criterion. We defined the brainstem contusion as the lesion with a hemorrhagic character in the brainstem tissue, as viewed microscopically. We considered that the brainstem contusion would be a primary lesion or a consequence of an expansive process from the other brain lesions. Also, we noted the presence of meningeal hemorrhage or intracranial hemorrhage from the histopathological reports.

Statistical analysis was carried out using the MedCalc Statistical Software version 19.4.1 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2020). Quantitative data was tested for normality of distribution using the Shapiro Wilk test and was characterized by median and 25, 75 percentiles. Qualitative data were expressed as frequency and percentage. Comparisons between groups were performed using the Mann-Whitney or chi-square tests, whenever appropriate. A p value <0.05 was considered statistically significant.

RESULTS

The demographical and clinical data are described in detail, in table I. In this study there were 36 patients with histopathological brainstem contusion. Patients with brainstem contusions were significantly younger than patients without them, but there was no difference noted between males and females. Also, we analyzed the impact of the brainstem lesion on the clinical status of patients. We did not observe a correlation between the consciousness state and the patients with brainstem contusion, neither with the severity of the TBI. Patients with comorbidities such as chronic consumption of alcohol, arterial hypertension and atrial fibrillation presented a significant occurrence of brainstem contusion. The surgery status was not related with the localization of the lesions.

Table 1. Demographic and clinical data

Variable		Non histopathological brainstem contusion (n=34)	Histopathological brainstem contusion (n=36)	p
Age		65 (56; 82)	59.5(32.5; 73.5)	0.014
Sex, n (%)	M	21 (61.8%)	27 (75%)	0.3
	F	13 (38.2%)	9 (25%)	
GCS		4 (3.75; 7.25)	3.5 (3; 7)	0.4
TBI, n (%)	mild	5 (14.7%)	4 (11.1%)	0.7
	moderate	7 (20.6 %)	6 (16.7%)	
	severe	22 (64.7%)	26 (72.2%)	
Comorbidities, n (%)	None	7 (20.6%)	22 (61.1%)	0.01
	Arterial hypertension	7 (20.6%)	6 (16.7%)	
	Chronic alcohol composition	4 (11.8%)	5 (13.9%)	
	Atrial fibrillation	16 (47.1%)	3 (8.3%)	
Surgery, n (%)	No	9 (26.5%)	12 (33.3%)	0.7
	Applied	25 (73.5%)	24 (66.7%)	
Complications, n (%)	None	25 (73.5%)	26 (72.2%)	0.1
	Hemorrhagic shock	0 (0.0%)	2 (5.6 %)	
	Septic shock	3 (8.8%)	0 (0.0%)	
	Bronchopneumonia	6 (17.6%)	8 (22.2%)	
Days of hospitalization		8.5 (4.5; 15.25)	6 (3; 10)	0.8

Table 2. Imagistic data

Variable		Non histopathological brainstem contusion	Histopathological brainstem contusion	p
Subdural hematoma, n (%)	Absent	5 (14.7%)	8 (22.2%)	0.6
	Present	29 (85.3%)	28 (77.8%)	
Thickness of subdural hematoma, mm		9.5 (6.75; 19.50)	15.50 (11; 24.5)	0.3
Intraparenchymal hematoma, n (%)	Absent	25 (73.5%)	20 (55.6%)	0.1
	Present	9 (26.5%)	16 (44.4%)	
Thickness of intraparenchymal hematoma, mm		32.5 (11; 71.5)	31 (6.25; 41)	0.9
Subarachnoid hemorrhage, n (%)	Absent	25 (73.5%)	24 (66.7%)	0.7
	Present	9 (26.5%)	12 (33.3%)	
Brain contusion and laceration, n (%)	Absent	23 (67.6%)	13 (36.1%)	0.01
	Present	11 (32.4%)	23 (63.9%)	
Midline shift, mm		10.5 (5.5; 14.5)	7 (4; 9.5)	0.4
Diffuse axonal injury, n (%)	Absent	30 (88.2%)	21 (58.3%)	0.01
	Present	4 (11.8%)	15 (41.7%)	
Brain edema, n (%)	Absent	7 (20.6%)	6 (16.7%)	0.9
	Present	27 (79.4%)	30 (83.3%)	
Brain herniation, n (%)	Absent	26 (76.5%)	18 (50.0%)	0.04
	Present	8 (23.5%)	18 (50.0%)	
Cranial Fracture, n (%)	Skull dome	19 (59.9%)	16 (44.4%)	0.5
	Skull base	9 (26.5%)	8 (22.2%)	
	Skull dome and base	4 (11.8%)	7 (19.4%)	

Table 3. Histopathological data

Variable		Non histopathological brainstem contusion	Histopathological brainstem contusion	p
Meningeal hemorrhage, n (%)	Absent	3 (8.8%)	5 (13.9%)	0.7
	Present	31 (91.2%)	31 (86.1%)	
Intracranial hemorrhage, n (%)	Absent	19 (55.9%)	7 (19.4%)	0.004
	Present	15 (44.1%)	29 (80.6%)	

CT detected all the other brain lesions, beside the brainstem injury. The supratentorial brain lesions were assessed according to the presence or absence of brainstem contusion. The cerebral blood collections did not seem to have a direct relation with the brainstem injury. The meningocerebral collection such as the subdural hematoma (SDH) was an independent factor of TBI. Neither the thickness of the subdural hematoma or the midline shift did not describe a causal relation with the posterior fossa lesion. Beside this, a direct relation was found between the supratentorial brain laceration and the brainstem contusion. Diffuse axonal injuries were detected in a significant number of patients with brainstem contusion (p= 0.011). Another diffuse brain injury, namely brain herniation as a consequence of brain edema, was a significant information which showed a correlation with brainstem contusion. All the supratentorial lesions and their comparisons are mentioned in Table II.

Analyzing the histopathological data, we observed a significant presence of intracranial hemorrhage in patients with brainstem contusion (p=0.004), but this association was not reported for meningeal hemorrhage. The comparisons of these histopathological aspects are described in table III.

Discussion

In some cases of brain trauma, the exact mechanism which lead to death is difficult to explain. The physiopathological mechanism that follows TBI is not completely known and is still an investigated subject. The fatal head impact was characterized by a depression activity on electrophysiology in both cortex and brainstem and of course, death occurred immediately. (11) In mild and severe TBI, the lesion could be limited at a part of the brain. In terms of its location, it does not always include the vital centers from the brainstem that generate and maintain the cardiac and respiratory rhythm. It is well known that

the mechanisms of central control are complex, by receiving signals from other sites while also having a nervous, reflex and humoral regulation. It is still challenging to know the mechanism of death in TBI when the primary lesion does not include the vital centers from the brainstem or spinal cord. In this study we were interested to find out the variables associated with the brain lesions from different locations of the brain. We were looking at the supratentorial and the brainstem lesions, focusing on their imagistic and microscopic aspects.

In regard to the relation with the supratentorial injuries, Mannion et all studied the aspects of the brain lesions, detected mostly on MRI. (12) In their study, the brainstem injuries were observed in association with severe diffuse axonal injury or in the context of a significant mass lesion and all of those patients had a poor outcome.(12) Only two patients from their study had a good outcome and that was in association with minor supratentorial abnormalities. (12) Evaluating the outcome, John R Williams showed in their study that the patients with associated brainstem and cerebrum injury had an unfavorable outcome compared with Duret hemorrhage alone or brainstem contusion.(13) In contrast, the Duret hemorrhage was associated with transtentorial herniation as a consequence of severely elevated intracranial pressure (14) In our study we showed a significant association of brainstem injury with supratentorial lesions, including diffuse axonal injuries and brain herniation.

Despite worse outcome, Moen et all evaluated through MRI the traumatic axonal injuries and they demonstrated the reduction of non-hemorrhagic lesions from hemispheres and corpus callosum and the complete absence of brainstem lesions, 3 months after TBI. (15) The hemorrhagic axonal injuries were only attenuated at the 3 months examination. (15) Even though, they observed an important evolution of traumatic axonal injury, the number of lesions and their volume on MRI predicted a worse clinical prognosis. (15) In the same study, quoted at 4 points, the authors found that isolated traumatic axonal injury or other brainstem lesions with a volume less than 1 ml measured on the CT-scan, predicted a favorable outcome. (4) In contrast, the brainstem lesions (contusion or Duret hemorrhage) with a volume larger than 1 ml were against the favorable long-term outcome. (4) Isolated TAI in brainstem are caused mostly after rotational acceleration mechanism and they tend to have the prospect of recovery. (16) (17) (18) Besides, the hemorrhagic brainstem contusion and Durret hemorrhage are the result of more complex intracranial mechanisms and they could lead to a more severe brainstem injury. (16)

The poor neurological assessment evaluated by GCS was not an independent variable in relation with brainstem lesions in our study. That was probably caused by the complexity of TBI. We did not include this variable in a multivariate analysis considering the poor outcome for all patients. Two extensive studies, the International Mission on Prognosis and Analysis of Clinical trials in Traumatic brain injury database (IMPACT models) and the Corticosteroid Randomisation After Significant Head Injury trial data (CRASH models) were performed to predict the mortality and unfavourable outcome and in both the GCS variable predicted it. (19)(20)

Conclusion

The brainstem contusion was reported to the clinical, imagistic and other histopathological aspects of TBI. Related to the primary supratentorial lesions, the extensive brain laceration was significantly associated with the brainstem injury. Diffuse axonal injuries were detected on CT for a significant number of cases with brainstem contusion ($p = 0.01$). The mass effect with brain herniation in the posterior fossa was associated with the occurrence of brainstem contusion, possibly as an extensive process. The histopathological data showed a significant presence of intracranial hemorrhage with hemorrhage contusion in brainstem, but not with meningeal hemorrhage. The poor neurological assessment evaluated by GCS was not an independent variable in relation with brainstem lesions. That was probably caused by the complexity of TBI.

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Brain abscess – a still high mortality medical condition. Our clinic experience and literature review

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ABSTRACT

Background. Even in the 21st century, infections of the central nervous system and their secondary damage still represents a high mortality condition. Furthermore, brain abscesses (BA) are huge public health issues due to their high mortality and morbidity with high financial implications for the health care system.

Material and methods. In this article, we want to present our clinic`s experience in the management of brain abscesses between 2012 and 2021. A 10 years retrospective study was performed in the 4th Neurosurgery Department of "Bagdasar-Arseni" Clinical Emergency Hospital in Bucharest

Results. In the last 10 years, our clinic admitted 46 patients, 10 women and 36 men. The mean age was 47 years old. The most common symptom was headache (42 cases). In 39 cases, patients had solitary abscesses while seven patients presented multiple abscesses. The therapeutic approach was classic surgery in 37 cases. In four cases abscess drainage was performed and in five cases conservative treatment was used. At discharge, 31 patients were healed and seven patients died.

Discussions. In BA management, antimicrobial therapy is crucial. Thus, identifying the pathogen is crucial for accurate antimicrobial treatment. Unfortunately, in too many cases, the agent remains unknown and empiric treatment is required. Aspiration of the abscesses proved to be safe and with similar results compared to classic surgery.

Conclusions. Brain abscesses remain a high challenge to manage even in the 21st century. Broad-spectrum antibiotic treatment should be applied as soon as possible until the pathogen is identified and specific treatment will be used.

BACKGROUND

Even though trepanation of the skull is one of the first medical procedure performed [10], the first documented surgical intervention of a brain abscess was performed by the S.F Morand in 1952 for a temporoethmoidal abscess [11]. Despite the evolution of techniques

and technology such as marsupialization proposed by King [12], aspiration tried by Dandy [13] or enucleation of the encapsulated abscess tried by Vincent [14], the first case reported to be successfully treated my medical management was in 1971, by Heineman [15]. However, Vincent [16] proved the efectivness of complete excision of the brain abscess back in 1936.

Even in the 21st century, infections of central nervous system and their secondary damage still represents a high mortality condition [1]. Furthermore, brain abscesses (BA) are a huge public health issue due to its high mortality and morbidity with high financial implication for health care system [2], [3]. Brain abscess represents a puss collections located in the brain parenchyma and a life-threatening emergency. The incidence of BA may widely vary between countries. It is known that developed countries have a lower incidence (about 1-2%) while developing countries may reach an incidence of 8% [4], [5], [6]. The most affected ages are young pediatric population and the elderly with an increased predisposition to male patients.

Brain abscesses are dynamic focal forms of intracranial lesions. Their formation is a long and elaborate process that can be divided in four stages [7], described in Table 1.

Stage	Duration
Early cerebritis	1-4 days
Late cerebritis	4-10 days
Early capsule development	11-14 days
Late capsule development	>14 days

Table 1. Formation of cerebral abscess.

The study of the brain abscess was achieved using CT and MRI scans. The first stage, early cerebritis is characterized by the increase of neutrophil, edema and tissue necrosis. In this stage, the microglias and astrocytes activates. They usually remain activated through whole abscess development [8]. The cytokines TNF-alpha and IL-1 have key roles in the establishment of antibacterial response in the central nervous system [8]. Few studies sugested high level of necrosis factor-alpha, interleukin 1beta and macrophage inflammatory protein-2 are detected from the third week of infection with Staphylococcus aureus [9]. The late cerebritis phase is characterized by a lymphocyte and macrophage infiltrate. Between 11 to 14 days, the development of the capsule begins. In this stage, a highly-vascularized abscess wall is form, limiting the expansion of the infective process, thus preserving the brain function and structure.

In almost half of the cases (40%), the origin of BA remains unidentified. In the developed countries, brain abscesses are usually a surgical intervention complication [17]. Before the discovery of antibiotics, the most common isolated pathogen was Staphylococcus aureus [18]. Sometimes, fungal infections and intracranial tuberculosis may present as an abscess [19], [20], [21]. Very often, the pathogenic source is polymicrobial. Even though there is a wide range of pathogens responsible for BA, the most isolated pathogens are Staphylococcus aureus and streptococcus viridans in about 40% of the cases.

There were described three types of sources for pathogens to reach the cerebral parenchyma. The first way is due to spread of infection from pericranial contagious focus, in almost half of the cases (25-50%) such as middle ear, dental infections or sinusitis. Dental infections and frontal or ethmoidal sinusitis tend to spread in the frontal lobe, while mastoiditis and chronic otitis media tend to spread through temporal lobe or cerebellum [21].

Hematogenous spread is the second mechanism of pathogenic spread from a distal focus of infections. The most common source is the bacterial endocarditis, but other foci such as lung abscess, skin infections or intraabdominal infections were reported [22]. Hematogenus spread was encountered in 15% to 30% of the cases [23].

The third mechanism is the direct inoculation through head trauma, implantable devices or neurosurgical interventions. This mechanism is the most frequent in the developed countries, having an increased number of road accidents that can lead to head trauma and therefore to brain abscesses [24].

Clinical features of the patients is non-specific and may vary depending on the location of the abscess. The most frequent presentation symptoms are headache and vomiting, due to high intracranial pressure. In more than half of the cases, seizures were reported in literature. The patients may accuse focal neurological deficit and altered states of consciousness. The most common symptoms are displayed in Table 2.

Symptoms	Frequency (%)
Fever	54.5-60
Hemiparesis	20.2
Headache	72-92.8
Cranial nerve	39.8
Meingism	52.2
Altered level of consciousness	10-100
Seizure	21-25.3
Nausea	31-40
Papilloedema	4,1-50
GCS at admission	
3-8	10.3
9-12	28.0
13-15	61.7

Table 2. Most common symptoms [27].

Both MRI and CT can be used to emphasize BA, similar features being available for both investigation. However, magnetic resonance imiging has a better ability to differential diagnose the cerebral abscess from other ring-enhancing lesions. A typical CT scan of a brain abscess describe a ring of isodense or hyperdense tissue with uniform thickness and central low attenuation and surrounded by vasogenic edema. Ventriculitis may be present as well and confirmed by the enhancement of the ependyma [27],

However, MRI offers better resolution images compared to CT scan. The specific image of peripheral enhance of contrast substance is emphasized. Differential diagnosis can be performed using diffusion-weighted sequences or spectroscopy, showing central diffusion restriction, a typical aspect of brain abscess [27], [28].

There is no well-defined treatment guidelines for brain abscesses and each case should benefit of tailored treatment strategy. Regardless of chosen therapeutically approach, a rapid broad spectrum antibiotic treatment should be initiated. The most important characteristic of the chosen antibiotic is the penetration of CSF barrier in adequate concentration [29].

Despite de symptomatic treatment, anticonvulsant medication should be initiated as soon as possible for patients with BA [30]. The anticonvulsant treatment must be sustained for at least two years of no seizures for patient and no epileptic activity emphasized on EEG.

Surgical approach of brain abscesses must be taken into consideration when patients present lesions bigger than three cm. A bigger than 5 mm midline shift or brain herniation should be emergency signs for surgical treatment. Moreover, surgical excision of the BA should me the elective treatment when the lesion is located close to the ventricular system. In the last decade, stereotactic CT-guided aspiration became widely used for BA drainage. It is a less invasive maneuver that permits the microbiological analysis of the abscess content, a key factor for a proper antimicrobial therapy. Furthermore, stereotactic CT-guided aspiration is considered as effective as classic surgical intervention [31].

MATERIALS AND METHODS

In this article we want to present our clinic`s experience of management of brain abscesses between 2012 and 2021.

A 10 years retrospective study was performed in the 4th Neurosurgery Department of "Bagdasar-Arseni" Clinical Emergency Hospital from Bucharest. It included 46 patients with brain abscesses who benefited of either medical or surgical treatment of brain abscess.

RESULTS

In the last 10 years, in our clinic were admitted 46 patients with brain abscesses, 10 women and 36 men. The mean age was 47 years old, ranging between 16 to 69 years old. A detailed chart of patient`s age is available in Fig.1.

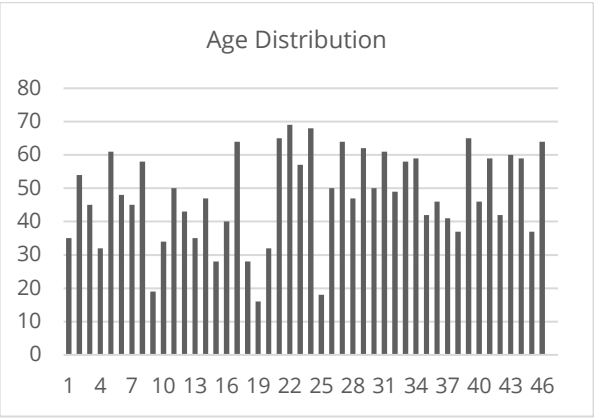

Figure 1. Distribution of patients` age.

The most common symptoms accused by patients at admission were headache (42 cases) and motor deficits (32 patients). Moreover, 24 patients had seizures prior to admission. In 20 cases, aphasia was identified and 14 patients had sings of elevated intracranial pressure such as vomiting. Furthermore, 14 patients had fever over 39 degrees Celsius.

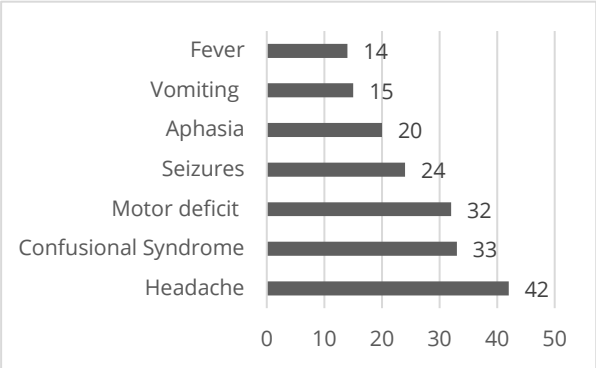

Figure 2. The most frequent symptoms of patients.

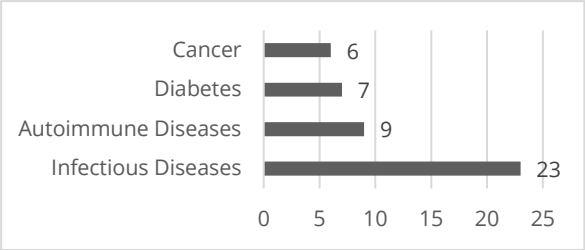

Figure 3. Comorbidities of patients.

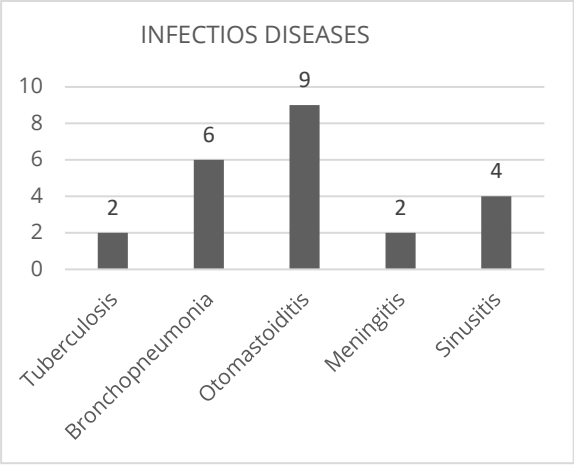

Figure 4. Main foci of infection

In terms of comorbidities, 23 patients presented infectious diseases prior to occurrence of the brain abscess. Autoimmune diseases were reported in nine cases and seven patients presented diabetes. Moreover, six cases had a history of cancer with radio/chemotherapy. The main sources of the infections disease that led to formation of cerebral abscesses are detailed in the Fig. 4. In the most of cases, osteomastoiditis was the main focus of infection.

Only eight patients affirmed a traumatic history. The rest of them reported no traumatic history or surgeries. In 39 cases, patients had solitary abscess while seven patients presented multiple abscesses. The mean diameter of the abscesses was about 36 mm, ranging between 10 to 63 mm. One third of the lesions were located in the frontal lobe. In 11 cases, the abscess was present in the temporal lobe and in nine patients in the parietal lobe. The distribution of brain abscesses is available in Fig. 5.

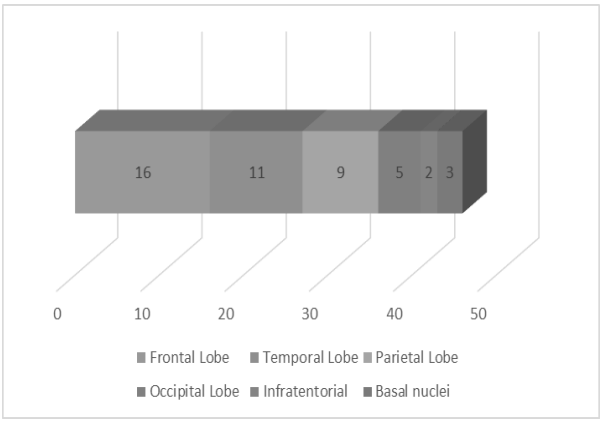

Figure 5. Distribution of brain abscesses.

When the abscesses exceed the size of 3 centimeters and cause a mass effect, the same surgical approach as an expansive intracranial process is required, and total resection is the gold standard, especially in the case of encapsulated abscesses.

Therapeutical approach was classic surgery in 37 cases. In four cases abscess drainage was performed and in five cases conservative treatment was used (Fig. 6). Even though only five patients received a conservative treatment, no pathogen grew on the culture in 25 cases. Detailed chart of pathogens identified is available in Fig. 7. In terms of postoperative complications: Two cases had bone flap osteitis. Two patients had extradural hematoma and in four cases abscess recurrence was noted. At discharge, 31 patients were healed and seven patients died. The clinical and neurological state was improved in six cases.

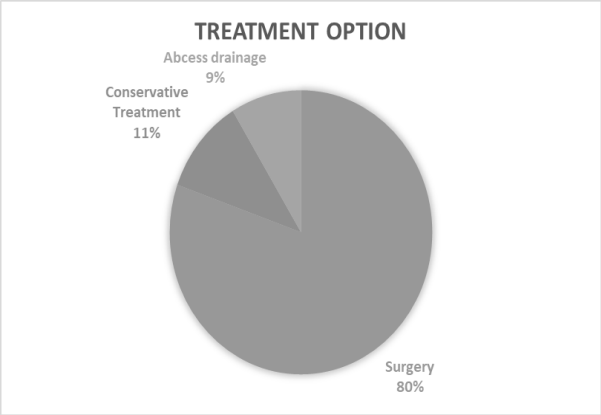

Figure 6. Treatment options of our patients.

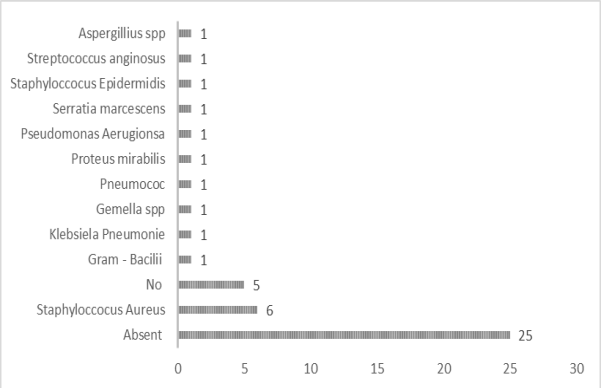

Figure 7. The pathogens identified after culture examination.

CASE 1 – SURGICAL APPROACH

First case is a 65-year-old patient, hospitalized for motor aphasia and right hemiparesis, without other medical history. A cerebral MRI scan was performed and revealed high left fronto-parietal space replacement process with imaging appearance suggestive of a brain abscess (Fig. 8).

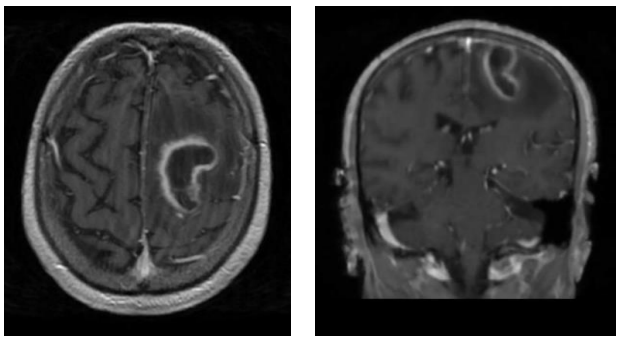

Figure 8. A fronto-parietal left lesion with suggestive aspect of brain abscess. Important perilesional edema.

Integrating the clinical examination (motor aphasia; right hemiparesis) with the paraclinical investigations (cerebral MRI with contrast substance - fronto-parietal left lesion with suggestive aspect of brain abscess and important perilesional edema), the patient presents a neurosurgical indication. The patient underwent surgery and the total ablation of the abscess is performed (Fig. 9). Cultures are taken for the antibiogram and tissue for the histopathological examination. Postoperative brain CT scan confirmed the total removal of the lesion without any signs of hemorrhage. Postoperatively, the patient shows a slow favorable evolution under antibiotic treatment (cefepime 6g with vancomycin 2g), daily intake of anticoagulants, antiedematous treatment, depletives, anti-inflammatory treatment. The smear detects gram negative bacilli. In the antibiogram culture, no germs developed after 5 days of incubation. The skin threads are suppressed seven days postoperatively. The patient is then sent to an infectious disease department for further treatment. At discharge, the patient is in good condition, conscious, cooperative, with partially remitted aphasia and almost completely remitted right hemiparesis.

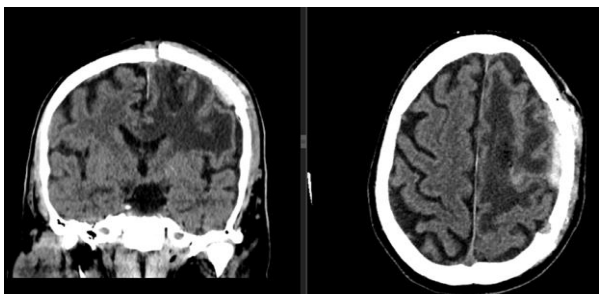

Figure 9. Postoperative cerebral CT scan that shows the complete removal of the abscess.

CASE 2 – CONSERVATIVE APPROACH

The 35-year-old patient is hospitalized in the 4th Neurosurgery Service of "Bagdasar Arseni" Emergency Hosptial for visual field disorders and balance disorders with sudden onset approximately 24 hours ago. The cerebral MRI scan performed by the patient revealed multiple intracranial expansive processes in etiological observation. Based on the investigations carried out, the associated pathology (infective endocarditis with Klebsiella and Streptococcus), the clinical and neurological

consultation, the diagnosis of multiple cerebral abscesses is established.

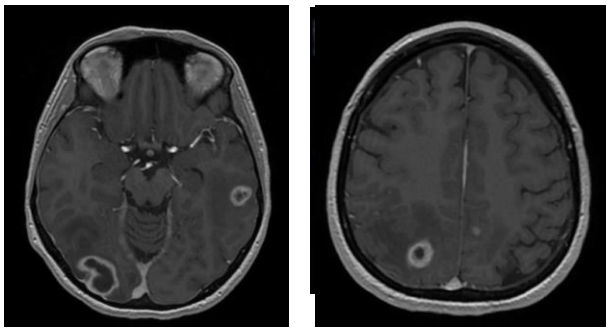

Figure 10. Expansive intracerebral processes, mostly supratentorial, one millimeter infratentorial, with an MRI appearance suggesting an infectious substrate - brain abscesses.

A whole-body CT-scan was performed and showed liver abscess as well.

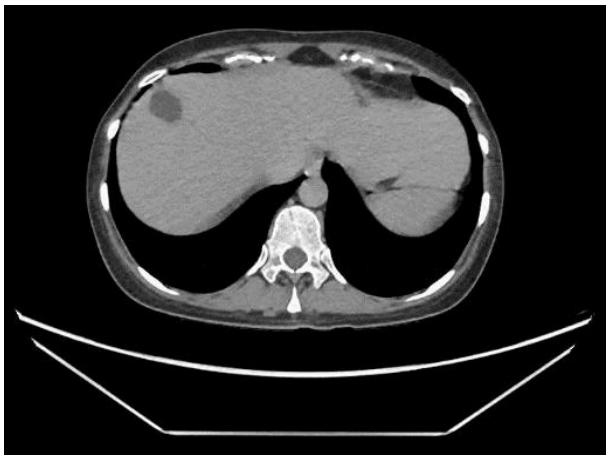

Figure 11. Liver lesion with a CT appearance suggestive of an infectious inflammatory substrate (abscess).

The condition and its therapeutical options are presented to patient and her relatives (surgical for the right occipital lesion, conservative according to the antibiotic scheme recommended on the "wait and see" principle) and they opt for conservative treatment, in full knowledge of the possible risks/benefits. Under maximum antibiotic treatment (Meropenem 6g/day, Vancomycin 2fl/day, Gentamicin 80mg 2fl/day) associated with symptomatic treatment (corticosteroid with Dexamethasone), the patient's evolution is slowly favorable, with quasi-total remission of symptoms at the time of discharge. Imaging investigations (repeated head CT, repeated cerebral MRI) show the dimensional decrease of infectious processes from the liver and brain.

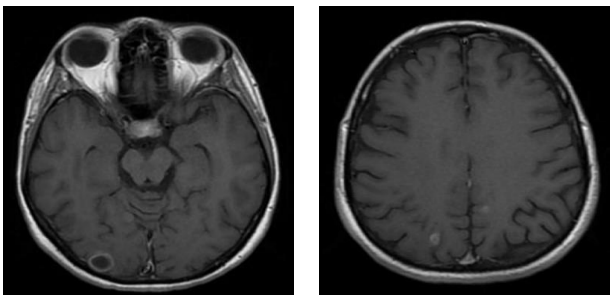

Figure 12. MRI 4 weeks after conservative treatment. Regression of the lesions.

She was discharged almost four weeks later, afebrile, conscious, cooperative, without neurological deficits and referred to cardiovascular department for the surgical intervention in the field of cardiovascular surgery. She will return for clinical and imaging follow-up according to the schedule.

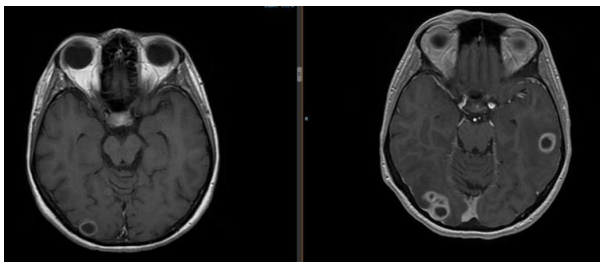

Figure 13. Comparison of the lesions at admission (right) vs discharge (left).

At two months follow-up check, patient's clinical and neurological state were improved. MRI performed showed an important downsize of the main two foci (right occipital lesion and left parietal lesion) and the complete remission of other lesions (Fig. 14).

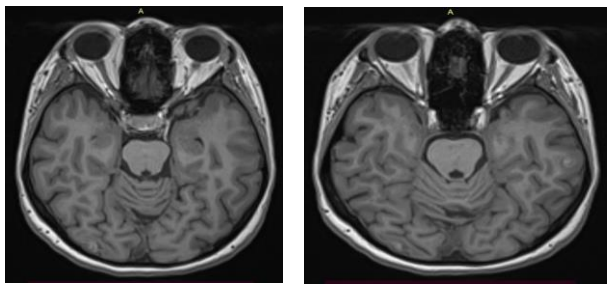

Figure 14. 2 months after discharge MRI. Important shrink of the main foci (right occipital lesion and left parietal lesion) and complete remission of the other lesions. No edema was emphasized.

Discussion

In BA therapy, antimicrobial therapy is crucial. Thus, identifying the pathogen is crucial for an accurate antimicrobial treatment. Unfortunately, in too many cases, the agent remains unknown and empiric treatment is required. In our clinic, the pathogen was not identified in 65% of cases (25 cultures were sterile and in five cases patients chose the conservative treatment). Therefore, seven patients lost their lives in the process, despite the maximal therapy. M Al Masalma et al [32] the authors used ribosomal DNA amplification and achieved pathogen identification in 9 of 21 culture-negative BA, identified 44 distinct bacterial species not previously described in BA, and determined polymicrobial infections at a significantly higher rate than by culture. This way more targeted treatments could be used for a better outcome of the patients.

Even though brain abscesses are more frequently identified in low/middle-income countries, they did not completely disappear from developed countries. In developed countries, most cases of BA occurred at immunocompetent patients after surgical interventions such as neurosurgical interventions or after professional tooth cleaning procedures, as LP Pallesen et al described in their article [25]. However, brain abscesses remain one of the most feared neurosurgical intervention complication. In the last decades, the number of BA increased in developed countries due to a higher number of neurosurgical intervention.

The surgical approach evolved as well in the last decades. Aspiration of the abscesses proved to be safe and with similar results compared to classic surgery. Furthermore, stereotactic guided aspiration of the BA proved to be superior to classic surgery in the hardly accessible areas such as infratentorial space. K. Elango et al [26] presented in their paper the stereotactic CT-guided aspiration of a brainstem abscess of a 38 years old female. The patient clinical and neurological state were improved after surgical intervention and aggressive antibiotic therapy. Furthermore, the authors consider CT-guided aspiration the best approach for deep lesions such as a brainstem abscess due to its minimally invasiveness and minimal morbidity and mortality [33], [34].

Conclusion

Brain abscesses remain a high challenge to manage even in the 21st century. Rapid broad spectrum antibiotic treatment should be applied as soon as possible until the pathogen is identified and specific treatment will be used. Signs of intracranial pressure, midline shift >5 mm or abscesses >3 cm should be strong arguments for an invasive approach of the lesion. Even though less invasive surgical approaches were developed in the last decades (such as stereotactic CT-guided aspiration) the evolution of the patients is hard to predict due to their primary foci and their comorbidities. Conservative treatment is worth trying in cases with multiple lesions, located deep or in eloquent areas, with dimensions smaller than 3 centimeters, in cases where we know the pathogen and the starting point and the patient's neurological condition allows this.

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Intracranial aneurysms - a battle against time

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Keywords
cerebral aneurysm, intracranial haemorrhage, microsurgical clipping, neurosurgery

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ABSTRACT

Introduction: Intracranial aneurysms consist in abnormal dilatation of the cerebral arteries, most frequently asymptomatic, with symptoms appearing in the case of aneurysm rupture. From an imaging point of view, a cranial CT scan shows the subarachnoid haemorrhage caused by aneurysm rupture and the "gold standard" for aneurysm diagnosis is cerebral angiography.

Case presentation: A 49 years-old female, Ukrainian refugee, presented with a unique comitial crisis and chronic headache. Following an MRI performed in Kiev, it was decided to perform a bilateral carotid and vertebral angiography in our clinic. Clinical and imagistic results showed a giant left middle cerebral artery aneurysm. Postoperative, the patient had a favourable neurological recovery, with no neurological deficits. Additionally, control angiography and CT scan highlight complete occlusion of the aneurysm and no complications.

Conclusions: Cerebral aneurysms represent a high-risk vascular condition that needs a CT scan and angiography to be precisely diagnosed, surgical clipping should be performed as soon as possible.

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INTRODUCTION

Cerebral aneurysms are abnormal dilatation of the cerebral arteries, which are developing because of pre-existent defects of the arterial wall. Usually, cerebral aneurysms are asymptomatic, becoming symptomatic in case of rupture of the aneurysm, leading to clinical signs suggestive for subarachnoid hemorrhage, or in case of excessive aneurysmal volume growth, it can cause a mass effect on the cerebral parenchyma. Main signs and symptoms are intense headache (described by patient as being the fastest headache of their life), neck

pain, vomiting, dizziness, photophobia, motor deficit, focal deficits of cranial nerves etc.
An essential aspect is clinical manifestation from subarachnoid hemorrhage which can be caused by rupture of a cerebral aneurysm. For definite diagnosis we need radiological imaging, such as cerebral CT, to accurately identify the subarachnoid hemorrhage. Moreover, if subarachnoid hemorrhage diagnosis will be confirmed, a cerebral angiography is indicated for definite identification of the lesion and cause of haemorrhage.

Neuroimaging diagnosis

Necessary neuroimaging investigations are:
Computed tomography (CT) - mandatory exam for any subarachnoid hemorrhage. Hemorrhage appears hyperdense. A scale that helps us in CT scan examination of the patient is Fisher Scale (1980). [1]
Cerebral Angiography - represents the next step in imaging investigation and stands as the "gold standard" for aneurysms identification. After angiography, we can diagnose the cerebral aneurysm, and also identify the aneurysmal parent artery. A control angiography is necessary after surgery to verify the success of neurosurgical occlusion of the aneurysm.

Case presentation

Female patient, 49 years old, Ukrainian refugee, was admitted to The National Institute of Neurology and Neurovascular Diseases, Bucharest, Romania for comitial crisis and chronic headache with evolution in last years and increased frequency of crisis in the last months. Neurological evaluation revealed Grand Mal type comitial crisis and elements of expressive aphasia. The patient presented with a native head MRI performed in Kiev. MRI shows a round-oval structure, of 3/2 cm located at middle cerebral artery bifurcation on the left side, hypointense in T1 and hyperintense in T2, in contact with left sylvian artery suggestive for a giant aneurysm of left middle cerebral artery. The rest of MRI shows normal aspect of the brain in T1 and T2 sequences.

A bilateral carotid and vertebral angiography was performed, which highlighted a giant saccular aneurysm inserted at the medial cerebral artery bifurcation on the left side, with antero-inferior orientation, with a maximum diameter of 1,6 cm and neck of approximately 7 mm. No other abnormal modifications were observed.

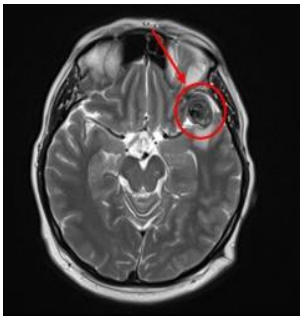


Figure 1. MRI T2 sequence

Figure 2. MRI FLAIR sequence

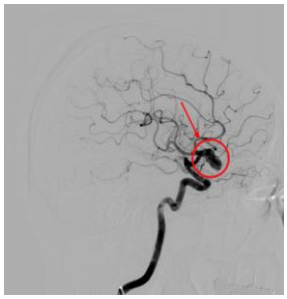
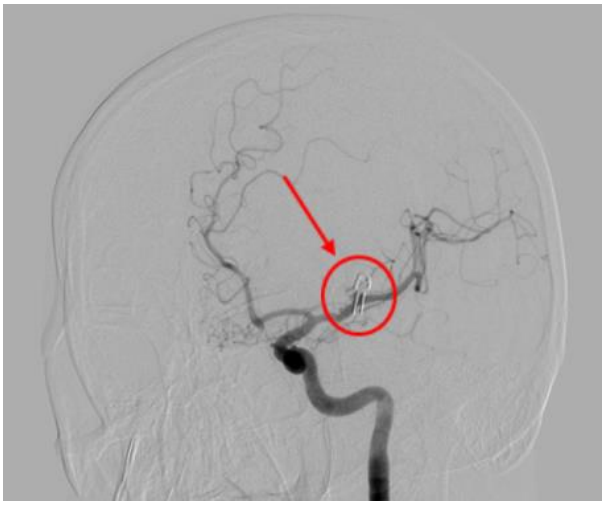


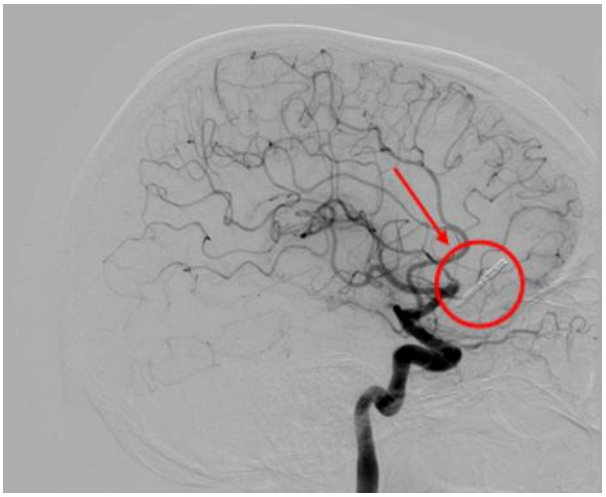
Figure 3. Left carotid angiography, profile incidence.
Figure 4. Left carotid angiography, anteroposterior incidence.

Surgery was performed and clipping of the giant left middle cerebral artery aneurysm with a maximum diameter of approximative 3,5 cm and neck of approximative 10 mm, was performed. The aneurysm required opening and evacuation of intraluminal thrombus under temporary clipping before fixing the definitive clip. Postoperatively, evolution was favorable with no complications.

Figure 5. Incision place – postoperatively.
Figure 6. Standing patient

Control left carotid angiography highlights clipping of the aneurysm at neck level and preservation of both branches of the left middle cerebral artery.





Figures 7,8. Control angiography

Postoperative native cerebral CT scan, revealed correct positioning of the clip at left sylvian cistern level and a hypodense area with ischemic aspect at left frontal lobe.

Figure 9. Control cerebral CT-scan

The patient was discharged 7 days after the surgery, neurological examination at discharge revealed no neurological deficits (normal motor function, normal speech, normal cranial nerve's function). Rankin Scale at discharge was 0.

Discussions

Intracranial aneurysms are a result of abnormalities to the normal arterial vessel structure, usually from collagen deficiency in the internal elastic lamina, situated between the tunica intima and the tunica media (the muscle middle layer) of the arterial vessel. The most common presentation is subarachnoid hemorrhage, which can be seen from a CT scan, which raises the suspicion of a cerebral aneurysm, angiography showing exactly the aneurysm localization, morphology and dimensions. The surgical management of aneurysm has been debated over time, according to the literature, microsurgical clipping should be used in cases of aneurysm rupture, as in our case, while coil embolization remains recommended in non-ruptured aneurysm. Choosing between microsurgery or endovascular treatment in cases of unruptured aneurysm, the risk-benefit ratio should be taken into consideration and the final decision will be made together with the patient. [2]

Pseudotumoral giant aneurysms represent a rare aneurysm presentation and can simulate a neoplasm, as explained in a study from W. Wijethunga et al. (2018) of a intracavernous aneurysm that clinically and imaging simulated a pituitary macroadenoma. Due to the multilayered and "halo" appearance of the lesion on MRI, a CT angiogram was performed, which revealed a large aneurysm from the cavernous portion of the left internal carotid artery. This article shows the necessity of angiography for a correct diagnosis of an aneurysm, since heterogeneity present on an MRI can direct the diagnosis to other pathologies, such as tumors. [3]

E. Kalin-Hajdu et al. (2011) presented a unruptured fusiform aneurysm of middle cerebral artery, which underwent spontaneous occlusion and regression. Angiography indicates a pseudotumoral-like mass, supposedly from inflammation and neovascularization within the aneurysm wall and body. Inflammation and neovascularization is associated with giant cerebral aneurysms and intramural hemorrhage. Before embolization,

angiography revealed complete spontaneous thrombosis of the aneurysm. Due to this event, endovascular treatment was not necessary anymore. The patient presented at 11 months follow up and the MRI revealed near complete regression. Those spontaneous healing mechanisms are currently unknown, but they're probably explained by theory of inflammation and secondary neovascularization. [4]

In another case presentation, O. Doron et al. (2016) described a giant partially thrombosed left carotid-ophthalmic aneurysm with a bone erosion of the sphenoid sinus, re-shaping the intracranial micro-environment. Bone erosion was correlated with giant aneurysm and has multiple implications regarding pre-surgical planning. Clipping was performed due to the optic nerve and chiasm relations and excision of the thrombosed part, as in our aforementioned case. From this case report, multiple theories were proposed for the evolution of a giant thrombosed aneurysm. First of all, repeated endothelial damage caused by turbulent flow and healing can significantly enlarge the aneurysm dimensions through an inflammatory cascade. Secondly, a slow growth can be determined from recurrent hemorrhages. So, the understanding of thrombosed aneurysm evolution is becoming more clear in the last years, helping with pre-surgical management and being ready for spontaneous structural modifications. [5]

Conclusions

Cerebral aneurysms are vascular lesions which can endanger the patient's life when they rupture. Intracranial hemorrhage can significantly affect nervous cells` metabolism and the patient state of consciousness, explaining the clinical presentation. Additionally, the hemorrhage can fill the basal cisterns and ventricles, altering the state of conscience. Emergency hospitalization is mandatory for a complete clinical and imaging evaluation; surgical intervention needs to be performed as soon as possible.

Regarding our case of a large, thrombosed aneurysm, due to the aneurysm nature, endovascular embolization cannot be achieved, and the treatment of choice will be surgical approach. Before clipping, thrombus evacuation under temporary clipping is necessary for a complete and long-term occlusion of the aneurysm. Additionally, the real dimensions of the aneurysm can only be seen intraoperatively, during microscopic inspection, because the contrast agent from angiography will not enter completely into the aneurysm body.

In cases of non-ruptured and asymptomatic aneurysm, deciding between microsurgical clipping and endovascular embolization should be made by a well-informed patient. In a few of those cases, conservative treatment will be taken into consideration to avoid surgical interventions and possible postoperative complications. Thus, neurosurgeons have the obligation to correctly inform the patient about different surgical procedures and their alternatives.

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Surgical management of spinal cord hemangioblastoma. Our clinic experience and case report

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Keywords
hemangioblastoma, von Hippel-Lindau, stereotactic radiosurgery

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ABSTRACT

Background. Hemangioblastomas are considered rare tumours that are located, in most cases, in the posterior cranial fossa. In most of cases, spinal hemangioblastomas are identified on the thoracic and cervical levels and can be associated in one-third of cases with von Hippel Lindau Syndrome.

Material and methods. In this paper, we are presenting our clinic`s experience with spinal hemangioblastomas and the follow-up of the patients in the last 10 years.

Results. In our study, we included six men and three women with a mean age of 45 years, ranging between 36 to 61 years. The mean hospitalization days was 17 days. Among nine patients, there were identified 12 tumors. Six patients presented cervical spine hemangioblastomas, two of them had thoracic spine lesions and in one case, the tumour was identified at the lumbar level. Furthermore, two patients presented multiple lesions. Two patients had been associated with von Hippel Lindau Syndrome. In all cases, surgery was the therapeutic approach.

Discussions. Despite the rapid advance of technology and the new alternatives for the treatment of these lesions, surgical resection of hemangioblastomas remains the gold standard treatment.

Conclusions. Hemangiolbastomas are benign tumours that can be associated with von Hippel Lindau. A whole-body scan is required to confirm or exclude this syndrome. Even though the surgical treatment for asymptomatic patients remains debatable, surgical intervention is the only treatment that can lead to the total removal of the tumour.

BACKGROUND

Hemangioblastomas are rare intra-axial tumors that usually occur in the posterior fossa [1]. Histologically wise, these are benign, highly-vascularized tumors that can present a muriform nodule. Moreover, spinal cord hemangioblastomas are rarely identified and represent one to six procents of all spinal cord tumors and just 1-2,5% of all central nervous system tumors [2]. In most cases, spinal hemangioblastomas

are identified on the cervical and thoracic segments and are usually described as intramedullary lesions situated at the posterior pole of the spinal cord, due to their development from dorsal root precursors [5], [7]. Spinal hemangioblastomas may be sporadic lesions but in up to 30% of the cases, they represent a feature of von Hippel Lindau Syndrome [3].

Von Hippel-Lindau (VHL) disease is a rare autosomal dominant tumor syndrome characterized by the development of benign and malignant tumors in the parenchyma of the various organs and systems, including the central nervous system [4]. It usually affects young adults, and in the VHL context, multiple hemangioblastomas are identified [12]. Over 50% of the people with VHL (63%) present central nervous system tumors, and usually the first manifestations of the syndrome are determined by hemangioblastomas [6], [11]. One of the most affected organs by VHL is the kidney. VHL determines renal cell cysts and clear cell carcinoma [8]. Other organs usually affected by the syndrome are the pancreas and retina [9], [10].

The most effective tool to identify these lesions is magnetic resonance. The rapid and constant evolution and accessibility of magnetic resonance imaging (MRI) raised the discovery rate of hemangioblastomas and more accurate descriptions were obtained [13], [14]. On T1-weighted MR imaging, the tumors have the aspect of bright enhancing lesions, and T2-weighted imaging can be used for a better characterization of the tumor, as well as emphasize any accompanying edema or syringomyelia [14]. However, spinal hemangioblastomas` features are not always well defined and difficult clinical diagnosis may occur.

The symptoms of patients with hemangioblastomas may range based on the segment where the lesion is located. Despite de rapid advance of technology and the new alternatives for the treatment of these lesions (such as embolization, stereotactic radiosurgery, and even some molecules such as bevacizumab and other inhibitors of angiogenetic signaling pathways), total removal of the hemangioblastomas remains the most appropriate therapy. However, even after the most laborious microsurgical excision, postoperative neurological degradation is not uncommon, being reported in up to 50% of the patients [15], [16]. Therefore, the management of asymptomatic lesions is still under debate. Furthermore, the long-term outcome of the patients with intramedullary hemangioblastomas is not well defined, due to the small number of cases.

Materials and methods

In this article, our target is to describe our clinic`s experience with spinal hemangioblastomas and the follow-up of patients with spinal hemangioblastomas in the last 10 years.

We performed a 10 years retrospective study that included 9 patients who benefited from surgical treatment for intramedullary spinal cord hemangioblastoma at the 4th Neurosurgery Department of "Bagdasar-Arseni" Clinical Emergency Hospital from Bucharest.

Results

In our study were included three women and six men with a mean age of 45 years, ranging between 36 to 61 years. The mean hospitalization days was 17 days, ranging from 7 to 36 days. Detailed hospitalization dates are available in Fig. 1.

Table 1. Patient's presentation state.

#	Age/ Sex	Sex	Signs/ Symptoms	Duration (months)	Location of tumor	No. of tum-ours
1	42	M	headache, gait impairment, right hemiparesis	6	cervical	1
2	43	F	headache, dysphagia, dysphonia	4	cervical	1
3	61	M	gait impairment, dysphagia, tetraparesis	2	cervical	1
4	41	F	paraparesis, sphincter dysfunction	4	lumbar	1
5	45	M	headache, ataxia, right hemiparesis	3	cervical	1
6	39	M	paraparesis, numbness of lower limbs	5	thoracic	2
7	36	M	paraparesis, sphincter dysfunction	6	thoracic	3
8	48	F	headache, paraparesis, sphincter dysfunction	3	cervical	1
9	51	M	paraparesis, numbness of upper/lower limbs, sphincter dysfunction	4	cervical	1

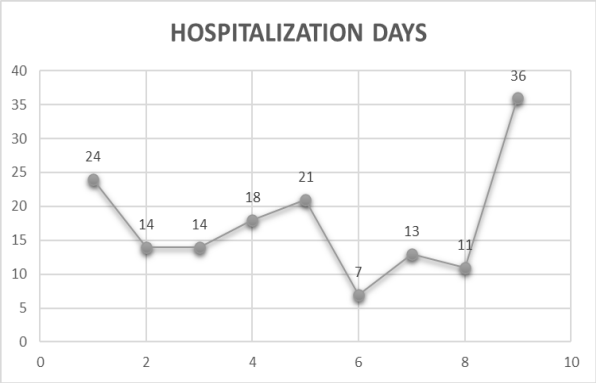

Figure 1. Hospitalization chart for each patient.

The signs and symptoms of the patients at admission vary depending on the level of the lesion and they will be detailed in Table 1. Karnofsky's performance score and McCormick's functional score for each patient as well as their discharge state and follow-up are presented in Fig. 2 and Fig. 3.

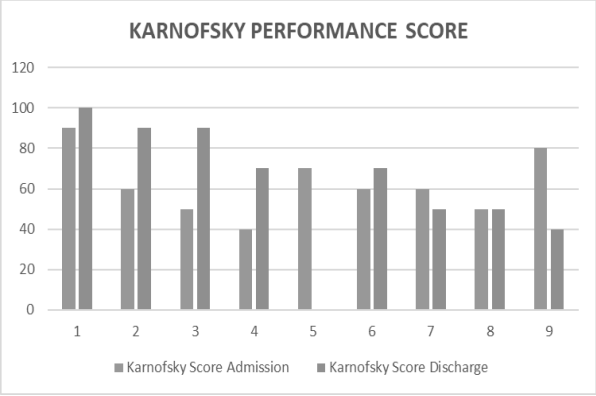

Figure 2. Karnofsky Performance Score at admission and discharge.

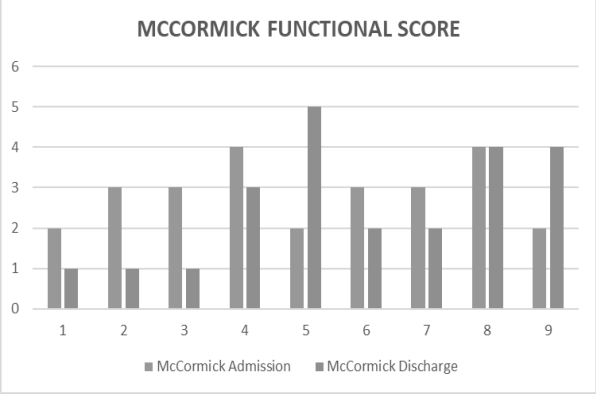

Figure 3. McCormick Functional Score at admission and discharge.

The presence of the tumours, localization, distribution and other possible characteristics such as the presence of syringomyelia were evaluated for each patient using MR imaging. Among nine patients, there were identified 12 tumors. The MRI described seven cases of hemangioblastomas associated with cystic component. Six patients presented cervical spine hemangioblastomas, two of them had thoracic spine lesions and in one case, the tumor was identified at the lumbar level. Furthermore, two patients presented multiple lesions. It is worth noting that both cases presented thoracic hemangioblastomas. One of them presented two lesions while the other had 3 thoracic spinal hemangioblastomas, located on the posterior edge of the spine. Because of the risk of multiple lesions for these patients, they were imagistically checked for vHL syndrome, such as brain tumors, retinal angiomas, pancreatic lesions renal masses and. All of them benefited from CT scans in order to emphasize the other possible tumors. Two patients were linked with vHL syndrome, one presented with pancreatic cyst and the second patient had multiple kidney cysts. None of them had a documented family history of the disease. In all cases, surgery was the therapeutic approach. The patients were placed in ventral position. After midline incision was performed, spinal laminectomy and posterior midline approach for the resection of spinal tumors were used. Laminectomies were performed at the level of the tumor as well as adjacent levels to ensure better visualization of the tumor and to avoid postoperative compressive edema. Complete resection was achieved in all cases, under microscope magnification. One patient had concomitent removal of both hemangioblastomas from the thoracic segment while the second patient with multiple thoracic lesions underwent two surgical interventions in order to completely remove his three tumoral masses. Due to preserved articular capsules, none of the patients required instrumentation, and no signs of instability were accused on the follow-up. The postoperative evolution of the patients was heterogeneous. Two patients developed hydrocephalus and 3 of them developed. Unfortunately, one patient died during hospitalization, due to multiple comorbidities. The follow-up was between 6 to 36 months. Four patients were lost after 12 months of follow-up. During this

time, two patients presented tumoral recurrence which required another surgical intervention.

CASE PRESENTATION

A 51-year-old male presented to our clinic for headache, progressive numbness of the limbs, and paraparesis high-level Frankel C. The onset of the signs and symptoms was 4 months ago. He had no significant pathological history and no traumatism was reported. Head and cervical MRIs were performed. Head MRI had presented no tumoral masses Intra/extra-axial and no other lesions of the brain, dura mater, or bone were identified. On the other hand, the cervical spine MRI emphasized an intramedullary subdural tumor at the C2 level with medullary infiltration (Fig. 4).

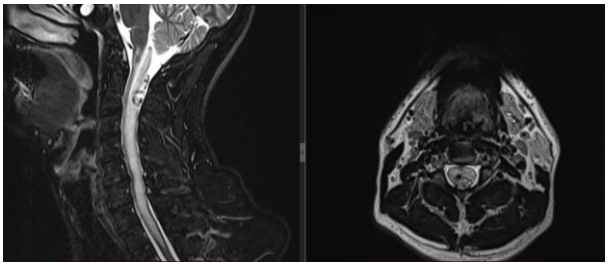

Figure 4. Cervical spine MRI - intramedullary subdural tumour at the C2 level with medullary infiltration.

Compelling the clinical and neurological state of the patient with the imagistic finding, the patient had surgical indication. After the written consent of him and his family, the patient underwent surgery. Under total anesthesia, he was placed in a ventral position. A C1-C3 midline incision was performed. The paravertebral muscles were detached bilaterally at these levels and laminectomies of C2 and C3 levels were performed in order to ensure better control of the tumor. Dura mater was carefully incised on the midline and the tumor was revealed, covered by the arachnoid. After the arachnoid layer was dissected as well, a large muriform highly vascularized tumor with a high caliber feeder vessel in the cranial side of the tumor was exposed. Using microscope magnification, circumferential dissection was performed with bipolar forceps and cotton pads. The accurate localization of the main nutrient artery is a crucial step in surgery. The main feeder was carefully dissected at cut using bipolar forceps and surgical scissors after tumor dissection was complete. The tumor was sent to the anatomopathological laboratory. After laborious hemostasis, the dura mater was sutured in a watertight proof fashion and the surgical wound was closed layer by layer, performed respecting the anatomical planes.

Figure 5. Dura mater was opened. The CSF exited with high pressure when the arachnoid layer was incised.

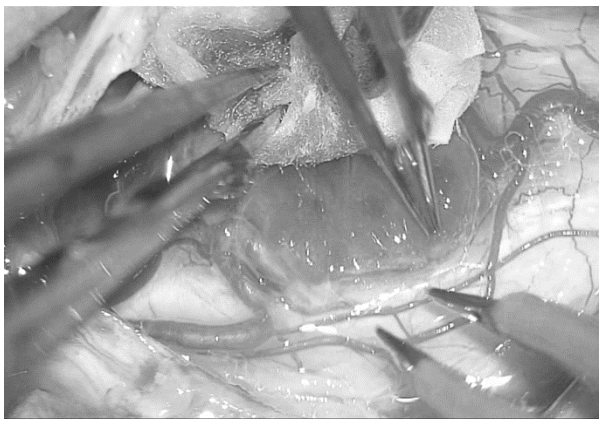

Figure 6. After complete exposure of the tumour, carefully dissection was performed using bipolar forceps.

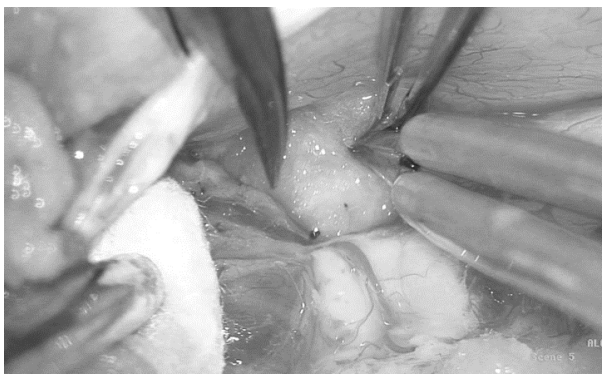

Figure 7. Complete resection of the lesion was achieved. The tumour is pushed cranially to obtain better exposure to the main feeder. Dissection of the main feeder.

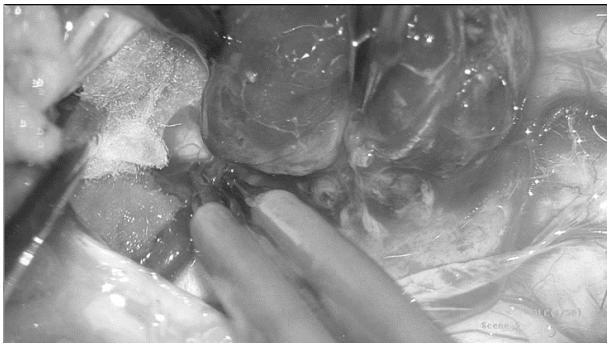

Figure 8. The main feeder was coagulated and sharply cut using a surgical scissor.

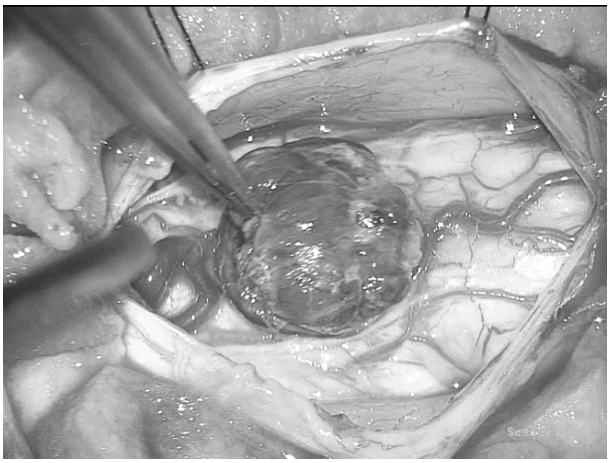

Figure 9. Complete dissection of the tumour was achieved. It was sent to histopathological analysis.

Postoperative, clinical and neurological state of the patient remained stationary. Postoperative MRI firmly established the total removal of the lesion and some blood that respected the surgical passage without any medullary compression

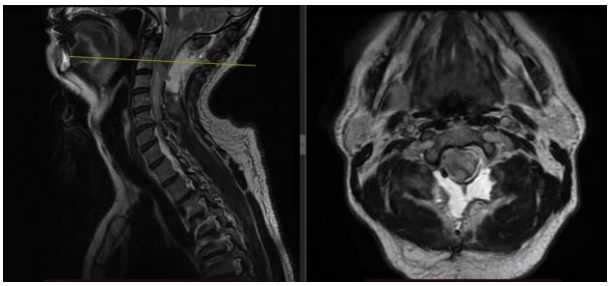

Figure 10. Postoperative MRI.

One week after the surgical intervention, the patient started to feel drowsy, he accused headache and nausea as well. A brain CT scan was performed (Fig. 11). CT scan showed slight enlargement of the ventricles and periventricular edema, with clear signs of hydrocephalus. Moreover, hemorrhage was identified in the right occipital corn.

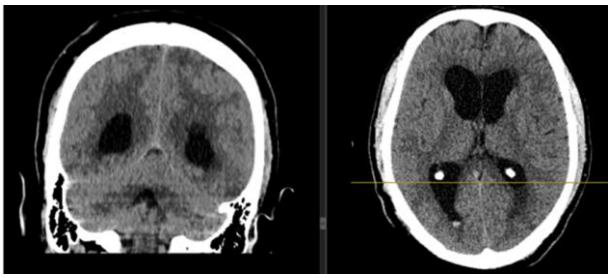

Figure 11. Discrete enlargement of the ventricles. Periventricular edema. Intraventricular hemorrhage in the right occipital corn.

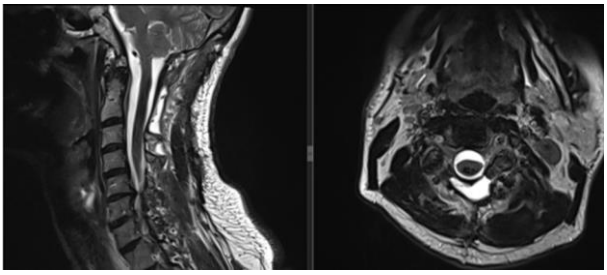

Figure 12. Postoperative MRI – 2 months after surgical intervention. The spinal cord presents a normal signal, without signs of compression, and no blood signal in the tumoral bed.

The patient underwent a new surgical intervention to evacuate the blood clots and to preserve CSF drainage in order to preserve the normal CSF flow. Postoperative, the newly installed symptoms were remitted. The patient was transferred to Neuromotory Rehabilitation Clinic, stationary compared to the admission state. After two months of kinesiotherapy, the patient is able to walk again and take care of himself by performing simple yet critical actions, such as changing his clothes or holding a glass of water.

Discussions

Hemangioblastomas are rare, vascularized tumors that usually develop in the posterior cranial fossa. Spinal cord hemangioblastomas constitute about 1-6% of all spinal cord tumoral pathology. Therefore, there is a lack of large cohort studies regarding the subject in the specialty literature. The accurate localization of the main nutrient artery is a crucial step in surgery. Especially in the cervical region, hemangioblastomas present a rich network of blood

vessels and the removal of one of them may prove to be difficult and with major consequences for spinal cord vascularization. Total resection may be very difficult due to intraoperative hemorrhage that can occur and blur the interface between the spinal cord and the lesion. To prevent intraoperative bleeding, preoperative embolization can be performed. However, preoperative embolization presented multiple complications such as neurological deterioration and intradural hemorrhage and its use remains controversial [17], [18].

Histologically wise, hemangioblastomas are benign tumors and the recurrence rate is low. However, it was noted a higher recurrence among the patients with von Hippel Lindau Syndrome [19]. Moreover, 20-30% of spinal hemangioblastomas are linked with vHL [20].

In order to avoid intraoperative and postoperative risks, alternative treatments were developed. In recent years, stereotactic radiosurgery was used as a therapeutic adjuvant, optimizing tumor dose while sparing the spinal cord [21], [22]. The biggest downside of stereotactic radiosurgery is the radiation-inducted myelopathy with potential permanent neurological impairment, which has been reported already in some cases [23], [24]. In addition, the overall recurrence rate after stereotactic radiosurgery is higher compared to classic surgery as few articles suggested [25], [26], [27], [28].

Conclusions

Despite the multiple treatment options available today for hemangioblastomas, the surgical approach remains the gold standard therapy. A whole-body scan is required to confirm or exclude von Hippel Lindau syndrome. Even though the surgical treatment for asymptomatic patients remains debatable, surgical intervention is the only treatment that can lead to the total resetion of the lesion. However, the clinical and neurological condition of the patient is not always improved. A multidisciplinary team is required in order to achieve the best results for the victim of this pathology and the best quality of life.

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PICA ischemic stroke. The importance of urgent neurosurgical treatment

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Keywords
PICA,
urgent neurosurgical treatment,
ischemic stroke

ABSTRACT

The posterior inferior cerebellar artery (PICA) has a unique anatomical complexity, which is of great clinical importance and is involved in many pathologies, such as aneurysm, ischemic stroke, neurovascular compression syndrome (NVCS), arteriovenous malformation (AVM) and brain tumour (1).

PICA has a sinuous and variable trajectory, divided into 5 segments. PICA infarction usually manifests lateral bulbar syndrome and is more likely to cause mass effects. PICA frequently compresses the bulb and cranial nerves, resulting in various neurovascular compression syndromes (NVCS) (2).

The ischemic stroke caused by thromboembolism in the PICA segment is accounted for more than 2% of all cases of ischemic stroke (3). Moreover, it tends to be underdiagnosed due to the symptomatology, represented usually by vertigo which mimics a possible peripheral vestibulopathy (4). .

✉
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CASE REPORT

The patient aged 50 years old, known with venous thrombosis of the transverse and sigmoid sinuses, proximal internal jugular vein on the right, HTA, thrombophilia, mild mitral insufficiency, without chronic treatment at home, presents herself in UPU Sibiu for balance disorder and postural instability with a sudden on-set, on 01.11.2022, around 22:00.

The symptomatology debuted due to the sudden voluntary stop of the anticoagulation medication by the patient, against the recommendation of the attending physician.

The patient had another 2 similar episodes 2 days ago and 7 days ago, respectively, spontaneously remitted. It was decided to hospitalize the patient in the Neurology department for further investigations and specialized treatment.

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The patient presents altered general condition, norm ponderal, conscious, uncharacteristic facies, warm skin and mucous membranes, normally coloured and hydrated, normally represented adipose connective tissue, normal superficial ganglion system, osto-articular system mobile integrity; normal conformed thorax, vesicular murmur present bilaterally, SpO2 = 98% spontaneous; heart noise rate, arterial pressure = 150/90mmHg, cardiac frequency = 73bpm; spontaneous and on palpation painless abdomen; liver and spleen nonpalpable; eGFR= 88,66 mL/min/1,73 m2, Giordano Sign negative bilateral, cooperative, temporo-spatial oriented.

Neurological examination at admission

Upon admission, the neurological examination reveals the following:

- No signs of meningeal irritation, no involuntary movements
- Orthostatism and difficulty walking
- Cranial nerves: preserved ocular motricity, without nystagmus, without amputations of visual field
- Negative paresis samples
- No coordination disorder in bilateral I-N and C-G tests
- Osteotendinous reflexes Symmetrical triggered
- Negative Babinski Sign
- No sensibility disorder
- Normal control of sphincters
- Fluent language
- Conscious, cooperative, temporo-spatial oriented
- GUSS scale = 5/5 points
- Rankin Score before = 0 points
- Rankin Score after = 1 point
- NIHSS score = 0 points

Pre-operative Status

On 01.11.2022, a native emergency head CT scan was performed.

Hypodense areas with the appearance of patchy ischemic strokes can be detected at the left cerebellar and right parasagittal cerebellar level.

On 02.11.2022, a head MRI is performed, which reveals an acute ischemic vascular lesion located in the inferior cerebellar (vermian and bihemispherical - predominantly on the left side) in the left PICA vascularization territory, established in FLAIR. Left retrobulbar Swan hyposignal image, along the path of the left PICA artery, is suggestive for the presence of thrombus at this level.

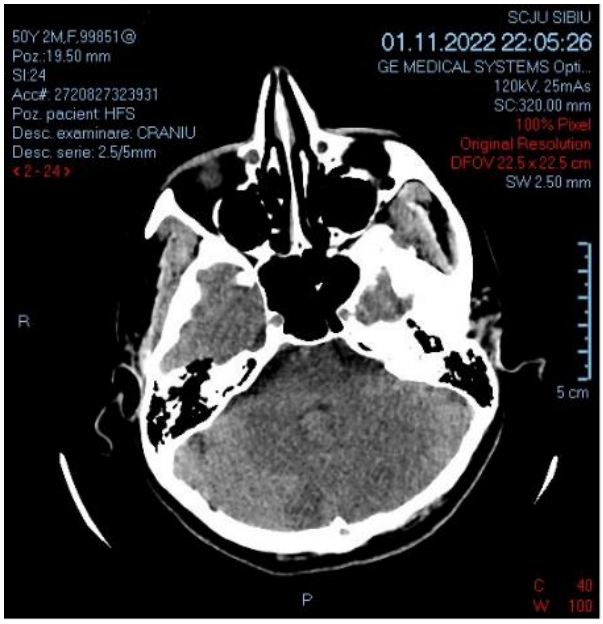

Figure 1. Native CT Head performed on 01.11.2022.

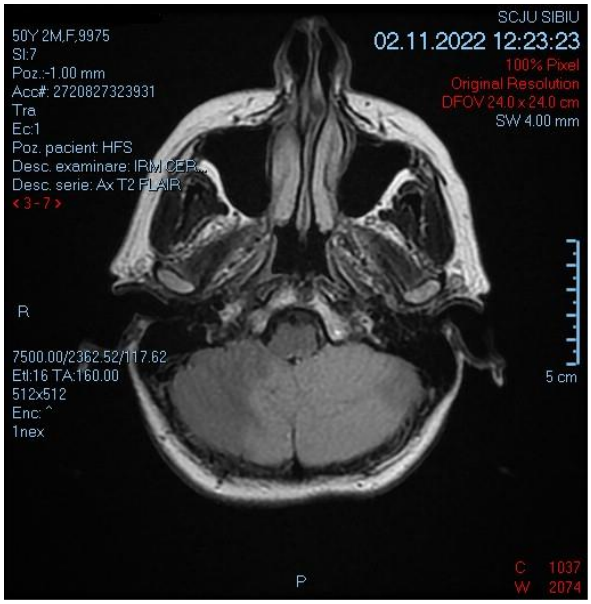

Figure 2. MRI Head performed on 02.11.2022.

On 03.11.2022, the second native Head CT is performed, which shows a hypodense area in the right paramedian, vermian cerebellum and at the level of the lower left cerebellar hemisphere, with the deletion of the differentiation between white and gray matter and the cortical grooves, with mass effect on the brain stem and the IV ventricle.

The patient has an episode of worsening of the symptoms, after which she complains of intense frontal headache and nausea.

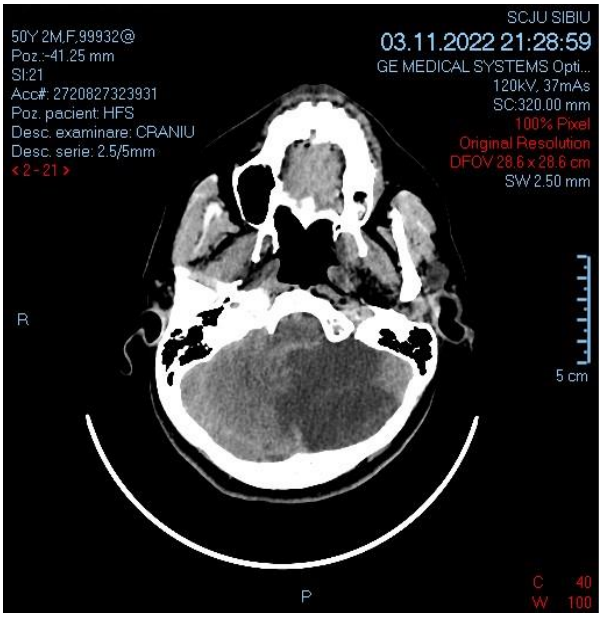

Figure 3. Native CT Head performed on 03.11.2022.

On 04.11.2022, a native head CT scan is performed, in which an extensive cerebellar ischemic stroke can be observed, with infratentorial mass effect, with supratentorial hydrocephalus; the ventricular system is on the median line, asymmetric, enlarged supratentorial.

Also, during the neurological examination, the patient is conscious, drowsy, answers questions with difficulty, opens her eyes spontaneously and on command with difficulty, spontaneously mobilizes bilateral inferior member, presents divergent strabismus of the right eye, squeezes the examiner's fingers with bilateral superior member on command; Urgent neurosurgical consultation is requested.

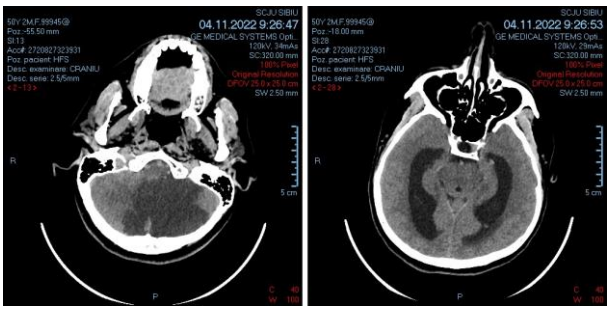

Figure 4. Native CT Head performed on 04.11.2022.

The 50-year-old patient is transferred from the Neurology ward, in critical condition, comatose, GCS score 4 points and equal pupils and admitted to the Neurosurgery department for investigations and specialized treatment.

Operation Stage

On 04.11.2022 at 07:25 a.m., neurosurgical intervention takes place under general anaesthesia by performing an occipital craniectomy, to reduce the infratentorial and supratentorial mass effect, caused by the massive cerebral edema due to bilateral ischemic PICA stroke, having a history of previous thrombosis of transverse and sigmoid venous sinus and right internal jugular vein.

Post-Operative Evolution

The evolution on the ICU and Neurosurgery ward is favourable under painkillers, anti-inflammatory, antibiotic and hemostatic treatment with a clean, exposed surgical wound, without Celsian signs, the wound being closed with sutures suture to the skin.

The native head CT is re-performed on 05.11.2022 post-operatively, in which an extended infratentorial hypodense area and patchy occipital craniectomy area are observed, with a reduction of the infra and supratentorial compressive effect.

Figure 5. Native CT Head performed on 05.11.2022.

Post-intervention haematological status for massive cerebral edema, due to ischemic stroke. Patient had a history of thrombosis of transverse and sigmoid venous sinus and internal jugular vein, hyperhomocysteinemia and lupus anticoagulant for which she took Warfarin and later Aspenter and Plavix, later discontinued.

Due to the increased risk score for thrombosis, required anticoagulation with Clexane 0.6 x2- 30 days + therapy of the neurological and neurosurgical department. After In 30 days, it will be decided whether to switch to Sintrom or another anticoagulant.

On 11.11.2022, the transfer to the Neurology ward was decided, the patient being conscious, cooperative, temporo-spatial oriented, in good general condition, afebrile with neurological symptoms in remission.

Discussions

The conservative medical approach is a factor that leads to an increase in the mortality rate among patients with extensive bilateral ischemic strokes, because these patients have a very high risk of developing massive cerebral edema with mass effect if the neurosurgical treatment is delayed (5).

These aspects are important to be taken into consideration since the therapeutic benefit requires early intervention, before the adjacent brain structures are affected by the mass effect (6).

The thromboembolism represents a key point when speaking about an ischemic stroke. It is usually seen in atrial cardiopathy, such as atrial fibrillation, which cause is determined by a systemic vascular disease that affects the tissue of the atria (7).

The atrial fibrillation represents one of the main factors that can determine an ischemic stroke due to the formation of the thrombus inside the left atrium. Due to this situation, it is shown the importance of following the treatment with anticoagulant, without a voluntary sudden stop by the patient (8).

The recent studies show that the decompressive craniectomy approach represents that golden standard for space occupying infarctions, but it must be performed up to 48 hours since the first sign of ischemic stroke for the best results (9).

Moreover, the goal of a very quick, "ultra-early" surgical intervention is to reduce the mortality rate, not the disabilities that are permanent consequences of the strokes (10).

Conclusions

The goal of a very quick, "ultra-early" surgical intervention is to reduce the mortality rate, not the disabilities that are permanent consequences of strokes.

Decompressive craniectomy remains the only chance of survival for patients who develop malignant edema after an episode of stroke.

Decompressive craniectomy is not a therapeutic method but a life-saving one when other methods have failed.

Decompressive surgical treatment reduces mortality, but the family must know that this intervention does not guarantee a quick and spectacular recovery and that the patient will present a certain degree of disability.

The procedure should be performed within the first 48 h from the onset of the heart attack or as soon as possible.

In patients with suspected TIA or stroke, general and neurological examination, followed by diagnostic brain imaging should be performed immediately upon arrival at the hospital so that treatment can be initiated promptly.

Post-operative recovery also depends on the comorbidities that the patient has before the onset of the stroke

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Evaluation of surgical characteristics and clinical outcome of 11 patients with thoracic discectomy through transfacet approach

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Keywords
discectomy, herniation, spine, thoracal, transfacet

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ABSTRACT

Background: In thoracal disc herniation (TDH) requiring surgery, the size, level, anatomic location, and calcification of the disc are extremely important in the selection of the technique to be applied. Since the thoracic region does not allow spinal cord manipulation, the surgery is difficult and requires experience. A consecutive series of patients who underwent thoracic discectomy through a posterior transfacet approach is presented in this study.

Methods: Eleven patients (6 men, and 5 women) underwent surgery at 12 disc levels. The mean age was 53.54 years (range 28-72 years). Patients presented with myelopathy (n = 8, 73%), radiculopathy (n = 7, 64%), back pain (n =10, 91%), and urinary dysfunction (n = 6, 55%). Seven (58%) lateral, 3 (25%) calcified, and 4 (33%) large disc herniations were revealed by preoperative imaging. The mean follow-up period was 21.02 ± 8.04 months (range 6 – 43 months).

Results: A posterior transfacet approach was used for all eleven patients with TDH. Thoracic discectomy was performed at T11- 12 (36%) level for 4 patients, and equally at T10- 11 (36%) level for the other 4 patients. A bilateral approach with laminotomy was performed in one patient, and a two-level discectomy was performed in another patient. Unilateral partial laminectomy was added for 3 patients. The average operating time was 146.85 minutes (range 125-220 minutes). The average hospital stay was 4.2 days (range, 2- 13 days) while no neurological functional deterioration was observed in any of the patients after surgery. Postoperative 1-month and 6-month ODI scores were found significantly different from preoperative ODI scores in all patients.

Conclusions: Thoracal discectomy through the posterior transfacet approach route is a safe and effective technique to achieve adequate decompression without requiring instrumented fusion.

INTRODUCTION

Surgical treatment of symptomatic thoracal disc herniation (TDH) is a major challenge for spine surgeons because the thoracic spine is not suitable for manipulation. The main problem of thoracic disc surgery is the lack of a “gold standard” surgical technique to be applied. Total

laminectomy, which was performed for a period, has been abandoned today as a result of severe complications (15, 21, 26). Recently, advanced techniques for the treatment of TDH, including the transpedicular, microsurgical pedicle-sparing transfacet, costotransversectomy, lateral extracavitary, transthoracic, and thoracoscopic approaches have been used in different centers (1, 8, 15, 18, 20, 24, 25, 27, 31, 36). Each technique has particular disadvantages and potential complications. Ultimately, the goal of any of these procedures is to reduce the patients' pain, improve their quality of life, and improve their neurological status with limited morbidity.

This study presents a consecutive series of surgically excised TDH through a posterior transfacet approach. The goal was to assess the outcomes and complications in patients undergoing transfacet discectomy.

Materials and methods

Patient Characteristics and Operative Indications

Eleven patients with symptomatic extradural TDH surgically treated by a single surgeon between January 2010 and January 2016 were analyzed clinically, radiologically, and surgically. Ethical approval was obtained from the ethical committee and written informed consent was obtained from participants in the study before surgery. Six men and 5 women (mean age; 53.54 years, range 28-72 years) were included, with surgery performed at 12 disc levels (Table 1). History and neurologic examination were obtained at the initial presentation and follow-ups. Indications for surgery included myelopathy, radiculopathy, and urinary dysfunction. Patients with isolated back pain without neurologic symptoms were not considered for surgical intervention. All patients underwent preoperative spinal magnetic resonance (MR) and computed tomographic (CT) imaging. Imaging studies were reviewed for assessment of calcification, location relative to midline, and size of disc herniation. The size of disc herniation was classified into three groups: small (0-10% canal occupation), medium (10-20% canal occupation), and large (>20% canal occupation).

Operative parameters including surgical time, estimated blood loss, the length of hospital stay, and complications were tabulated from the available record. The standardized Oswestry Disability Index (ODI) questionnaire (23) was used to determine the disability of the patients preoperatively and postoperatively 1 month and 6 months. SPSS 21 (Statistical Package for Social Sciences) for Windows Software was used for the evaluation of the findings. A p-value less than 0.05 was considered statistically significant. The paired t-test was used for the comparison.

Surgical Technique and Operative Data

A posterior transfacet approach was used for all patients. A midline skin incision was used in all of the 11 patients. Of those,10 patients underwent a unilateral subperiosteal approach with bony decompression. One patient with a large central TDH and severe cord compression had undergone bilateral exposure with laminectomy before attempting discectomy.

Patients were positioned prone on the operating table following induction of general anesthesia and endotracheal intubation. Intra-operative spinal cord monitoring was utilized in six patients (patients number 4, 7, 8, 9, 10, 11) while the remaining five did not have any spinal cord monitoring during the procedure. The incision was marked using lateral C-arm fluoroscopy. After a 4-cm midline skin incision centered over the disc space, posterior vertebral elements were exposed in standard fashion out laterally to the transverse processes using a subperiosteal dissection. The surgical level was confirmed intraoperatively with fluoroscopy on the transverse process overlying the disc of interest. The facet complex is partially removed with a high-speed drill under the operative microscope. This proceeded through a limited unilateral laminotomy with medial facetectomy. The foraminal soft tissue is coagulated using bipolar cautery and the lateral annulus is exposed. Following exposure of the disc space lateral to the thecal sac, focal posterolateral soft disc herniations were removed, working in a lateral to the medial direction to create a central cavity. For large midline calcified TDH, a small trough was additionally drilled into the adjacent vertebral bodies, and the cavitation was extended medially through the disc space and adjacent endplates to undermine the herniation. The herniated disc material is decompressed into the disc cavity by using angled microrongeurs, nerve hooks, and reverse-angle microcurettes. The microscope is angulated medially and the patient is tilted contralaterally to allow visualization across the midline. The disc fragments

were then removed cautiously with curettes and pituitary forceps to achieve adequate decompression. Suction drains are not routinely placed. An exercise program is started one week after discharge to strengthen the paravertebral muscles and the patient is advised to return to daily activities.

RESULTS

Preoperative Findings

The mean time from symptom onset to surgical decompression was 22.6 months (range, 1-54 months). Eight (73%) patients presented with myelopathy, 7 (64%) with radiculopathy, 6 (55%) with urinary dysfunction, and 10 (91%) with axial back pain. Preoperative magnetic resonance and computed tomographic imaging showed 2 small (17%), 6 medium (50%), and 4 large (33%) discs. The majority of cases were lateral disc prolapses (n = 7, 58%), with 3 centrolateral (25%) and 2 centrally (17%) located. Five cases were soft disc prolapses (42%), 3 were calcified (25%), and 4 were partially calcified (33%) (Table1).

Table 1. Sex ratio of patients

Patient	Age/Gender	Duration of Symptoms (months)	Presenting Symptoms	Level	Axial Location	Size	Calcification	Approach
1	55/M	22	BP, M, R	T10-11	L	Medium	Calcified	TF + pL
2	67/M	39	BP, M, R, U	T11-12	CL	Large	Partial	Bilateral TF + L + Fusion
3	52/F	14	BP, R	T11-12	L	Small	Soft	TF
4	28/M	6	BP, M, R, U	T10-11	C	Large	Soft	TF
5	63/F	45	BP, M, U	T8-9	CL	Medium	Calcified	TF + pL
6	46/F	42	BP, M	T11-12	L	Small	Soft	TF
7	72/M	24	BP, M, R, U	T9-10 T10-11	CL L	Medium Medium	Calcified Partial	TF + pL TF
8	49/F	1	BP, U	T11-12	C	Large	Partial	TF
9	54/M	18	M, R	T10-11	L	Medium	Soft	TF
10	37/M	11	BP, M, R, U	T9-10	L	Large	Soft	TF
11	66/F	27	BP, M	T8-9	L	Medium	Partial	TF

Surgical Findings and Functional Outcomes

Eleven patients underwent a total of 12 operated disc levels. Figure 1 illustrates preoperative and postoperative imaging for a selection of typical cases from the series. Ten patients underwent surgery on a single level, one of those (patient 2) had a large centrolateral TDH with severe cord compression and underwent a bilateral transfacet approach with bilateral laminotomy before attempting discectomy. Interbody autograft bone fusion was added to that patient. Two-level discectomy was performed in one of the patients (patient 7) while unilateral partial laminectomy was added for 3 patients (patients 1, 5, 7). The average operating time was 146.85 minutes (range, 125-220 minutes). The average blood loss was 580 ml (range, 150-1200 ml) (Table 2). Neurophysiological status was monitored via SSEP and MEP testing intraoperatively with no deterioration in signals noted in any of the 6 patients. One patient (patient 9) required a second operation for a TDH at a different level on the contralateral side 25 months after the first surgery.

There were no cases of neurological deterioration after surgery, and there were no major complications and no wrong-level surgeries in this series. A dural tear occurred in one patient who had

a calcified centrolateral disc herniation (patient 5). The dural tear was repaired with primary suture and fibrin sealant, and it healed without complication.

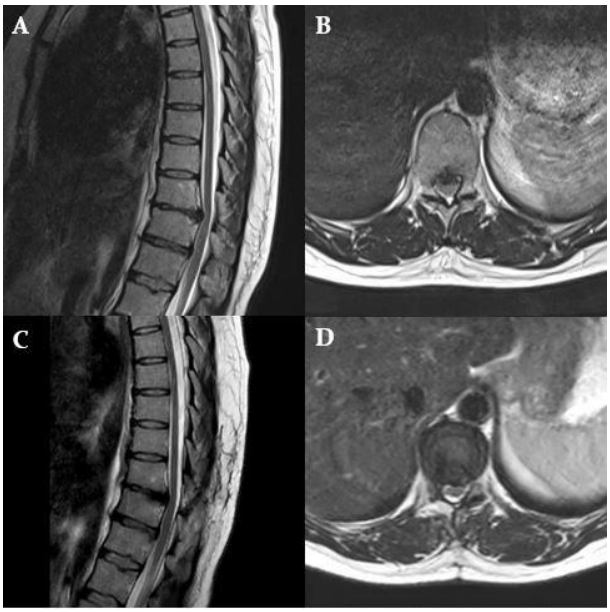

Figure 1. Sagittal (A) and axial (B) preoperative T2-weighted MR images of T8-9 disc herniation with cord compression. Sagittal (C) and axial (D) postoperative T2-weighted MR images after decompression with discectomy through the unilateral transfacet approach.

Table 2. Operative data of the patients

Operative Data	
Average operating time (minutes)	146.85 (range 125-220)
Average blood loss (ml)	580 (range 150-1200)
Average hospital stay (days)	4.2 (range 2- 13)
Mean follow-up period (months)	21.02 ± 8.04 (range 6 – 43)

The average hospital stay was 4.2 days (range 2- 13 days). The mean follow-up period was 21.02 ± 8.04 months (range 6 – 43 months) (Table 2). The ODI scores decreased significantly in both 1-month and 6-month follow-up evaluations from a mean preoperative score of 42.44 ± 11.38 to 27.46% ± 7.44% ($p<0.05$) and 24.16% ± 6.48% ($p<0.05$), respectively. No postoperative instability was developed requiring an instrumentation-assisted secondary fusion.

Discussion

In spine surgeons' practice, symptomatic thoracic disc herniation is a relatively rare pathology among spinal disc herniations. Appropriate surgical management of this rare pathology continues to be a subject of clinical studies. There have been several surgical techniques and various approaches for the treatment of TDH. The features of the herniated material, comorbidities of the patient, and the experience of the surgeon are primarily important factors in selecting an approach. Furthermore, severe neurological symptoms and the presence of spinal deformity should be considered while deciding on the technique. In the present series of transfacet approaches for thoracic discectomy, we noted functional improvement with significantly decreased ODI scores, relief of radicular pain, and no major complications. A two-level approach was used in one of these cases without difficulty. It was previously reported that in the rare occurrence of multiple disc herniations, multilevel discectomies via the transfacet approach may be performed (10). Any further surgery on the operated thoracic region was required by any patients in the series.

Thoracic discectomy using the transfacet pedicle-sparing approach was first described by Stillerman et al. in 1995, in which the lateral articular process is excised to reach the intervertebral disc (35). This method avoids the risk of neurological injury caused by intraoperative traction of the dural sac. The interference to the dural sac is minimal during exposure and the herniated disc can be well exposed for complete excision. Diminished operative time, decreased blood loss, limited bone removal, and limited soft-tissue disruption are the main advantages of this procedure. Compared with the transpedicular discectomy, less postoperative localized axial back pain was seen due to the preservation of the pedicle. Moreover, shortened hospital stays and earlier return to work give an advantage over the transthoracic and lateral extracavitary approaches. They recommended the transfacet approach for the surgical management of all soft symptomatic herniations, lateral calcified, and selected centrolateral calcified thoracic discs (35).

The transfacet approach is comparable with the other posterolateral procedures concerning the surgical trajectory and the relatively small amount of bone removal. One advantage of this approach is that the pedicle and most of the facet joints are preserved. In cases of calcified disc extension caudal to the disc space, the superomedial pedicle cortical wall resection favored greater access (35). The

inferomedial cortical wall of the pedicle, the transverse process, and related rib are preserved to protect the nerve root. It is suggested that the incidence of long-term localized pain secondary to loss of mechanical integrity will be reduced with this transfacet approach (35). There is no common consensus on the requirement for instrumented fusion after a thoracic discectomy. Some authors claim anterolateral and more extensive posterolateral techniques need instrumented fusion more commonly than the posterior unilateral transfacet approaches (19, 37). Patients with an intact unilateral facet, or >50% of facets remaining bilaterally, were considered stable by other clinical reviews reporting that fusion is uncommonly required (20, 22, 24). Although some authors have argued for the importance of an intact bilateral facet complex for stability (7, 29), others report relatively minor destabilizing effects of total facetectomy (12, 34). In the current series, evidence of preexisting segmental instability was not seen in any case. Interbody autograft bone fusion following discectomy via bilateral transfacet approach with bilateral laminotomy was performed on one patient (patient 2) who had a large centrolateral TDH. We also recognize that the addition of a partial laminectomy without instrumentation in 3 cases does not induce spinal instability at the related segment in the follow-up period.

There were several thoracal discectomy reports evaluating blood loss, operating time, the length of hospital stay, and ODI scores in the literature (7, 9, 34, 38). In the study of Sivakumaran et al., the average operating time was found 125 minutes for 24 patients who had transfacet and transpedicular approaches for thoracic discectomy (34). The mean hospital stay was found to be 3.3 days (2-10 days) when they excluded 3 patients who needed care of sociorehabilitative service because of significant preoperative neurologic dysfunction. Bransford et al. reported their experience with thoracic discectomy using a modified transfacet pedicle-sparing decompression and fusion (7). In this 16-case series, the length of postoperative hospital stay ranged from 3–11 days (mean 4.2 days) when they excluded 2 patients because of wound infections that lengthened the hospital stay. The average estimated blood loss was found to be 870 ml (range 150–3000 ml). In the study of Carr et al., the average blood loss of thoracic discectomy via posterior unilateral modified transfacet pedicle–sparing decompression with segmental instrumentation and interbody fusion was found at 770 mL (range 25-2000 mL) for 32 operations (9). Yüce et al. reported their 23 patients who had thoracic microdiscectomy with bilateral decompression via a unilateral approach.

The ODI scores of the patients significantly decreased from a mean preoperative score of 43,86 ± 8,73 to 26,52 ± 7,11 in early postoperative and 25,91 ± 6,78 at 12 (late) months ($p < 0,05$) (38). Some reports were on the comparison of anterior and posterior approaches (3, 30). Oltulu et al. reported significantly improved postoperative ODI scores of the patients with thoracic discectomy via posterior approach ($p < 0.05$) while the anterior group remained stable ($p>0.05$) (30). They found that the mean blood loss was 390.88 ml (range 50-2000 ml) for the anterior group (68 patients), 602.78 ml (range 25-2550 ml) for the posterior group (18 patients) ($p = 0.983$). Arts et al. compared the results of the anterior approach (56 patients) and the posterior approach (44 patients) (3). The average duration of the surgery through the posterior approach was 98 minutes (no stabilization done), while it was 229 minutes through the anterior approach. Blood loss in the anterior procedure was 1157 ml, and in the posterior one, it was 213 ml. The average hospitalization of patients treated through the anterior approach was markedly longer (10.1 days) than the posterior one with an average hospitalization of 4.9 days.

In this series, there are no giant thoracal disc herniations as those occupying more than 40% of the spinal canal based on preoperative imaging. These giant thoracic discs have a unique clinical presentation, surgical considerations, and outcomes as compared to smaller size TDHs. A giant calcified central TDH increases the risk of intradural extension due to erosion and progressive thinning of the dura thus making its excision more difficult and more prone to surgical complications (4, 16, 28, 32). Generally, a transthoracic approach is preferred to gain excellent exposure to the ventral aspect of the spinal canal without the need for manipulation of the dura. Thus, ventral dural access and direct repair of the defect can be possible with this approach (7, 13, 14). Thoracoscopic discectomy may be another choice for central disc herniations with the advantage of reducing morbidity (5, 11, 17). The primary disadvantage of the transfacet approach is

that opening the dura for the removal of an intradural disc fragment may not be possible because of inadequate direct ventral visualization (6, 34, 35). There was no obvious intradural penetration found in the present series.

Results of the newer minimally invasive techniques using tubular or endoscopic systems for thoracic disc resection, such as posterior and posterolateral approaches demonstrate significant improvements in pain relief, neurological outcomes, and postoperative spinal stability (2, 5). In some studies, endoscopy-assisted thoracic discectomy via posterior approaches was found useful for visualizing the ventral dura (20, 33, 35).

This study is limited by a few factors. This study has a small series of patients who underwent surgery by a single surgeon at a single institution. Another limitation is the analysis of the data in a retrospective manner rather than a prospective one. Despite the retrospective nature of this report, the efficacy and safety of the procedure are confirmed by the symptomatic improvement of the patients without concomitant morbidity. Further studies should focus on late collapse, mechanical back pain, and re-herniation in long-term follow-up of the patients who underwent a transfacet approach for thoracic discectomy.

Conclusion

While deciding on thoracic discectomy, it is necessary to know spinal biomechanics and the surgical techniques very well with their advantages and disadvantages. The study presents a single surgeon's experience with the thoracic discectomy via the transfacet approach with the results of a significant symptomatic improvement and no major complications. For the treatment of thoracal disc herniated patients with myelopathy, radiculopathy, and back pain, thoracal discectomy through the posterior transfacet approach route is a safe and effective technique to achieve adequate decompression without requiring instrumented fusion.

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Cerebrospinal fluid leak after combat penetrating gunshot wound to the head

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Abstract

Introduction: Cerebrospinal fluid leak is a common complication after head gunshot wounds, which commonly leads to infectious complications. This complication may prolong hospital staying and prevents soldiers from return to operation theatre as soon as possible.

The purpose of this article is to determine the impact of the quality of primary surgical debridement and other factors that influenced the presence of cerebrospinal fluid leak in the military stuff with gunshot wounds to the head.

Materials and methods: This is a retrospective study of 20 military cases with cerebrospinal fluid leak, which were admitted during the combat actions in Eastern Ukraine in the period from March 2014 to the end of December 2017. Information was collected on demographics, evacuation assistance, type of injury and infectious complications. R commander version 4.2.0 (http://www.r-project.org) was used for statistical analysis. Statistical significance was defined as $p<0.05$.

Results: Cerebrospinal fluid fistulas were detected in 20 cases (25,31%). Factors affecting the rate of leaks are number of re-operations ($p<0.001$), multiple sites of injury ($p=0.002$), ventricular injury ($p<0.005$). CSF leakage significantly lengthens hospitalization time.

Conclusions: CSF fistula influenced significantly rate of infection complication. Reoperation should follow initial surgery in cases of CSF leak development. To avoid development of cerebrospinal fluid fistulas, the operation should be performed by neurosurgeons in specialized department.

Keywords
CSF fistula,
infection complication,
gunshot wound,
surgical debridement

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Introduction

Cerebrospinal fluid leak (CSFL) is a common complication of gunshot wounds to the head, which in many cases lead to infectious complications [3, 8]. Such patients should receive high-quality and comprehensive medical care, but not all front-line hospitals have neurosurgeons and trained personnel capable of correctly diagnosing and determining tactics. In the conditions of war presence of CSFL is often ignored, which can have even fatal consequences [19]. The effectiveness of medical care that will be provided in the next stages, and how quickly the injured personnel will return to combat missions, depends on the correct diagnosis and the chosen tactics.

The purpose of this article is to determine the impact of the quality of primary surgical debridement and other factors that influenced the

presence of cerebrospinal fluid leak in the military personnel with gunshot wounds to the head.

Materials and methods

The study is based on medical records of patients that were treated at National Military Medical Clinical Centre "Main Military Clinical Hospital" (NATO Role IV) from 1st of May 2014 until 31st of December 2017. All patients were servicemen who were injured during military action in the Eastern Ukraine.

Medical information was collected from patient records and include demographics, clinical examination findings during evacuation and at the treating hospitals, laboratory results, computed tomography scans. Surgical and medical interventions after injury also were collected.

Statistical analysis was performed using R version 4.1.2 (http://www.r-project.org). In univariable analysis, variables were compared between groups by Fisher's exact test for categorical variables and the Wilcoxon signed-rank test for numerical variables. Statistical significance was defined as $p<0.05$. Local ethics committee approval was obtained before the study.

Results

Among 79 patients with penetrating head injury, we found 20 cases (25,31%) with CSFL who were treated in our department and participated in military conflict in Eastern Ukraine. The average age of the wounded was 28.5±8,69 years (min 19.9, max 54.5), all injured were males. The average number of days in the hospital was 68.4 ±40,89 (min 6, max 157). The average number of days in intensive care unit is 15.2 ±24,87 (min. 2, max. 88). The type of CSF leak was defined as one nasal, one orbital, two cases of otorrhea and 16 wound leaks.

The most of wounded on battlefield received assistance in the form of self-help or mutual aid, a sterile bandage was applied to stop the bleeding, painkillers were administered. Antibiotics were not administered in all cases, but no exact details could be extracted from medical records.

Consciousness upon admission to the hospital was assessed using the Glasgow Coma Scale (GCS) and presented in Table 1. The neurological status was evaluated in all patients, pyramidal signs were detected in 14 wounded which correlated with traumatic origin of the injury.

Table 1. GCS score on admission to main hospital

GCS	Number
15 - 14	11
13-12	4
10	1
6	2
4	1
Not evaluated	1

The vast majority, 13 observations, were injured with missile fragments, five observations injured with bullets and two patients were injured due to the blast wave. Type of injury included: penetrating (11), perforating (4), ricochet (2), tangential (1), and blast wave related injuries (2). Injuries reached or passed through the ventricular system were found in nine cases.

Isolated craniocerebral trauma was diagnosed in 10 cases, in five cases injuries of more than two anatomical areas were found, average Injury Severity Score (ISS) was 28.8 ±7,42 (min 18, max 49).

All patients underwent head computed tomography (CT) on admission. Epidural hematomas were visualized in two cases, subdural hematomas in seven, intracerebral hemorrhage in eight, depressed fractures in three, and intraventricular hemorrhages were found in five cases.

According to CT, bone fragments were detected in 16 cases, in 10 cases, bone fragments remained unremoved after the first surgery during previous stage. Metal fragments were revealed in 14 patients, and in 6 patients these fragments were removed at the previous stage.

All victims underwent surgery. Reoperation was performed in 16 cases. The terms of reoperation were different (Table 2).

Table 2. Patients which were reoperated because of different causes and types of infection complications

Id. number	AIS	Type of complication	Type of CSFL	Number of reoperations
12383	25	meningitis	wound	2
12691	33	-	wound	2
12823	25	meningoencephalitis	wound	1
15287	29	-	rhinorrhea	2
20064	35	-	wound	1

9126	26	abscess, ventriculitis	wound	2
21745	25	encephalitis	wound	1
24244	25	abscess, ventriculitis	wound	2
14020	34	-	rhinorrhea	1
28726	26	meningoencephalitis	wound	2
32057	25	meningitis	wound, otorrhea	1
13255	25	meningitis	wound	1
21464	26	abscess, ventriculitis, empyema	wound	1
20429	26	meningitis	wound	2
161	26	meningoencefalytis	wound	3
24493	45	meningitis	rhinorrhea	2

Fourteen patients (70%) developed infectious complications (Table 2). Diagnosis of infectious complications was based on the following data: clinical symptoms, hyperthermia, redness around the wound, leukocytosis, neutrophilic pleocytosis in the CSF, positive meningeal signs, and CT data. In 9 cases the culture was sent from the wound, and in 3 of them Pseudomonas aeruginosa was detected.

Two patients with otorrhea were managed conservatively with dehydration and antibiotic therapy. One of them was also diagnosed with purulent otitis. The otorrhea spontaneously disappeared in these two patients on the 5th and 7th posttraumatic day respectively. One patient with nasal CSF leak was also treated conservatively. A patient with transorbital CSF leak underwent reoperation by multidisciplinary team with the reconstruction of the anterior cranial fossa.

Treatment outcomes were assessed using Glasgow Outcome Score (GOS) and are shown in Table 3.

Table 3. Outcomes in patients with CSF fistula

GOS1	1
GOS2	1
GOS3	11
GOS4	6
GOS5	1

Table 4. Analysis of factors that influence rate of infection CSF fistulas

	Yes CSF fistula N=20	**No CSF fistula N=59**	**P value**
Year of admission 2014 2015 2016 2017	 9 (45%) 7 (35%) 3 (15%) 1 (5%)	 19 (32.2%) 18 (30.5%) 12 (20.3%) 10 (16.9%)	 0.502
GCS on admission to main hospital[1] GCS 3-5 GCS 6-12 GCS 13-15	 1 (5.3%) 5 (26.3%) 13 (68.4%)	 3 (5.2%) 7 (12.1%) 48 (82.8%)	 0.294
Type of penetrating agent Bullet Missile Blast wave	 5 (25%) 13 (65%) 2 (10%)	 11 (18.6%) 45 (76.3%) 3 (5.8%)	 0.542
Multiple site of injury	9 (45%)	7 (11.9%)	0.003
ISS on admission	26 (25-30)	25(25-31)	0.357
Ventricular injury	9 (45%)	9 (15.3%)	0.011
Repeated surgeries	16 (80%)	14 (23.7%)	<0.001

Discussion

Based on the literature data, CSFL varies from 4.75% to 25.6% [6; 7]. The frequency of CSFL in our study was 25.31%. This is most likely due to the fact that the evacuation and medical care system was not well established in the early stages of the war. Wound CSF leak, otorrhea and rhinorrhea negatively affect treatment outcomes [2; 3; 8; 11; 15]. In our study it was not a significant factor (p=0.196) but we found significant correlation between presents of CSF leak and the number of hospitalization days (p=0.007).

The most common type of CSF leak was CSF leak from the wound, less commonly diagnosed were CSF otorrhea and rhinorrhea. Some authors also distinguish transorbital CSF leak [2; 8]. In our series we also had one case.

Some authors reckon that there is a direct relationship between the patient's condition on admission and the development of CSF leak [18]. They state that a lower GCS score has an influence on the rate of CSF fistulas. We could not find such a relationship, likely due to lack of information about GCS score on admission at the third and second

echelon, where they mainly hospitalized from combat theatre.

In nine patients canal passed through or reached the ventricular system, and the postoperative clinical course after the first surgery was accompanied by wound CSFL. Our and literature data [2; 3] show that injury to the ventricular system contributes significantly to the risks of CSF leak ($p = 0.01$).

Early detection of CSFL is crucial to prevent the possible development of meningitis or abscess [16]. In 20 wounded with CSFL, the number of infection complications reached 70% (14 patients), its twice as many as in the group without CSF leak, and this is definitely influence rate of infection complications (IC) in wounded cohort ($p = 0.002$).

The most common cause of wound CSF leak is misinterpretation during primary surgical examination (PSE) of the wound and the impossibility of transferring an open penetrating wound into a closed one. If, after PSE, there is CSF leak from the wound, then preference is given to early reoperations before the development of infectious complications. Same was also recommended by some authors [11].

Neurosurgical treatment should be performed in specialized neurosurgical departments, after a precise examination of the patient, assessment of the general and neurological conditions and nature of the wound. These measures work as a prevention of CSF leak and IC, with chances to reduce mortality [3; 10; 11; 17]. High level of wound CSF leak in our study in the early period of hostilities may be due to the fact that interventions were mainly carried out in frontline hospitals, where working conditions are quite tense, complicated by massive admissions, which usually affects the quality of care [9]. Evidence of this is the large number of repeated surgeries ($p<0.001$) associated with the presence of wound CSF leak, which is comparable to other reports [2; 13].

Watertight closure and dural reconstruction is mandatory during surgery [8, 19]. In all our surgeries, we performed reconstruction with the fascia lata. Though we agree that other options like using the pericranium and temporal fascia [2 - 4; 14] or an allograft [7; 8], and artificial dura [20] are also valuable. In addition, plastic of meningea prevents the risk of epilepsy and facilitate cranioplasty in the future, prevents brain prolapse in the wound [4]. All reoperations were performed using magnifying techniques, which in our opinion improves the results and allows to better sewing the defects [12].

In the presence of CSF leak our strategy includes multiple lumbar punctures and insertion of continuous lumbar drain. Thirty-degree head elevation, antibiotic prophylaxis, control of hydration, electrolytes are important. Similar approach was reported by other authors [2; 6-9; 13].

One case of otorrhea was diagnosed on the first day after injury and closed spontaneously within 72 hours after injury. Two wounded, who were diagnosed with otorrhea, received medical treatment (moderate dehydration therapy). In other series where the conservative approach and continuous lumbar drain were ineffective, patients underwent surgery [14]. Described cases with manifestation of otorrhea within 48 hours of injury [11], also described cases with later manifestations of otorrhea after craniofacial injury [21].

Conclusion

CSF leaks are the risk factor of infectious complications after head gunshot wounds. The presence of CSF leaks prolongs hospitalization time.

Primary surgical treatment of penetrating gunshot wounds to the head is the main element in the prevention of CSF leak and infectious complications. It is important to transfer a gunshot wound from a penetrating to a closed non-penetrating; it is the first step to avoid CSFL. Primary surgical wound exploration better to perform in specialized neurosurgery departments, after a precise examination of patients using not only X-ray, but also CT.

Limitations

This study has several limitations. Firstly, some of the data were missing due to its retrospective design. In addition, the relatively small sample size did not allow us to analyze the contribution to CSF leak of other important factors.

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Double curve linear incision approach in cases of sagittal craniosynostosis

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Abstract

Craniosynostosis is the premature fusion of one or more sutures in the cranial dome or anterior skull base, resulting in an abnormal head shape. This pathological process is observed less frequently in Eastern geography and approximately one in 2000 to 2500 births in Western countries. Isolated sagittal synostosis accounts for more than half of craniosynostosis cases. In our study, the duration of surgery, duration of anaesthesia, duration of hospital stay, estimated amount of bleeding during surgery and the months of surgery were examined in 16 patients. The performed craniotomy is not different from the four different craniotomies described in the literature. Strip craniectomy and barrel osteotomy were performed on each patient. According to the incisions described in the literature, the incision type and location are different. As the described incision provides less skin dissection, less bleeding and less dead space formation allows surgery in earlier months.

Keywords
sagittal,
craniosynostosis,
double curve linear incision

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Introduction

Craniosynostosis is the premature fusion of one or more sutures at the cranial dome or anterior skull base, resulting in an abnormal head shape. Reconstruction of craniofacial structure is typically required when physical or mental well-being becomes affected. This pathological process is observed less frequently in the Eastern geography, at about 2000 to 2500 births in Western countries (1). The first surgical treatment was reported with linear craniectomy to open fused sutures in the 1890s, and this method was used for a long time until the 1960s (2,3). Craniofacial surgical techniques were described in the 1960s with the repositioning of the frontal bone to enlarge the cranial volume. Since this revolutionary medical event, the surgical procedure for craniosynostosis has been developed in various ways based on various ideas through trial-and-error methods.

A recent study found that 84% of the patients had isolated craniosynostosis, 7% had other clinical symptoms, and 9% had suspected syndromic craniosynostosis. This is consistent with a frequency of 0.4 to 1.0 per 1000 live births for nonsyndromic craniosynostosis.

Sagittal and unicoronal synostosis patients are predisposed differently based on their gender, with sagittal synostosis happening more frequently in males at a rate of 4:1 and unicoronal synostosis occurring more frequently in females at a rate of 3:2.2. (4) In a review of 519 subjects, the sagittal suture was affected in 56 percent, the coronal suture in 25 percent, the metopic suture in 4 percent, and the lambdoid suture in 2 percent of cases (5).

Although many families with craniosynostosis children present to the craniofacial surgeon with the goal of restoring normal head shape for purely cosmetic reasons. The fundamental reason for intervention is to avoid the consequences of intracranial hypertension (defined as more than 15 mm Hg). Although the exact prevalence of intracranial hypertension is unknown, it can cause neurodevelopmental delay. According to the most recent research, cerebral hypertension affects 15% of the population(6). However, the resulting neurodevelopmental delay is more difficult to predict and is likely multifaceted, with factors such as hydrocephalus, anatomical alterations in the brain, preterm, and family history all playing a role. Some studies have shown indications of neurodevelopmental delay in patients with single suture craniosynostosis as high as 37%(7).

Another much debated question is the timing of surgical intervention. Surgery is normally postponed for nonsyndromic children until they are at least 3 months old, which is considered to help the child to better adjust for the physiologic stress of bleeding. Although the amount of blood lost after surgery is typically non-substantial, it accounts for a bigger proportion of the baby's growing total blood pool than in older patients.

In addition to the effect of brain growth on head shape, proponents of an early surgery for open repair point to the advantages of avoiding further advancement of secondary craniofacial alterations and having more readily shaped bone stock. Furthermore, children who get early care are more likely to spontaneously correct any lingering calvaria problems. Late intervention supporters point to the greater rate of revision necessary in early intervention children.

In practice, most surgeons intervene in between 3 and 12 months of age, and this decision is affected by technique and surgeon bias. In our clinic, we will talk about a method that will shorten the surgical time and reduce the complications and eliminate the deformity.

Patient and methods

Patients who underwent craniosynostosis surgery between 2016-2021 were retrospectively reviewed. Between these dates, due to sagittal synostosis; 16 patients who underwent the front-to-back double-curved method were identified in our clinic. The duration of their surgery, duration of anesthesia, amount of bleeding, length of hospital stay and preoperative weights of the patients were examined. Patients who will undergo cranial synostosis surgery; It was expected to exceed six kilos in order to reduce the risks of anesthesia and surgery. It was decided to perform a surgical procedure with preoperative physical examination and 3D computed tomography.

Surgical procedure

The same surgical technique was applied to all patients discussed in our study. In cases where the sagittal suture was closed, the patient was positioned in the prone position and the sagittal suture, coronal suture and lambdoid sutures were exposed using a front to back double-curved anterior to posterior incision starting from the front of the coronal suture and progressing until past the lambdoid suture at the back. (Figure 1)

Figure 1. Sagittal synostosis and cranium are seen after skin incision.

Two bilateral burr holes were opened 2 cm in front of the coronal suture, one cm lateral to the midline. Two burr holes were opened at the rear, one cm

lateral to the midline at the lambda level. Craniectomy was performed along the 2 cm wide suture centered on the sagittal suture. The suture spacing was expanded by excising the lambdoid suture with a kerrison. Barrel osteotomies were performed 2 cm apart on the parietal bone. (Figure 2) A drain was placed under the skin and the operation was terminated. (Figure 3)

Figure 2. Strip craniectomy parietal and occipital barrel osteotomies.

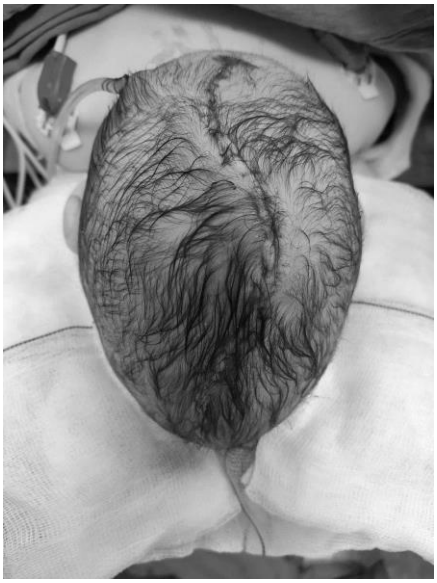

Figure 3. Postop skin incision.

STATISTICAL ANALYSIS

Statistical analysis was performed using the TURCOSA (Cloud-based statistical software) program using the Student's t test, p-value of less than 0.05 ($p < 0.05$). was considered statistically significant.

Table 1. Demographic information of patients

No	Age	Closed suture	Length of stay in hospital	Amount of bleeding (ml)	Preop Hgb	Weight (Kg)	Polideks (ml)	Surgery Time (min)	Anaesthesia Time (min)
1	6 months	Sagittal posterior	3	20	12	6,1	100	75	145
2	5 months	Sagittal	2	35	12,3	5	80	100	160
3	5 months	Sagittal posterior	4	50	10,7	8	140	95	175
4	6 months	Sagittal	4	60	10,2	8	300	102	175
5	4 months	Sagittal	3	55	10,7	6,5	160	75	150
6	4 months	Sagittal	3	20	11	7	85	95	170
7	4 months 11 days	Sagittal	3	30	12,3	8	200	102	150
8	5 months 7 days	Sagittal	3	40	11,1	7	80	80	130
9	5 months 8 days	Sagittal	3	80	11,3	8,5	250	80	145
10	4 months 18 days	Sagittal	3	30	10,6	7	200	77	143
11	5 months 1 days	Sagittal	3	20	11,7	7	130	85	138
12	4 months 26 days	Sagittal	3	30	12,2	8	125	100	160
13	5 months 11 days	Sagittal	2	30	12,1	6	120	93	140
14	4 month 20 days	Sagittal	2	30	12,4	7,1	300	72	120
15	4 months	Sagittal	3	30	9	7	100	78	128
16	6 months	Sagittal, lambdoid	3	50	10,7	8	150	70	140

Table 2. Statistical results are shown in the table

	n	Mean and Standard Seviation	p
Duration of surgery group A Our data	50 16	174.9±400 86.1±11.6 (min)	<0,001
Duration of surgery group B Our data	22 16	136.1±30.4 86.1±11.6 (min)	<0,001
Amount of bleeding group A Our data	50 16	113.3±100.3 38.1±16.7(ml)	<0,001
Amount of bleeding group B Our data	22 16	168.1±50.6 38.1±16.7(ml)	0,004
Volume of crystalloid in group B Our data	22 16	329.4±70.8 157.5±73.1(ml)	<0,001

Results

Of the 16 patients who were operated in the examined date range, 3 were female patients and 13 were male patients. The mean age of the patients was 4.9±0.6 months (min 4 months, max 6 months), preop weight was 7.14±0.9 any developmental delay was observed in any of the patients. No examination finding suggestive of increased intracranial pressure was detected in any of the patients. The mean hospital stay of the patients was 2.94±0.5 days, the mean amount of bleeding was 38.1ml±16.7ml. Mean surgery time is 86.1±11.6 mins, mean anesthesia time is 148±16.3 mins. (Table 1)

As the control group in the study of Christopher M. Runyan et al. named 'Long-Term Outcomes of Spring-Assisted Surgery for Sagittal Craniosynostosis'(8) defined as group A and Paul J. Escher et al.'s 'Minimizing transfusion in sagittal craniosynostosis surgery: the Children's Hospital of Minnesota Protocol'(9) The craniotomy group in the study was defined as group B. When the means and standard deviation values in articles A and B were compared with the means and standart deviation in our study. (Table 2)

Discussion

The main finding in patients with craniosynostosis is premature closure of the cranial sutures; The malformations that occur in the anatomical regions it affects are proportional to the extent of closure of which sutures. Malformations are usually prominent in the vertical direction of the affected joint. Since the aim of surgery is to prevent head deformity by recreating the closed suture line, the application of surgical intervention in the first six months after birth, when head development is rapid, prevents the occurrence of secondary effects on head shape development. A smoother head shape result can be obtained in surgeries performed in the first six months. In infants, low weight and fragile hemodynamics cause many risks related to anesthesia as well as surgical difficulties. Although surgeries for craniosynostosis have been performed since 1890, today the development of anesthesia and the development of surgical techniques allow for a decrease in morbidity, mortality and better surgical results.

Because of the myriad risks of allogeneic transfusions such as infection, hemolytic reactions, allergic reactions, and transfusion-induced acute lung injury (TRALI), strategies to reduce the need for transfusions in patients with craniosynostosis are a subject of ongoing research. Preoperative EPO use and iron replacement therapies have been described in the literature(10–12). Although replacement therapy was not applied to our patients, none of the patients required blood transfusion therapy.

The aim of the described surgical techniques is to correct the head deformity. The success of the surgery directly affects the success of the surgery. In surgery, it is necessary to perform the procedure to reveal the largest suture line of the cranium. Although it is not related to the intracranial area, it should not be forgotten that the superior sagittal sinus is under the suture. Since minimal bleeding in the surgical procedure enables early intervention, it indirectly affects the success of the surgery.

From the 1960s to the 1990s, the evolution of operative intervention for sagittal craniosynostosis involved increasingly extensive cranial dome reshaping(13). These techniques included wide stripe craniectomy with bilateral parietal wedges, extended vertex craniectomy, and complete calvarial remodeling via the pi procedure(14–16). Such operations were associated with long operative time, high blood loss, and prolonged hospital stays(13,17). In the early 1990s, surgical techniques reduced the morbidity of these operations. During this time, surgeons also began to explore the use of force therapy to counter the cranial vault's tendency to relapse after surgery and realized that surgical intervention provides a unique opportunity for cranial molding early in life.(13,18,19) A more minimally invasive approach, Jimenez and Barone

1990 showed that endoscopic strip craniectomy has low morbidity and that the cephalic index can be normalized when combined with postoperative helmet therapy.(18)

Basically, four different craniotomy have been defined; strip craniectomy alone, strip craniectomy with wedges, strip craniectomy with parietal barrel staves and midline osteotomy with separate burr holes for spring placement. The technique we use is strip craniectomy with parietal barrel staves. Although the width of the osteotomy performed in the literature varies inversely with the age at which the surgical intervention was performed(20–22), we used the same width of craniectomy for each patient regardless of age. With the help of barrel osteotomies, it was observed that the head took its normal shape and expanded the craniectomy area. In our surgical procedure, in addition to strip craniectomy with parietal barrel staves, occipital barrel states were added to provide a wider area for remodeling. The most important difference from the literature is our double curved incision, which remains completely at the vertex. Considering the area where the scalp is stripped from the calvarium and the area being worked on, the more unnecessary calvarium area in the classically applied bicoronal incision causes more bleeding and a longer operation time. It is not possible to create occipital barrel staves by reaching as far back as we reached with a bicoranal incision.

In the study of Runyan et al. (8) with 50 patients and in the study of 22 patients by Paul J. Escher's friends(9), the mean operative time was stated as 174 and 136 minutes, respectively. Again, the mean amount of bleeding is indicated as 113 and 168 milliliters. In the study of Paul J. Escher with his friends, the average use of crystalloids during surgery was found to be 329 milliliters. In our technique, the amount of crystolloid used during surgery was found to be statistically less. In this case, it can be associated with direct bleeding and less volume loss. Considering that the same craniotomy model was applied, where our only technical difference with these studies is the incision difference, we can say that our incision statistically reduces the operation time and the amount of bleeding compared to the bicoronal incision.

As a result of our study, none of the patients needed intensive care and no complications were encountered, suggesting that our surgical method was successful. In one study(23), 26 pediatric neurosurgeons reported an average hospital stay of 1 to 4 days after surgery. In our patient group, the mean hospital stay was 2.9 days.

Our study has important limitations. This study is a retrospective study of a single center surgical team. The small sample size is the limitation of this study. For more reliable data, the study should be developed as a multicenter and control group.

Conclusion

The purpose of the incision in sagittal craniosynostosis operations is to reveal the largest line of the cranium. In our study, one of the four different craniotomy methods defined basically was used. In the literature, strip craniectomy and parietal barrel osteotomies, which are generally performed with bicoronal incision, reduce surgical time and surgical damage with a new incision with a smaller and less dead space component. The earliest surgical intervention in surgical surgery had a positive effect on the success of the surgery in terms of results. The benefits of this technique will be more visible with the children of patient visits and follow-up periods. This incision is prominent in sagittal synostosis treatments.

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Evaluation of the benefit of placing a drain in the epidural space in patients undergoing craniotomy

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ABSTRACT

Background. Placing a drain in each of the intracerebral, subdural, epidural, and subgaleal spaces during craniotomy may be a result of the traditional approach. It may be more appropriate to identify the locations of the drains individually for each case and avoid certain behaviours. We, therefore, planned a study on the necessity of epidural drains, which are commonly used.

Methods. The study was conducted by screening the charts of the patients who had undergone surgery at İzmir Bakırçay University Çiğli Training and Research Hospital's Neurosurgery Department between June 1st 2021 and September 1st 2022. The study was of the retrospective cohort type. There were two groups in the study. Twenty cases where only a subgaleal drain was used formed the first group (SG group). Twenty cases where subgaleal and epidural drains were used together formed the second group (SG+E group). A total of three parameters were evaluated between these groups. The first parameter was the myocutaneous tissue thickness on the first postoperative day. The second one was epidural collection thickness on the first postoperative day. The third parameter was the rate of wound site infection development in the two groups. The results of the two groups were compared with the Wilcoxon rank sum test. A two-way p-value below 0.05 was considered statistically significant.

Results. A statistically significant difference was present between the two groups in terms of myocutaneous tissue thickness (p=0.035). The mean myocutaneous tissue thickness was 15.8±3.24 mm in the SG+E group and 12.4±5.98 mm in the SG group. The mean epidural collection thickness in the SG+E group was higher than in the SG group and the difference was significant (10.3±3.29 mm and 6.30±3.13 mm, respectively, p<0.001). No infection developed in any of the patients in either group.

Conclusion. In patients undergoing craniotomy, placing a drain in the epidural space may be an ineffective intervention. The basic principle should be to complete the operation in the least invasive manner and the shortest time possible.

Keywords
epidural,
drain,
craniotomy,
benefit

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INTRODUCTION

Manuals play a very important role in neurosurgery operating procedures. It is also common to be influenced by a senior in the form of a master-apprentice relationship and to maintain this influence over the years. There may sometimes be problems with this arrangement but appropriate surgical behavior is usually observed. Placing a drain in

each of the intracerebral, subdural, epidural, and subgaleal spaces during craniotomy may be a result of this traditional approach. It may be more appropriate to identify the locations of the drains individually for each case and avoid certain behaviors. We therefore planned a study on the necessity of epidural drains, which are commonly used.

MATERIALS AND METHOD

The study was conducted by screening the charts of the patients who had undergone surgery at İzmir Bakırçay University Çiğli Training and Research Hospital's Neurosurgery Department between June 1st 2021 and September 1st 2022. The study was of the retrospective cohort type. The inclusion and exclusion criteria were as follows.

Inclusion Criteria:

1. Supratentorial pathology
2. Cranial tumors, cranial vascular surgery cases, cranial compression fractures, and cranial epidural hematomas
3. Those with a subgaleal drain among the above cases
4. Those with a subgaleal and epidural drain among the above cases

Exclusion Criteria:

1. Infratentorial pathologies
2. Subdural hematomas
3. Cases with a subdural drain
4. Cases without any drain
5. Patients with uncontrolled or untreated comorbidities that could facilitate the development of wound site infection
6. Patients with a coagulation disorder

There were two groups in the study. Twenty cases where only a subgaleal drain was used formed the first group (SG group). Twenty cases where subgaleal and epidural drains were used together formed the second group (SG+E group). A total of three parameters were evaluated between these groups. The first parameter was the myocutaneous tissue thickness on the first postoperative day. The second one was epidural collection thickness on the first postoperative day. While performing the calculations, the thickest part of the relevant area was measured in coronal sections of cranial tomography. The distance from the highest point of the scalp to the bone was measured when calculating the second parameter. The third parameter was the rate of wound site infection development in the two groups. In order to evaluate the third parameter, the patients were followed-up for local infectious changes in the wound for 15 days.

Descriptive statistics were expressed as numbers and percentages for categorical variables and as mean±standard deviation for constant variables. The results of the two groups were compared with the Wilcoxon rank sum test. A two-way p value below 0.05 was considered statistically significant. The analyses were performed with the R software, version 4.0.0.

RESULTS

There were 12 females (60%) and 8 males (40%) in Group 1. The mean age was 56.3 years. Group 2 included 9 females (45%) and 11 males (55%). The mean age was 63.4 years. Myocutaneous tissue thickness and epidural collection thickness measurements of all patients are shown in Table 1 and Table 2.

Table 1. Myocutaneous tissue thickness measurements in the tomography of the patients in Group 1 (subgaleal drain) and Group 2 (subgaleal+epidural drain) on the 1st postoperative day (mm).

Patient	Group 1 (SG)	Group 2 (SG+E)
1	15	13
2	14	16
3	7	9
4	7	18
5	14	14
6	15	15
7	18	16
8	16	18
9	7	12
10	10	15
11	6	15
12	7	16
13	22	21
14	15	24
15	25	18
16	20	13
17	3	16
18	6	18
19	11	15
20	10	14

Table 2. Epidural collection tissue thickness measurements in the tomography of the patients in Group 1 (subgaleal drain) and Group 2 (subgaleal+epidural drain) on the 1st postoperative day (mm).

Patient	Group 1 (SG)	Group 2 (SG+E)
1	11	8
2	10	11
3	3	5
4	5	12
5	5	9
6	12	8
7	13	10
8	7	10
9	6	9
10	5	8
11	4	12
12	6	16
13	3	9
14	8	19
15	3	12
16	5	15
17	3	8
18	6	9
19	3	8
20	8	8

A statistically significant difference was present between the two groups in terms of myocutaneous tissue thickness (p=0.035, Table 3, Figure 1). The mean myocutaneous tissue thickness was 15.8±3.24 mm in the SG+E group and 12.4±5.98 mm in the SG group.

The mean epidural collection thickness in SG+E group was higher than in the SG group and the difference was significant (10.3±3.29 mm and 6.30±3.13 mm, respectively, p<0.001, Table 3, Figure 2).

Table 3. The comparison of myocutaneous tissue and epidural collection thickness between Group 1 (subgaleal drain) and Group 2 (subgaleal+epidural drain).

	All patients, n=40	Group 1 (SG), n=20	Group 2 (SG+E), n=20	p
Myocutaneous tissue thickness (mm)	14.1±5.05	12.4±5.98	15.8±3.24	0.035
Epidural collection thickness (mm)	8.30±3.76	6.30±3.13	10.3±3.29	<0.001

Group 1 and Group 2 were also compared in terms of infection development. No infection developed in any of the patients in either group. These results were not suitable for statistical analysis.

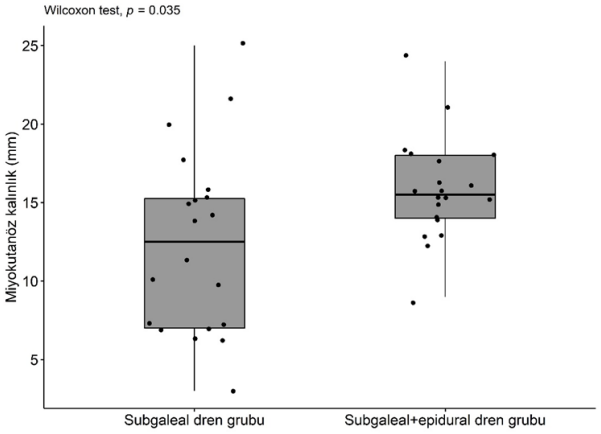

Figure 1. The comparison of myocutaneous tissue thickness between Group 1 (subgaleal drain) and Group 2 (subgaleal+epidural drain).

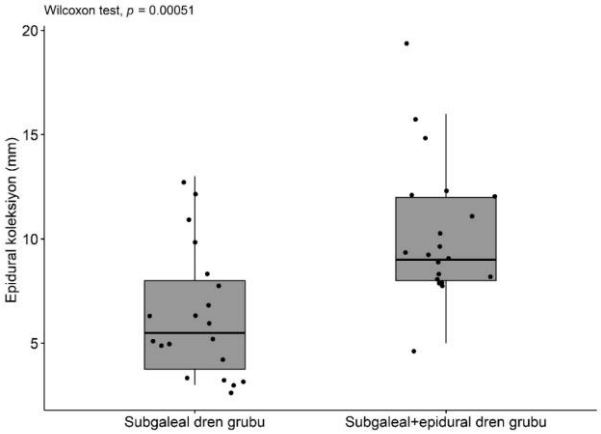

Figure 2. The comparison of epidural collection thickness between Group 1 (subgaleal drain) and Group 2 (subgaleal+epidural drain).

Discussion

Neurosurgeons place a drain in the epidural space on the assumption that it will decrease hematoma development and related complications at the surgical site. This practice is sometimes maintained as a habit or because the physician has learned this from a senior (1). We evaluated whether epidural drain placement is beneficial in the current study. We also wanted to see how a catheter placed in the epidural area changes infection rates. Historically, subgaleal drains were first used by Ames et al. (6). The number of studies evaluating the effect of placing subgaleal plus epidural drains or only subgaleal drains after craniotomy on the infection

and other complication rates is low. The number of studies comparing the relative benefits of drain location is also low. We believed that a simple and conclusive study was required. This study was planned to understand the necessity, advantages, and disadvantages of epidural drain placement and to evaluate the adequacy of using a subgaleal drain only.

The results indicated that the epidural hematoma thickness on the first postoperative day in patients with both subgaleal and epidural drains (S+E) was statistically significantly higher than those with a subgaleal drain only (S). These results demonstrate that the current approaches are incorrect. The reason for the current results may be the accumulation of blood oozing from the bone in the epidural area while opening the epidural catheter site and the widening of the burr hole for the drain. Another possibility is the insufficiency of the suspending sutures where the drain is placed in the epidural space. Although it is difficult to reach a clear conclusion, these are the primary factors to consider.

The current results make epidural catheter use controversial. Drain placement in Group 2 (S+E) patients actually prolongs the duration of surgery. At this stage, the surgeon places the drain in the epidural space, fixes it, and widens the burr-hole to prevent compression in the area where the drain will pass in the craniotomy flap and calvarium. All these cause loss of time and prolongation of the surgery. We observed this procedure to take 7 minutes on average in our cases. Although not on a case-by-case basis, this would indicate a serious collective waste of time considering the high number of cranial surgeries performed. At the same time, widening the burr-hole where the epidural drain will pass creates an additional defect. This makes the procedure more invasive.

Another important point is that large amounts of CSF drainage can occur when watertight suturing cannot be achieved in the dura and the epidural drain is directed below the ear level. Complications such as subdural hematoma, decreased intracranial pressure, headache, brain edema, intracerebral hematoma, herniation, coma, and death may occur (2,3). A case where large amounts of cerebrospinal fluid drainage and low intracranial pressure following subdural hematoma surgery caused cerebellar hematoma (the zebra sign) is present in the literature. The hydrocephalus that developed later was reported to cause serious prolongation of hospitalization and decrease the Glasgow outcome score of the patient (9). The point we want to emphasize by providing this example is that an epidural catheter can also increase morbidity due to excessive CSF drainage.

Blood accumulation in the epidural space remains limited when the epidural space is reduced by suspending the dura with suspension sutures. The reason may be the prevention of potential bleeding with pressure as the space is reduced. Besides, the blood may have passed from the bone defects at the craniotomy borders to the subgaleal area and then drained from there with the subgaleal drain. We believe that both these factors played a role. Placing a drain in the epidural space to decrease epidural hematoma may therefore be useless. An epidural hematoma quickly solidifies once it develops and cannot enter the drain. The main approach to decrease an epidural hematoma should be to suspend the dura at appropriate intervals in order to reduce the epidural dead space.

An epidural drain has been reported to be effective in preventing subgaleal collection when the dura cannot be closed watertight during craniotomy in the parietal region in a study by Xin Li et al. However, a drain was not used in the control group in that study. We believe that similar results could also be observed if a subgaleal drain had been used in the control group. Subgaleal drainage is also a less invasive and more practical method than epidural drainage (10).

Philip A Boney et al. have reported that the location of the drain used in epidural hematoma was associated with repeat surgery and the length of the hospital stay due to residual or recurrent hematoma. They reviewed 52 cases, with a subgaleal drain in 25, epidural drain in 8, and both in 13 patients, no drain was used in 6 cases. The location of the drain was not found to be statistically significant as regards repeat surgery, but the length of hospitalization decreased as the use of drains decreased. These results are similar to ours (11).

The issue also needs to be evaluated in terms of susceptibility to infection. No statistically significant difference in terms of infection was found between the two groups in our study. Placing a second drain could increase the chance of skin bacteria being carried in. The procedure is also more invasive. The

increased duration of the surgery could increase the risk of infection (4).

The two groups in the current study were evaluated in terms of myocutaneous tissue thickness on the first postoperative day. The value was statistically significantly lower in Group 1 (SG). The reason could be the blood leaking from the bone tissue, muscle, and skin-subcutaneous tissue during epidural drain placement. An increased myocutaneous tissue thickness could impair wound healing. Any collection must be removed. The hospital stay of the patient will then be prolonged. From this point of view, placement of an epidural catheter may do more harm than good.

Prophylactic drain placement has been discontinued over the years in many surgical procedures other than neurosurgery. Schietroma M et al. have reported routine drain use after thyroidectomy to be unnecessary and postoperative drain placement to increase pain (7). Besides, the use of a drain after lumbar surgery did not change the epidural hematoma or infection rate but increased the patient's pain-related symptoms (8). However, the number of neurosurgical studies on this issue is inadequate. A subgaleal collection could prolong wound healing. A scalp hemorrhage can develop into a chronic cavity and cause serous fluid accumulation when a subgaleal drain is not placed, as this is a very vascular area. It can also impair wound healing and predispose to wound infection. Therefore, we think that a subgaleal drain is necessary. However, the subgaleal space is tighter close to the vertex and a subgaleal drain is not used with limited incisions close to the vertex in practice. The basic principle should be to complete the operation in the least invasive manner and the shortest time possible.

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Epidemio-clinical and therapeutic profile of non-traumatic medullary-radicular compressions at the University Hospital of Kinshasa

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Abstract

Context and objectives. As the world's population ages, non-traumatic medullary-radicular compressions are becoming more common. This work aims to describe their epidemio-clinical and therapeutic aspects at the University Hospital of Kinshasa.
Methods. It is a descriptive cross-sectional study from 2016 to 2022 concerning 61 cases. Variables of interest included: sex, age, cause, level of lesion, ASIA score, treatment, complications, and destination. Data were analyzed using SPSS 26 and STATA 16 software.
Results. One hundred and twenty patients were operated on for medullary-radicular compression, including 61 non-traumatic (50.8%) and 59 traumatic (49.2%). Among the non-traumatic, 31 patients were male (50.8%) and 30 females (49.2%). The average age was 51.51 ± 14.21 years. Patients between the ages of 40 and 69 accounted for 68.8%. The annual curve was increasing. On admission, the clinical presentation was dominated by an incomplete neurological deficit (67.2%). The mean time to diagnosis was 188.57 days. Degenerative pathologies (63.9%) including 31 herniated discs (79.4%) and 8 cases of canal narrowing (20.6%) predominated, followed by tumors 14 (22.9%) half of which included metastases. The most performed surgical procedures included decompression laminectomy (26.2%), laminectomy-discectomy (24.5%) and laminectomy-arthrodesis (32.7%). The postoperative course was unremarkable in 67.2%, except for 15 cases of surgical site infection (24.6%) and 3 deaths (4.9%). ASIA score on dischached improved in 62.7% ($p<0.001$). Only 2 patients (9.8%) continued their treatment in a rehabilitation centre.
Conclusion. Non-traumatic medullary-radicular compressions are frequent in the service, more caused by herniated discs and tumours. Both sexes are equally affected and the age group is ranging from 40 to 69 years. The neurological deficit is often incomplete cord injury. Laminectomy, discectomy and arthrodesis are commonly performed. The postoperative outcome is generally better.

Keywords
myelopathies,
non-traumatic spinal cord compression,
spine surgery,
traumatic spinal cord injuries,
vertebro-spinal lesions

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Introduction

Medullary-radicular compression is a constriction of the spinal cord and nerve roots due to traumatic or non-traumatic causes

(degenerative, tumoral, infectious, vascular) involving bony structures and/or disco-ligamentous complex of the spine. The spinal cord and nerve roots may be compressed by expansion of blood, tumoral processes, infectious collections, protrusion of bone or nucleus pulposus into the epidural space or meninges [1]. This lesion is a diagnostic and therapeutic emergency. If not treated early, it can lead to disabling neurological deficits in the short to medium term [2]. Medullary-radicular compression is much more common than other mechanisms: compromised blood flow, inflammatory processes, metabolic disorders or exposure to toxins [3].

The worldwide incidence rate of nontraumatic medullary radicular injuries (NTMRI) increases with age and ranges from 4 to 80 cases per million people per year [4]. The global prevalence rate ranges from 367.2 to 2,310 per million populations per year [5]. Only the study conducted in Malawi was able to give an idea of the incidence of NTMRI in Africa through a survey of all admissions across the country. According to this study, the incidence is 77 new cases per 1,000,000 inhabitants [6]. The prevalence of NTMRI should increase steadily with the aging of the population and exceed that of traumatic injuries [4].

NTMRIs pose various problems such as the low rate of publications compared to those of traumatic origin, devastating physical and functional damage for the patient and his family [7]. We can also mention the difficulty in establishing the diagnosis early for better care. Indeed, this diagnosis requires specific laboratory and medical imaging examinations, in this case CT-scan and MRI, which are often unavailable and inaccessible in several African regions [7]. The delay in diagnosis and the presence of comorbidities in elderly patients increase the mortality rate of NTMRI, which varies between 27,7% and 41 % [7,8].

Another challenge lies in the fact that the causes aforementioned of the NTMRI vary considerably between countries and regions. In developed countries, degenerative (16.4 to 50.9%), tumoral (15.5 to 30.5%) and vascular (12.5 to 40%) pathologies come first [9, 10, 11].

Whereas, in developing countries, infections such as tuberculosis (51 to 56%) and HIV/AIDS infection (18 to 50%) predominate [12,13,14]. Nevertheless, some African countries present the predominance of degenerative and tumoral causes. Gaddour et al [15], in Tunisia, Kassegne et al [16], in Togo, Ekouele Mbaki et al [17], in Congo-Brazzaville, observed a high frequency of degenerative and tumoral causes.

The DRC has cosmopolitan and crowded cities such as the City of Kinshasa where tuberculosis and HIV/AIDS continue to be spreading [18]. Several Congolese hospitals are not equipped with CT scan and MRI machines. However, there is no publication on NTMRI in general, and nontraumatic medullary-radicular compression (NTMRC), in particular. Do infectious NTMRC's predominate as widely described in the medical literature? What is the average consultation time? What is the result of their treatment? These questions prompted us to conduct this study with the aim of drawing up the epidemiological, clinical and therapeutic picture of non-traumatic medullary-radicular compression. The specific objectives pursued are:

- Determine the hospital prevalence and the distribution of NTMRC across gender and age groups.
- Present the clinical picture and paraclinical explorations.
- Give the different causes of NTMRC.
- Describe the treatment, the operative outcome, the complications and the destination upon discharge from the hospital.

Materials and methods

Study design

This is a cross-sectional and descriptive study, conducted at the University Hospital of Kinshasa, from 01 January 2016 to 31 August 2022. The data were collected retrospectively and prospectively. During this 6-year period, 84 patients with non-traumatic radiculo-medullary compression lesions were hospitalised. Only the records of 61 patients were retained, as they met the selection criteria.

Inclusion and exclusion criteria

All patients aged 10 years and older, admitted and operated in the Spinal Cord Injury Unit for non-traumatic medullar-radicular compression, with radicular medullary compression syndrome, from 1 January 2016 to 31 August 2022, were included. Patients with incomplete records were excluded.

Data collection technique. We collected data in two ways, retrospectively and prospectively, from hospitalization and operating room records. To

complete certain information, we contacted the patients and/or their direct family members.

Variables of interest were sex, age, cause, level of injury, neurological deficit according to the American Spinal Injury Association (ASIA) score [19,20], treatment, complications and destination after discharge.

Statistical analysis

Data were recorded and analysed using SPSS version 26 and STATA version 16 software. Descriptive analysis was performed for the main variables included in the study. We determined the possible associations between the different variables considered using Pearson's chi-square or Fisher's exact tests. Since the distribution was normal, we used Student's t-test to judge the effectiveness of the surgical treatment by comparing the mean ASIA scores at admission and discharge. The odds ratio and binary logistic regression model were used to estimate the risk of surgical site infection. A result was considered statistically significant when the p-value was less than 0.05.

Results

1. Prevalence of non-traumatic medullary-radicular compression

One hundred and twenty patients were operated on for medullary-radicular compression, 61 of whom were non-traumatic (50.8%) and 59 traumatic (49.2%).

2. Socio-demographic features

The average age was 51.51±14.21 years. We counted 50.8% male patients and 49.2% female, sex ratio was 1. Patients aged between 40 and 69 years accounted for 42 cases (68.8%). There were 67.2% of married patients, 34.4% of housewives and 29.5% of patients whose occupations were not reported (Table 1).

Table 1. Socio-demographic features

Parameters	frequency n=61	Percentage
Age (years)		
▪ 10 - 19	1	1,6
▪ 20 - 29	4	6,6
▪ 30 - 39	8	13,1
▪ 40 - 49	13	21,3
▪ 50 - 59	15	24,6
▪ 60 - 69	14	23,0
▪ 70+	6	9,8
sex		
▪ Female	30	49,2
▪ Male	31	50,8
Marital status		
▪ Married	41	67,2
▪ Single	12	19,6
▪ Widow	4	6,6
▪ Not reported	4	6,6
Profession		
▪ Households	21	34,4
▪ Not reported	18	29,5
▪ Public officials	6	9,8
▪ Health care workers	6	9,8
▪ Students and pupils	3	4,9
▪ Teachers	3	4,9
▪ Drivers and mechanics	2	3,3
▪ Soldiers	2	3,3

3. Annual incidence of non-traumatic medullary-radicular compression

We observed an increase in the number of cases in the years 2021 (16 cases) and 2022 (12 cases) (Fig. 1) while the annual average of cases during the 7-year period was 8.7 cases.

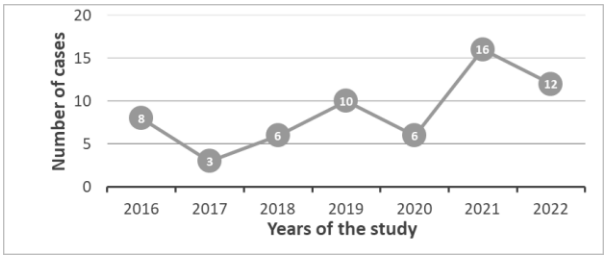

Figure 1. Annual frequency of NTMRC

4. Etiological and clinical data

The patients complained of low back pain in 47.5%, sometimes accompanied by bladder and bowel disorders (4.9%) and motor deficits, usually paraparesis (26.2%) or paraplegia (27.9%). Most patients had an incomplete spinal cord injury (67.2%: ASIA score B-D). ASIA E and D patients accounted for 32.8% and 29.5% of cases respectively compared to (16.4%) ASIA C and (21.3%) ASIA B on admission. Among the compressive causes, there were 39 (63.9%) cases of degenerative origin including 29 (74.3%) disc herniation and 10 (25.7%) narrow channel, 7 (11.5%) benign tumors, 7 (11.5%)

malignant tumors and 8 (13.1%) Pott's disease. On histopathological analysis, all benign tumors were meningiomas. In relation to the dura mater, they were intradural and extramedullary. All malignant tumors were metastases. The underlying primary malignant tumors were: 2 cases of breast cancer, 2 cases of hemangioma and 3 cases of prostate cancer. Patients aged 50 years and over suffered more from degenerative compression (p=0.013) and those under 50 years from infectious medullary-radicular compression, mainly tuberculosis (p=0.047). Tumoral (benign tumor) radicular spinal cord compression was much more common in women (p=0.040) (Table 2).

Table 2. Etiological and clinical data

- Parameters	Total n=61	sex		p-value*	Age (years)		p-value
		Male	female		<50	≥50	
Etiology							
Compressive							
▪ Degenerative	39	20	19	0,923	12	27	0,013
- Disc herniation	31	16	15		11	20	
- Canal stenosis	8	4	4		1	7	
▪ Tumoral	14	4	10	0,058	8	6	0,211
- Benign	7	1	6	0,040	4	3	
Intradural et extramedullary	7	1	6		4	3	
- Malignant	7	3	4	0.654	4	3	
▪ Infectious	8	7	1	0,026	6	2	0,047
- TBC	8	7	1				
Complaints				0,070			
▪ Neck pain	2	2	0		1	1	
▪ Neck +low back pains	4	4	0		3	1	
▪ Back pain	11	4	7		6	5	
▪ Low back pain	29	14	15		9	20	
▪ Low back pain + sensory-motor deficit	12	7	5		5	7	
▪ Low back + bladder disorders.	3	0	3		2	1	
Neurological deficit				0,463			0,980
▪ Monoparesia	3	2	1		1	2	
▪ Tétraparesia	3	3	0		1	2	
▪ Paraplegia	17	8	9		8	9	
▪ Paraparesia	16	8	10		8	10	
▪ no deficit	20	8	12		8	12	
ASIA				0,466			0,663
▪ B	13	7	6		7	6	
▪ C	10	7	3		5	5	
▪ D	18	7	11		6	12	
▪ E	20	10	10		8	12	

Table 3. Association between causes of non-traumatic medullary-radicular compression and ASIA score on admission

Causes	Total n=61	ASIA in admission				p-value
		B	C	D	E	
▪ Herniation disc	31	0	5	10	16	<0,001
▪ Canal stenosis	8	2	0	2	4	

▪ Benign tumor	7	3	2	2	0
▪ Malignant tumor	7	3	1	3	0
▪ Pott's desease	8	5	2	1	0
Total	61	13	10	18	20

Table 4. Surgical site infection according to age, causes, duration of surgery, and surgical procedures

Surgical procedures	ISO-/ISO+	Univariate analysis		
		OR	IC	p-value
▪ Laminectomy		1,03	(0,27-3,85)	0,965
▪ Laminectomy + Discectomy		1,15	(0,30-4,37)	0,830
▪ Laminectomy + Arthrodesis		2,22	(0,66-7,37)	0,187
▪ Corporectomy + Arthrodesis		1,34	(1,15-1,55)	0,412
▪ Laminectomy + excision		1,38	(1,17-1,63)	0,108
▪ Laminectomy+ excision + arthrodesis		1,33	(1,15-1,54)	0,565

5. Association causes of non-traumatic medullary-radicular compression and ASIA score on admission

All 20 ASIA E patients had degenerative pathologies, of which 16 (80%) were cases of disc herniation and 4 (20%) cases of canal narrowing. Thirteen ASIA B cases were of tumoral (46.1%), infectious (38.5%) and degenerative (15.4%) origin. Ten ASIA C patients had degenerative (50%), tumoral (30%) and infectious (20%) pathologies. Of the 18 ASIA D cases, 66.7% were degenerative, 27.8% tumoral and 5.5% infectious. Tumoral and infectious causes were more associated with ASIA B-C (72.7%) and degenerative causes with ASIA D-E (82.05%). The relationship between the different causes and ASIA scores on admission was statistically significant (p= <0.001) (Table 3).

6. Paraclinical diagnosis

The average time to diagnosis of NTMRC was 188.57 days. The diagnoses of tumoral and degenerative pathologies were established by MRI in 63.9% of cases, followed by CT scan in 24.6%. All tumor cases were confirmed and differentiated by histopathological analysis. The laboratory examinations helped to determine the specific causes of all infectious pathologies represented in our work by tuberculous spondylodiscitis.

7. Location of the injury

Six (9.8%) lesions were located on the cervical spine. We counted 10 lesions (16.3%) located on the thoracic segment, of which 8 (80%) were of tumoral origin. The lumbar spine was the site of 42 cases (68.9%). Thirty-three cases (83.1%) of the lumbar pathologies were degenerative and consisted of disc herniations and canal narrowing. The relationships between the different causes and their respective locations on the spine (p <0.001) and on the different vertebrae (p <0.001) were statistically significant.

8. Medical treatment

All patients received medical treatment including analgesics, anti-inflammatory drugs, gastric antisecretory drugs, postoperative corticosteroids, neurotropes and anticoagulants, and postoperative antibiotics. Anti-tuberculosis drugs were administered to patients with tuberculous spondylodiscitis.

9. Surgical treatment

The cervical segment was approached by both anterior (2 cases) and posterior (4 cases) routes. All cases in the thoracic, thoracolumbar and lumbar segments were approached via the posterior route. The surgical procedures performed were simple decompression laminectomy 16 cases (26.2%), laminectomy + arthrodesis 20 cases (32.8%) and laminectomy + discectomy 15 cases (24.8%). There were 2 cases (3.3%) of corporectomy and arthrodesis at cervical level. Laminectomy and excision were performed for tumoral conditions

10. Association of surgical procedures and post-operative complications

After the surgical treatment, we recorded 41 (67.2%)

patients with unremarkable postoperative courses and 20 cases of complications (32.8%) including 15 cases (24.6%) of surgical site infections (SSI), 2 cases (3.3%) of fistulas and 3 (4.9%) deaths. The 3 deaths were due to complications of comorbidities. The infection of the site of operation was not significantly related to the different surgical treatments. Patients who received osteosynthesis implants were twice as likely to develop a surgical site infection as those who did not. But the difference was not statistically significant (Table 4).

11. Assessment of ASIA score before and after surgical treatment.

Among 13 ASIA B patients at admission, 8 (61.5%) kept the same score and 5 (38.5%) improved their ASIA score at discharge, of which 2 (40%) by one grade, 2 (40%) by two grades and 1 (20%) by three grades. Eight (63.6%) ASIA C patients at admission improved their discharge score of which 4 (57.1%) by one grade and 4 (57.1%) by two grades. One ASIA C patient (9.1%) moved back one grade and 3 ASIA C patients (27.3%) maintained their admission score. Out of 16 ASIA D patients at admission, 5 (31.2%) kept the same score, 8 (50%) improved the exit ASIA score by one grade and 3 (18.8%) cases moved back in admission score of which 1 (33.3%) by one grade and 2 (66.7%) by two grades. Eighteen (85%) ASIA E patients before surgery kept their score and 3 (15%) moved back, of which 2 (66.7%) by one grade and 1 (33.3%) by three grades. Overall, 40 (67.2%) patients improved their initial ASIA score at discharge and 21 (32.8%) patients either kept their initial ASIA or worsened. The difference in mean ASIA scores before and after surgery was statistically significant (p=<0.001) (Table 5).

Table 5. ASIA score assessment before and after surgery

ASIA admission	Total	ASIA discharge				p-value
		B	C	D	E	
B	13	8	2	2	1	<0,001*
C	12	1	3	4	2	
D	18	2	1	3	12	
E	20	1	0	1	18	
TOTAL	61	12	6	13	30	

* We used the t-test for paired samples

12. Physiotherapy

All patients benefited from rehabilitation sessions by the physical medicine team. This rehabilitation should continue at home or in a rehabilitation centre. Physiotherapy improved the results of the surgical treatment and accelerated the functional recovery.

13. Discharge destination

Patients discharged to home accounted for 90.2% of cases. Two (3.3%) patients continued care in a rehabilitation centre. Three cases of death (4.9%) were recorded and only one patient was transferred to another specialist hospital outside the country.

Discussion

NTMRCs are known as pathologies of the elderly. They are increasing exponentially with the ageing of the world's population and may overtake traumatic spinal cord injuries [4,7]. According to the United Nations, the global population of people aged 65 years or older will triple by 2050 [21]. The average age varies from 48.5 to 67 years, depending on the different study series [4,14]. Our results support these data from the literature. The hospital prevalence of NTMRC (61 cases or 50.8%) was higher than that of traumatic origin (59 cases or 49.2%). The average age was 51±14.21 years. The curve of our series is increasing with a peak of 16 cases in 2021. Non-traumatic medullary-radicular injuries affect both sexes almost equally [22]. For some authors, men are more affected than women [23,24,25] and, for others, it is rather women who suffer more than men [15,26]. In this study, we observed a slight male predominance (51.8%), a sex ratio of 1. Twenty-five (67.2%) patients were married. McKinley et al recorded 57% married [27]. In people aged over 50, the incidence of degenerative and tumoral pathologies increases exponentially [28].

With regard to disc herniations, ageing favours dehydration of the intervertebral discs, disorganisation of the collagen architecture (IV, II, IX) and of the glycosaminoglycans of the nucleus pulposus and the annulus fibrosus. The annulus fibrosus becomes dry, fragile and causes the exit of the nucleus pulposus which compresses the intracanal nerve structures [29]. The increase in degenerative lesions of the spine in elderly women is linked not only to ageing but also to the fall in oestrogenic hormones at the menopause. The intervertebral disc is hormone-sensitive. Estrogens ensure the maintenance of the intervertebral disc

phenotype. Menopause is thought to accelerate the degeneration of intervertebral discs with the loss of their anatomical structure [30,31]. In addition, certain intrarachid tumours, such as meningiomas, are thought to be hormone-dependent in relation to the female sex hormones (oestrogen and progesterone) [32].

Tumors, especially metastases [17], and degenerative pathologies (herniated disc, narrow spinal canal) [9,10,15,33] are among the most frequent causes of NTMRC according to several studies. Our results show a predominance of degenerative diseases (herniated discs and narrow spinal canal, 63.9%) and tumoral diseases (meningiomas and metastases, 22.9%). This differs from previous series published by other researchers that give precedence to infectious pathologies, in particular tuberculosis and HIV/AIDS infection, in sub-Saharan Africa [12,13,14, 34]. Changing lifestyles, cultural mixing and increasing efforts to control the above-mentioned infectious diseases may justify this paradigm shift regarding the causes of NTRMRC in sub-Saharan Africa. Ones et al [35] pointed out that differences in the causes of NTMRC are dependent on social, cultural and genetic differences.

Neurologically, most patients (63.9%) had an incomplete neurological deficit (ASIA: B-D). Muller-Jansen et al [36] and McKinley et al [37] found similar results with all ASIA C-D patients. On further analysis, tumoral and infectious causes (Pott's disease) of NTMRI had a low ASIA score (B and C, 72.7%) and degenerative pathologies a high ASIA score (D-E, 82.05%).

New et al [21] reported a similar admission outcome for degenerative diseases, a high ASIA score (D-E: 65%) and for infections a low ASIA score (A-C: 62.1%).

The neurological manifestation of NTMRC is generally an incomplete neurological deficit [22,23, 37]. This would depend on the non-traumatic pathology itself and the stage of the spinal cord compression. Spinal cord compression of infectious origin and, to a certain extent, that of a tumour are often early and of acute deficits, with an ASIA score that is lower than that of a degenerative origin [38]. In the acute phase, Pott's disease can damage vertebral bodies, discs, and paraspinal soft tissues, resulting in the formation of caseous necrotic tissue, pus, and dead bone, which can enter the spinal canal and rapidly cause mechanical compression of the spinal cord resulting in early low ASIA score paraplegia [39, 40, 41]. Spinal cord compression in tumoral pathologies is usually caused by the collapse of a metastasised vertebral body but can also result from direct extension of the tumour into the spinal canal, mechanically compressing the cord and rapidly deteriorating its function [42]. Degenerative pathologies are much more insidious than the two previous ones, the ASIA score remains high for a long time [37].

Simple laminectomy, laminectomy-discectomy and laminectomy-arthrodesis by posterior approach were the most performed surgical procedures in our department with 26.2%, 24.5% and 32.8% of cases respectively. Similar results were observed by Gaddour et al [15], 39.5% of laminectomy and arthrodesis (16.6%), Dios et al, [43] 57.4% of laminectomy and 42.6% of laminectomy + arthrodesis. The predominance of degenerative pathologies in this study would justify these results.

A simple decompression laminectomy, well performed, a laminectomy-discectomy or a laminectomy-arthrodesis, following the importance of laminectomy levels, constitute sufficient surgical acts in case of radiculo-medullary compression. Furthermore, some studies have not found a significant difference between simple laminectomy and laminectomy-arthrodesis [43].

In general, the rate of surgical site infection for spinal surgery varies from 0.5 to 18.8% [44]. In our series, this rate is high (24.6%). Surgical site infection is not an uncommon complication after spinal surgery, but it remains a serious problem [45]. The important thing is to identify the risk factor and try to eliminate it. In our study, no factor was found to be significantly at risk, although the infection rate was high. Hence the need for a targeted study to identify risk factors for post-spinal surgery SSI. In relation to the three deaths due to comorbidities, it should be noted that comorbidities are described in the medical literature as significant risk factors for mortality after spinal surgery [4,46,47].

Forty-one (67.2%) patients were discharged with an improved ASIA score compared to 22.8% of cases with a stationary ASIA score. When comparing the mean ASIA scores before and after surgery, the relationship was statistically significant ($p=<0.001$). Other authors have also described the effectiveness of well-conducted surgery in improving the ASIA

score. With compressive pathologies, the surgical procedure removes compression and frees the nerve structures, thus favouring the progressive restoration of spinal cord function [38,48].

At the end of the hospital stay, 90.2% of patients went home. Halvorsen et al [49] recorded 73% and New et al 80.5% [22] of patients who returned home after hospital discharge. Once discharged from hospital, many patients prefer to continue outpatient rehabilitation in the family environment. The family atmosphere is said to provide comfort and speed up their recovery. In addition, patients mention the additional care costs of revalidation centres as well as the continuity of hospital isolation. Nevertheless, according to the work of Choi et al [50], the continuation of post-hospital physiotherapy exercises in a rehabilitation centre offers more benefits (e.g. early return to work) than those performed at home.

Strengths and limitations

This study is the first one to provide a general overview of the management of NTMRC in the city of Kinshasa in particular and in the Democratic Republic of the Congo in general. Despite some discrepancies, this work reveals many points of similarity with studies carried out in other countries.

The limitations of this study concern the data collection technique, which was largely retrospective. Some records were missing such as BMI, types of surgical site infections, occupations of some patients, some laboratory tests. The small sample size does not allow us to generalise our conclusions. Some epidemiological aspects are missing because the study was not conducted in the general population, it was based only on data from the Neurosurgery Department.

Conclusion

NTMRCs managed in hospitals are increasing. They are caused more by herniated discs and tumors and affect both sexes indiscriminately. On admission, the majority of patients present an incomplete neurological deficit. Patients with tumours and Pott's disease have a low ASIA score (B-C) while those with degenerative pathology have an ASIA score of D-E. Decompression laminectomy, discectomy and laminectomy-arthrodesis are the most commonly performed surgical procedures. Many patients have a simple postoperative outcome. Surgical site infection remains the major complication and opens new research perspectives to identify a reliable predictive factor. Much work remains to be done to bring patients to revalidation centres.

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Penetrating head injury caused by a screwdriver. A case report

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Abstract

Background: Penetrating head injuries (PHI) caused by sharp objects are associated with a high risk of potentially life-threatening complications and are estimated to account for approximately 0.4% of all head injuries. Since not many cases of PHI with a screwdriver have been described in the literature, the treatment of these patients is quite controversial and non-standardized. Therefore, the aim of this paper was to present our experience with treating a patient with a PHI caused by a screwdriver.

Case description: The authors present a three-year-old female patient who accidentally sustained a PHI with a screwdriver through the right orbit. A computed tomography scan of the head was performed, which demonstrated the presence of the metal end of a screwdriver in the anterior cranial fossa. The patient underwent emergency surgery and the foreign body was evacuated with the repair of dura and brain injury. The intervention was followed by a complete postoperative recovery without any gross neurological deficits. Follow-up examinations were performed up to three years after the injury, while the patient's condition remained unchanged. Our patient's case supports immediate neurosurgical intervention and removal of a foreign object from the endocranium.

Keywords
craniocerebral trauma,
craniotomy,
paediatric brain injury,
penetrating head injury

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Introduction

Penetrating head injuries (PHI) of non-missile origin caused by sharp objects are associated with a high risk of potentially life-threatening complications and are estimated to account for 0.4% of all head injuries (3). Areas with cranial openings and with a thinner bone, such as the orbit and the squamous portion of the temporal bone, are more susceptible to penetrating injuries caused by sharp objects (2). However, these injuries constitute only a small number in the pediatric population and the transorbital localization of PHI has been reported in about 45% of pediatric cases, while it occurs in 25% of adult PHI cases (1,6).

Although penetrating head injuries caused by a screwdriver are rare, these injuries should not be neglected due to the length of the screwdriver and the spiral force, as well as the fact that the metal end of the tool can rotate in the skull and cause serious trauma. Moreover,

the superficial skin wound does not correspond to the severity of intracranial trauma, so the extent of trauma can be easily overlooked (10). These injuries may be accompanied by rare contrecoup lesions and radiating skull fractures, depending on the dimensions of the screwdriver (8).

Since not many cases of PHI with a screwdriver have been described in the literature, the treatment of these patients is quite controversial and non-standardized.

Case report

The authors present a three-year-old female patient who accidentally sustained a PHI with a screwdriver through the right orbit (Figure 1). The patient did not lose consciousness or vomit after the injury. She was previously examined by an ophthalmologist and a pediatric surgeon at the local hospital. During the neurosurgical examination, on admission, the patient was conscious, oriented to time, space and person (Glasgow Coma Scale score of 15), cardiopulmonary stable, without any recorded gross neurological deficits.

Figure 1. The metal part of the screwdriver passes through the medial part of the orbit.

A computed tomography (CT) scan of the head was performed, which demonstrated the presence of a metal end of a screwdriver in the anterior cranial fossa (Figure 2, Figure 3). The CT scan did not detect any vascular or brain parenchyma injuries.

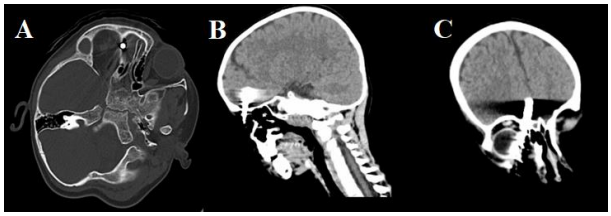

Figure 2. The axial (**A**), sagittal (**B**) and coronal (**C**) CT tomograms demonstrate a metallic foreign body, penetrating the medial wall of the right orbit and partially through the roof of the ipsilateral orbit, with the metal tip extending along the cerebral falx. The brain parenchyma was without evident and detectable injury.

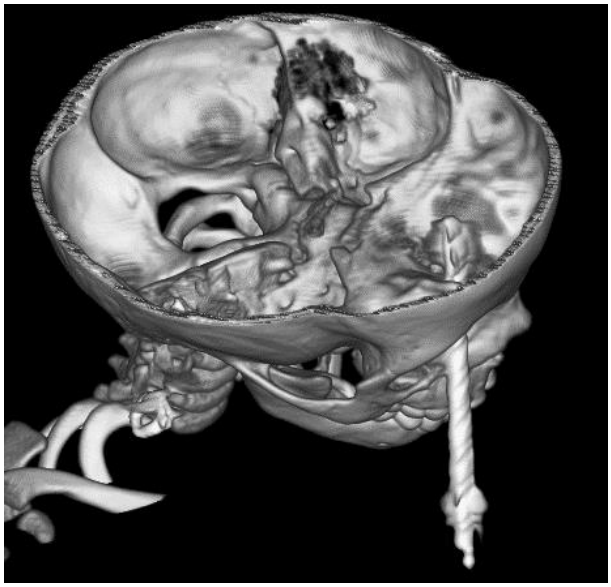

Figure 3. A 3-D CT scan revealed the penetrating injury in the anterior cranial fossa.

After an adequate preoperative examination, the patient underwent an emergency surgery. During the operation, the head was positioned for a pterional craniotomy with little deflection and greater rotation of the head by using the skull fixation device and an arcuate incision was made starting from the projection of the zygomatic arch anterior to the tragus in the length of about 15 cm and behind the hairline area. The dissection of the temporal muscle was done in the interfacial fashion.

Afterwards, the fronto-temporo-sphenoidal craniotomy was performed with the three points of trepanation.

Following an adequate hemostasis and the incision of the dura mater, the prophylactic dural tenting sutures (DTS) were placed through the perforations made along the edges of the pterional craniotomy.

Upon accessing the anterior cranial fossa and the olfactory cistern, a metal end of the screwdriver was encountered, which superficially injured the right olfactory bulb and right gyrus rectus, as well as the right medial frontobasal artery, while the metal tip was extending along the cerebral falx. Moreover, the screwdriver was then removed by pulling the handle outwards, with taking special consideration about the potential twisting of the screwdriver, which must not occur.

Furthermore, the authors managed the superficial injuries of the previously mentioned areas of the brain tissue and blood vessels with the use of regenerated oxidised cellulose (Surgicel®).

A penetrating bone defect was irrigated with hydrogen peroxide and normal saline profusely.
The dura mater was repaired with simple interrupted absorbable vicryl sutures and collagen-based dural graft (DuraGen®), an epidural drain was placed, while the bony lid was returned with titanium plates.

The patient was treated with dual antibiotic therapy (Ceftriaxone in the dose of 750 mg once a day and Metronidazole in the dose of 100mg three times a day) as well as with prophylactic anticonvulsant therapy (Levetiracetam-oral solution in the dose of 150mg twice a day). Both tetanus toxoid and tetanus immunoglobulin were administered due to the unknown immunization status of the patient.

The intervention was followed by a complete postoperative recovery without any gross neurological deficits. Follow-up examinations were performed up to three years after the injury, while the patient's condition remained unchanged.

Discussion

Due to the lack of adequate recommendations in the scientific literature, insufficient retrospective data collection, as well as described complications arising from such a rare mechanism of injury, there is no consensus on the adequate treatment of patients with PHI with a screwdriver. Although head CT indicated that there was no injury to brain and vascular structures, non-operative screwdriver extraction was initially rejected due to the possibility of injuring numerous structures of the brain base as well as the formation of a cerebrospinal fluid fistula.

Depending on the characteristics and dimensions of the screwdriver, whether the screwdriver has a larger or smaller cross-sectional area of the tip, taking into account the sharpness of the tip and the applied stabbing force, these objects make a disproportionately small skin stab wound in comparison to the injuries of the intracranial structures they cause (8).

Our patient reportedly tripped and fell head first on the tip of a screwdriver, sustaining a penetrating injury through the right orbit. Although the gold standard in the diagnostic assessment of these patients is brain CT with CT angiography if blood vessels injury is suspected (7), no brain injuries were reported on the brain CT, while superficial brain lesions were determined during the operation.

The most common complications of these injuries are vascular injuries, which occur in 19% of patients, and often in the form of pseudoaneurysms (46%) and cutting of blood vessels (32%), and therefore require treatment (5).

After a penetrating brain injury occurs, thromboplastin is released, which promotes blood coagulation, while on the other hand, intracerebral bleeding can occur as well. Disseminated intravascular coagulation, acute respiratory distress syndrome and neurogenic pulmonary edema may develop. If the screwdriver is not surgically removed 48 hours after injury, the chance of acquiring meningitis and brain abscess increases from 4.6% to 36.5% (8,9). For those reasons, the authors decided on an urgent operation and removal of the screwdriver from the anterior cranial fossa with preventive irrigation of the operative field and administration of dual antibiotic therapy.

Moreover, about 50% of these patients develop a late post-traumatic epilepsy (8,9). Consequently, we decided on convulsion prophylaxis for a year, and the patient has not experienced any form of convulsions to this day.

Although when deciding on a surgical approach, one could opt for the right frontal approach, the right subfrontal approach and other approaches (3), we decided on the pterional approach because it allowed us to see all the structures affected by the injury and enabled the repair of the dura mater lesion. Aesthetic reasons also played a role as most

of the scar would be covered by hair after the wound had healed.

The use of DTS in hemostasis is an important technique, which can lead to unnecessary complications if they are placed before opening of the dura. In elderly patients, subdural hygromas may occur after placement of DTS (4). We decided therefore to place DTS after opening the dura and visualizing the brain tissue through a microscope.

Conclusion

In conclusion, this is a very peculiar case of a PHI with a screwdriver, while the authors of this paper have not found a similar case described in the literature. It is necessary to make an adequate diagnosis as soon as possible and urgently surgically evacuate the screwdriver from the endocranium with adequate medical therapy in order to prevent possible complications.

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Ventriculoperitoneal shunt surgery in a Nigerian city. A single institutional experience

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Keywords
ventriculoperitoneal shunt, hydrocephalus, paediatric hydrocephalus

ABSTRACT

Introduction. Improvements in surgical techniques and advancements in antibiotic management have significantly reduced the complications associated with Ventriculoperitoneal Shunting which is still the most common procedure for the treatment of hydrocephalus. These complications are believed to be highest in Low and middle-income countries due to delayed presentation to care facilities. The authors report our experience of managing paediatric hydrocephalus in an institution with evolving Neurosurgical practice in North Central Nigeria.

Material and methods. We retrospectively reviewed all cases of VP shunting from 2011 to 2018 taking into consideration the demographics, aetiologies of hydrocephalus, length of hospital stay, postoperative morbidity and mortality, and overall outcome. Complications sought included, Surgical Site infections, shunt exposure, obstruction or any other cause of shunt malfunction. The minimum follow-up period was 24 months

Results. There were 27 VPS procedures done in 25 patients of whom 15 were males and 10 females (M:F ratio of 1.5:1). The age range was 8 days to 9 years with a median age of 5 months. Of the 25 cases, 24 (96%) were non-tumoral in origin comprising 17 congenital and 7 acquired hydrocephalus. At 2 years post shunt insertion, 21 (84%) of the 25 initial cases were still functional. The total complication rate was 28%, comprising Surgical Site infection, shunt exposure, shunt obstruction, seizure, and one death, There were 3 (12%) shunt failures from shunt obstruction (2) and shunt exposure (1).

Conclusion

With meticulous control of the surgical environment and improved experience in ventriculoperitoneal shunting, the complication rate can be significantly reduced. There is a need to increase the awareness of the population to the availability of care for seemingly hopeless conditions. The burden of the cost of care on individuals should be lightened through better health insurance coverage.

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Introduction

Hydrocephalus is one of the most common clinical conditions affecting children in Neurological surgery. Ventriculoperitoneal (VP) shunt placement is the mainstay of treatment for hydrocephalus in both adult and paediatric patients.(1, 2) Hydrocephalus accounts for over 69,000 hospital admissions and over 30,000 procedures performed every year in the United States.(3-7) with failure rates of 30–40% at 1 year and approximately 50% at 2 years in pediatric patients.(8) Some recent studies report a relatively lower rate of shunt failure.(1, 9, 10) It is believed that VP shunting complications are highest in Africa and other developing countries.(11) This is not unconnected with delayed presentation to care facilities as a result of poverty, ignorance and other socio-cultural factors.

Hereby, we report our experience of managing pediatric hydrocephalus in an institution with evolving Neurosurgical practice in North Central Nigeria.

Materials and method

The authors present a three-year-old female patient who accidentally sustained a PHI with a screwdriver through the right orbit (Figure 1). The patient did not lose consciousness or vomit after the injury. She was previously examined by an ophthalmologist and a pediatric surgeon at the local hospital. During the neurosurgical examination, on admission, the patient was conscious, oriented to time, space and person (Glasgow Coma Scale score of 15), cardiopulmonary stable, without any recorded gross neurological deficits.

Results

Demographics

There were 27 VPS procedures done in 25 patients of whom 15 were males and 10 females with a male-female ratio of 1.5:1. The age range was 8 days to 9 years with a mean age of 1.2 years and a median of 5 months. All patients had clinical features of hydrocephalus and confirmation was made with diagnostic Scan. The Occipito-Frontal circumference ranged betwwn 39cm to 65cm. All patients were treated with CChabra Slit and Spring Shunt. Length of post-operative hospital stay was 3 days to 16 days with a mean duration of 9.2 days.

Aetiology of hydrocephalus

Of the 25 cases of hydrocephalus, 24 (96%) were non-tumoral in origin with only one case (4%) caused by posterior fossa tumour in a 9 year-old child, who coincidentally is the oldest patient in this series.

Seventeen (68%) of the 25 cases were congenital in origin, comprising of Aqueductal stenosis (11), Arnold-Chiari Malformation (4) and Dandy-Walker malformation (2). The major cause of Acquired hydrocephalus was post-meningitic (5 of 8). There were 2 cases of Aqueductal stenosis with no history of infection. (Table 1b)

Table 1. Demographic profile of hydrocephalus

Variables (Total Number N=25)	Frequency (%)
A)	
Males	15 (60)
Females	10 (40)
B)	
Congenital	**17 (68)**
a) Aqueductal stenosis	11 (44)
b) Arnorld-Chiari Malformation	4 (16)
c) Dandy-Walker malformation	2 (8)
Acquired	**8 (32)**
a) Post-infective	5 (20)
b) Aqueductal Stenosis	2 (8)
c) Post fossa Tumor	1 (4)
C) Diagnostic Imaging	
MRI	6 (24)
CT Scan	17 (68)
TFUS	2 (8)

Diagnostic Imaging

Diagnosis was made in 17 cases (68%) with Computerized Tomographic (CT) scan. Magnetic Resonance Imaging (MRI) was deployed in 6 (24%) while Trans-fontanel Ultrasonographic Scan (TFUSS) was used in 2 (8%) patients (Table 1c)

Outcome

At 2-year post shunt insertion, 21 (84%) of the 25 initial cases were still functional. There were 3 (12%) shunt failures from shunt obstruction (2) and shunt exposure (1). Two of the shunt failures were revised. There was one post-operative death (4%).

There were 3 (12%) cases of surgical site infection (SSI) at the scalp region noted in the first week post-operative period, all of which grew Staphylococcus

aureus that was treated with Amikacin and Rifampicin. One of the cases of SSI led to shunt exposure which was promptly removed but the parents declined revision surgery and requested discharge from the facility. The child was lost to follow-up. One patient (4%) died on the third post-operative day accounting for the shortest period of hospital stay. Permission for autopsy was not granted by the parents. One patient developed seizure disorder post op.

Whereas shunt complication was seen in 28% of all patients, only 12% required shunt revision (Table 2). The other 2 cases of shunt failure were marked by increasing head circumference and reduced activities. These occurred within 6 months of the surgery. Shunt was promptly revised and the cause of failure was determined in both cases to be obstruction of the ventricular catheter by debris. These two patients have remained clinically stable.

Table 2. Outcome and complications of Ventriculoperitoneal Shunting
(*one case of SSI led to shunt exposure)

a) Summary of Outcome (n=25)	**Frequency (%)**	**Comments**
Favourable outcome	21 (84)	satisfactory
Poor outcome	4 (16)	3 failed, 1 died
a. Complications (7 of 25)	**Frequency (%)**	**Comments**
Surgical Site Infection (SSI)*	3 (12)	Antibiotics
Shunt Exposure*	1 (4)	Declined Treatment
Shunt Obstruction	2 (8)	Revised
Seizure	1 (4)	Anticonvulsant
Death	1 (4)	Post-op day 3

Discussion

Ventriculoperitoneal shunting remains the mainstay for treatment of hydrocephalus despite recent advances in neurological surgery practice. (1-3)

In this study the age range was between 8 days to 9years with a median of 5 months. Ninety two percent of the patients were below the age of 1 year and it is mainly caused by congenital anomalies. Hydrocephalus is predominantly a disease of infants and this is a common finding in Sub-Saharan Africa. (6, 11-15)

The male to female ratio of 1.5:1 is in keeping with the male preponderance noted in many studies. (6, 12-14, 16)

The occiptofrontal circumference (OFC) ranged from 39cm to 65cm. Increase in the OFC is the commonest sign of hydrocephalus seen in infants.(17) Grotesque head enlargement is common in underdeveloped countries due to late presentation and head circumference greater than 60cm is associated with higher rates of shunt failure.(11)

About 70% of the cases of hydrocephalus were congenital with Acqueductal stenosis being the commonest cause. (Table 1b) This is at variance with some of the studies cited (11, 12, 14-16, 18) and the reason may be partly related to volume of the study population. The other reasons may be geographical in nature. Many mothers who had infection during pregnancy in rural areas may not have been adequately looked after, thereby increasing the risk of maternal-to-fetal transmission. Neural tube defects (Arnold-Chiari Malformations with Spina bifida, and congenital posterior fossa anomalies) are still a challenge in low-income communities where adherence to Folic acid supplementation is sub-optimal.(15, 19)

The preferred imaging modality is MRI but this was used in only 24% of patients (Table 1c). CT scan was the most commonly used imaging modality in this study because of affordability. Transfontanel Ultrasonography has been used very frequently is our region for the similar reasons.(20, 21)

The overall complication rate in this series was 28%. (Table 2) The commonly reported incidence of complication is between 20 to 40%(10) though there are reported failures as high as 85%.(6) The incidence has reduced in more recent publications. The infection rate was 12% in this study. This is similar to the rate recorded by Yusuf et al(13) in an earlier study though they had a relatively higher volume in their series. The weighted average shunt infection rate across multiple studies is about 5.1% but could be as high as 39% in some studies.(18, 22-28) Staphylococcus aureus is one of the most implicated bacterial organisms in shunt infections.(29) Shunt infection has been reduced with advent of newer techniques including double gloving, prophylactic antibiotics and antibiotic-impregnated shunts (commonly with Rifampicin and Clindamycin)(30) Most of the shunts used in developing countries are fixed-pressure types of shunt; antibiotic-impregnated shunts are not affordable to most patients in underdeveloped countries where the

citizens are not adequately covered by health insurance and health care is paid on out-of-pocket basis.(20, 21) Other established factors that influence the shunt infection rate are the age of the patients, aetiology of the hydrocephalus, operating room settings to prevent infection, total operating time and experience of the surgeon.(26) Sharing the experience of the senior author in center with large volume has helped to cut down shunt failure rates in the country.

There were 3 (12%) failed shunts though 2 (8%) shunt revision surgeries were done in this study. One was caused by infection, while the other two were caused by shunt obstruction. The incidence of shunt failure is commonly seen in children younger than 6 months and often noticed within the first month of shunt placement.(18, 31)

Seizure was seen in one patient in our series, accounting for 4% and this was controlled with anticonvulsant. Seizure is a known complication of VP shunting accounting for 48%. It is believed that seizure is not due to direct placement of the VP shunt but to the underlying neurologic disorder.(32)

One patient (4%) died in the first week following VP shunt placement. The cause of death could not be determined because the parents declined postmortem. The shunt-related mortality has been reported to be 3.4% to 13.7%.(13, 33).

Though Endoscopic third Ventriculostomy is available in the country as shown in many studies, (13, 14, 16) this facility is not available in our center at the time of this study. It is expected that the face of hydrocephalus treatment will improve as soon as this is done.

Conclusion

With meticulous control of the surgical environment and improved experience in ventriculoperitoneal shunting, the complication rate can be significantly reduced. There is need to increase the awareness of the population to the availability of care for seeming hopeless conditions. The burden of the cost of care on individuals should be lightened through better health insurance coverage.

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Deep motor cortex cavernoma resection supported by navigational intraoperative monitoring. A case report

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Keywords
trans-sulcal approach, ultrasonography neuronavigation, intra-operative neurophysiological monitoring, cortical motor map, motor cortex cavernoma

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ABSTRACT

Introduction: Cavernomas are benign hamartomas of cerebral and spinal vessels, accounting for less than 1% of all arteriovenous malformations. In general, surgical resection is the treatment of choice for enlarging cavernomas or those associated with medically refractory seizures. Herein, we report a case of an enlarged deep precentral gyrus cavernoma, with a discussion of the surgical approach and the impact of intra-operative neurophysiological monitoring on the preservation of motor function.

Case description: A 30-year-old male was referred to our hospital due to 2-month history of focal seizures. Initial magnetic resonance imaging revealed right precentral cavernoma with minimal right parietal subarachnoid haemorrhage. Revealed the location of the cavernoma deep in the right primary motor cortex. Surgery was performed, trans-sulcal dissection was done with the aid of intraoperative ultrasonography neuro-navigation. The cortical motor map was localized by functional mapping with intra-operative neurophysiological monitoring, including somatosensory evoked potentials (SEP) and motor evoked potentials (MEP). Post-operatively, the left side weakness grade was 4/5, and the Glasgow coma scale was 15. Postoperative imaging confirmed successful resection of the cavernoma and associated hemosiderin ring with no SAH.

Conclusion: The use of preoperative MRI and intraoperative ultrasonography supplemented by neurophysiological monitoring utilizing SEP, MEP, and cortical mapping is essential for the safe resection of paracentral cavernomas.

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INTRODUCTION

Cavernomas are benign hamartoma of cerebral and spinal vessels. Its prevalence ranges from 0.1% to 0.8% in the recent literature, accounting for 8-15% of cerebral and spinal arteriovenous

malformations. Their formation is related to gene mutations such as CCM1, CCM2, and CCM3, which can occur in hereditary and sporadic forms [5]. They commonly comprise different presentation hemorrhages and calcifications according to age [6]. Intracerebral hemorrhage occurs in 30% of cases as the initial complication, leading to the frequently encountered presentation, seizures, and other neurological deficits [2,9].

Cavernomas can be managed conservatively; surgical resection is the treatment of choice for enlarging cavernomas or those associated with medically refractory seizures [7]. Paracentral Cavernomas are quite challenging cerebrovascular pathological entities owing to the prospects of their surgical resection without adversely affecting the eloquent areas around the central sulcus. Particularly in deep and subcortical cavernomas, wherein it is demanding to localize and excise. Following dissection, immediate impairment in sensory and motor activity may ensue. As such, direct electrical cortical stimulation (DES) for cortical somatosensory and motor mapping is an integral part of surgeries with such lesions to preserve function [12,13].

Herein, we report a case of a 30-year-old male who suffered from a 2-month history of focal seizures caused by an enlarged deep precentral gyrus cavernoma. We discuss the surgical approach and the impact of intra-operative neurophysiological monitoring on the preservation of motor function.

Case scenario

A 30-year-old male was referred to our hospital due to 2-month history of focal seizures. Initial magnetic resonance imaging (MRI) revealed right precentral cavernoma with minimal right parietal subarachnoid haemorrhage (SAH). The patient was advised to take a single session of stereotactic radiosurgery, but the lesion increased in size in spite.

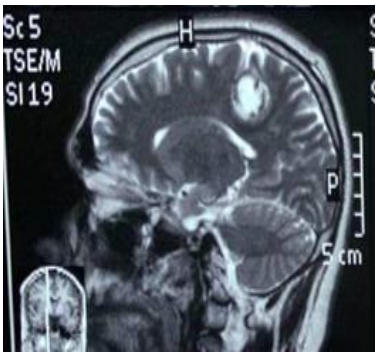

Figure 1. A: Pre-operative sagittal T2-weighted MRI, reveals the location of the cavernoma deep to the precentral gyrus (primary motor cortex).

B: Pre-operative axial MRA, views the relation between the cavernoma and the cerebral vasculature

Pre-operative MRI (Fig.1) revealed the location of the cavernoma deep in the right primary motor cortex. Surgery was performed, trans-sulcal dissection was done with the aid of intraoperative ultrasonography neuro-navigation (Fig.2). The cortical motor map was localized by functional mapping with intra-operative neurophysiological monitoring (IONM), including somatosensory evoked potentials (SEP) and motor evoked potentials (MEP). As the lesion was deep to the precentral gyrus, DES – bipolar mode (Fig.3) identified the face motor area. The area with the lesser corresponding facial motor activity was chosen to start trans-sulcal dissection. Complete resection of the cavernoma with the surrounding epileptogenic hemosiderin ring was achieved with preservation of the eloquent motor area.

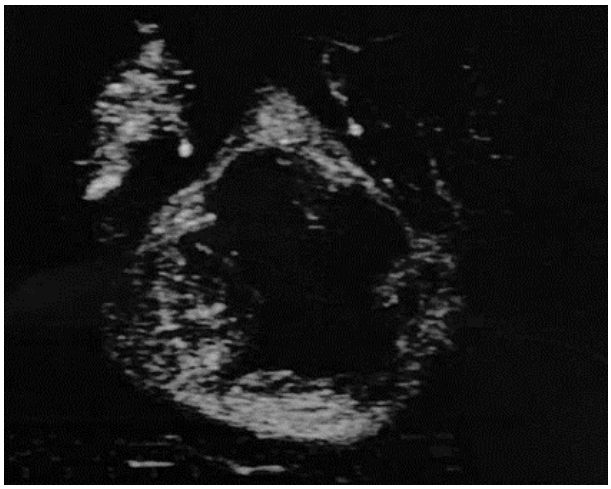

Figure 2. Intra-operative ultrasonography neuro-navigation showing the exact localization of deep motor cortex cavernoma.

Post-operatively, the patient had a seizure due to DES during neuro-navigation and left side weakness grade 4/5, which improved gradually 3 hours later. Glasgow coma scale was 15 (E4V5M6. A postoperative CT scan (Fig.4) confirmed successful

resection of the cavernoma and associated hemosiderin ring with no SAH.

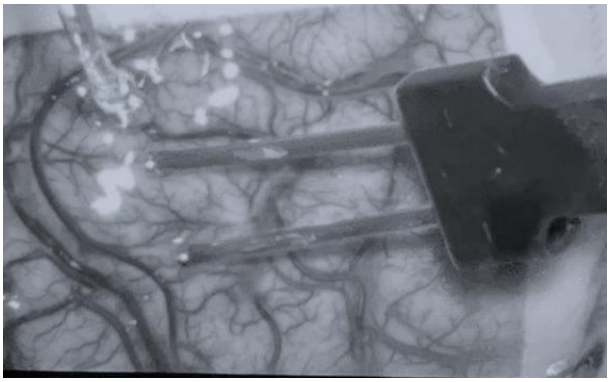

Figure 3. Intra-operative image through the right parietal approach, supine position, direct cortical stimulation – (Penfield method) bipolar mode for motor mapping.

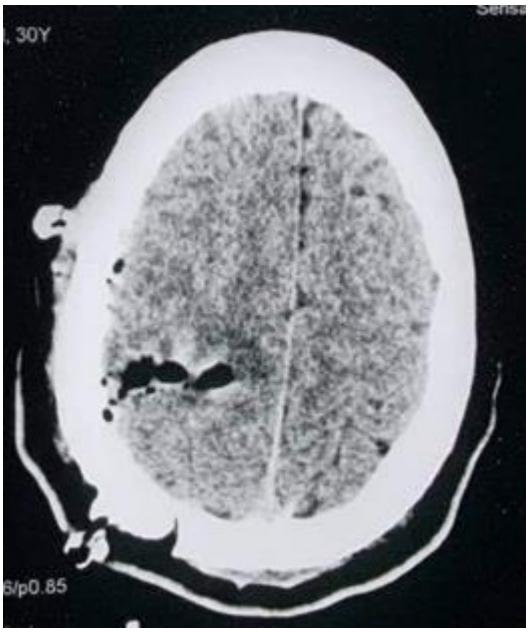

Figure 4. Postoperative axial CT scan, showing the complete resection of the cavernoma

Discussion

Paracentral cavernomas signify a significant challenge to the neurosurgeon, owing to the high risk of complications following its excision, especially in deep and small subcortical lesions, as it involves eloquent areas. Microsurgical operation for symptomatic cavernoma is the management of choice to reduce the frequency of seizures and alleviate the mass effect. But the risk of bleeding, and severe neurological deficits, make this decision difficult. Surgical removal can result in abrupt cortical damage and consequent sensory and motor function deterioration. Therefore, it is crucial to precisely recognize the anatomical landmarks preoperatively and intraoperatively to preserve vital structures, which can be achieved by the appropriate application of neurophysiological monitoring. In this report, successful removal of precentral cavernoma was accomplished through four vital components; meticulous identification of the lesion, accurate evaluation of motor function, minimally invasive trans-sulcal dissection, and optimal removal of the lesion with the surrounding hemosiderin tissue.

Epileptic seizures represent the most periodic symptom of patients with cavernoma. Deep cavernomas have a higher risk of hemorrhage than superficial ones, the blood by-products like iron precipitate in the vicinity of the lesion as hemosiderin stain ring with high epileptogenic latency. This makes the complete removal of the lesion insufficient for patients with epileptic seizures unless the stained tissue is excised. However, the intraoperative surgical decision depends on accounting for all possible complications and postoperative outcomes considering the eloquent area preservation a priority [8].

The trans-sulcal dissection is a harmless and applicable approach to target deep-seated cerebral lesions. It provides pursuing the natural aisles of the brain, the sulci, to obtain better exposure to the lesion and enough dissection depth. Dispensing brain retraction by dissecting the normal brain pathways is safer for gyral layers and confers motor function preservation. No serious complications of the trans-sulcal approach are reported especially with pre-operative MRI, IONM, intraoperative neuronavigation, and brain mapping [3].

Pre-operative CT scan demonstrates a typical hyperdense lesion in the right motor cortex and precentral gyrus around the omega sign of the central sulcus. MRI revealed a focal heterogeneous hyperintensity area deep in the right parietal lobe with a low signal intensity peripheral ring indicating a bleeding episode. Intraoperatively, exact localization was confirmed by intraoperative ultrasonography neuro-navigation; this assisted image guidance is believed to decrease morbidity. It can overcome intraoperative cerebrospinal fluid loss and cortical shifting, improving the neuro-navigation accuracy [10,11]. Proposed direct cortical stimulation by a bipolar handheld probe (Penfield Method) with

a setting of 50 Hz frequency, 5-10 mA current intensity, and 0.3-1 msec pulse duration. Cortical motor mapping was achieved by defining the central sulcus, stimulating the precentral gyrus, and localization of the primary motor cortex (Brodmann area 4) [1]. The area with the lowest face motor function was chosen to start the dissection. Pavia et al. reported that the complementary use of cortical motor mapping by DES and neuronavigation are the gold standards in deep lesions resection [8].

After using intraoperative ultrasonography neuro-navigation to visualize the position of the cavernoma, trans-sulcal dissection started by separating cortical vessels and dissecting through the central sulcus – peri omega sign of the right frontal lobe reaching 3 cm trans-sulcal depth (Fig. 5) [4]. Gross excision of the cavernoma with the associated epileptogenic hemosiderin ring was achieved. IONM confirmed intact limb movement after recording multiple responses from abductor pollicis brevis in the upper limbs and abductor hallucis in the lower limbs. Postoperative assessment of functional impairment was calculated by the karnofsky performance status scale (100 scores). Postoperative observation at the Intensive Care Unit for 24 hours and routine postoperative CT with regular follow-up was done.

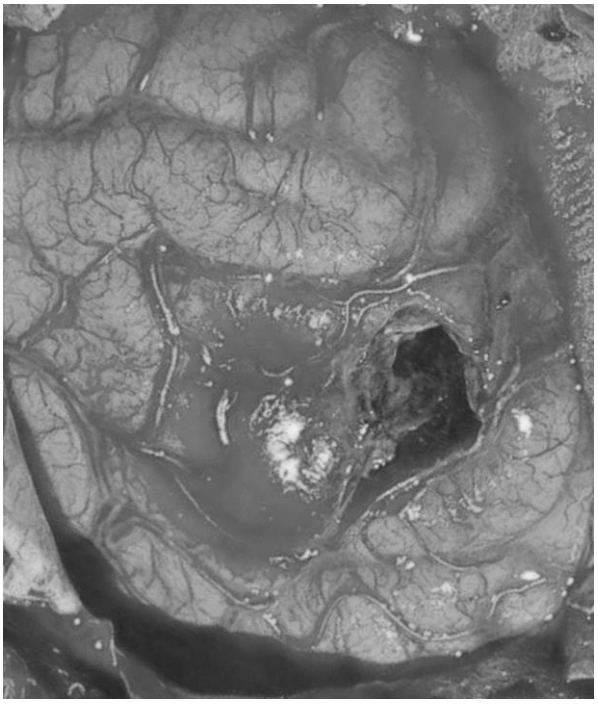

Figure 5. Intra-operative image shows the depth of the trans-sulcal dissection

The supplementary use of preoperative MRI and intraoperative ultrasonography and IONM using SEP, MEP, and cortical mapping is crucial to ensure safe excision of the lesion with preservation of the eloquent area. A trans-sulcal approach based on anatomical and neurophysiological data can provide safe and minimally invasive dissection for removing deep paracentral lesions with the surrounding hemosiderin tissue.

Conclusion

In this report, complimentary preoperative MRI and intraoperative ultrasonography supplemented by neurophysiological monitoring using SEP, MEP, and cortical mapping is essential for precise identification of paracentral cavernomas, to discern ominous signs, and to avoid traumatizing the eloquent area.

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Tangential gunshot wound to the head. A case report with review of literature

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Keywords
tangential gunshot wound,
head,
skull,
ICH

ABSTRACT

Introduction. Tangential gunshot wounds (TGSW) to the head is the high-velocity bullet that does not penetrate the cranium but passes through the tissue adjoining the cranial cavity, creating a "gutter" wound and indirectly causing cerebral injury. This article presents a reporting case of TGSW to the head, discusses the mechanism underlying this traumatic injury and the possible complications resulting from it, and reviews of literature.

Case description. A thirteen-year-old schoolboy was admitted to the emergency department (ER) of the neurosurgery teaching hospital in Baghdad, Iraq, with a tangential gunshot to the head of an unknown source during civilian protests in Baghdad. In addition to a seizure attack in the ER, his Glasgow coma (GCS) scale was 13 initially. The computed tomography showed multiple bilateral brain contusions, interhemispheric haemorrhage, partially depressed fracture of the frontal bone midline, and a Paramedian to the left with a significantly depressed skull fracture. Then, an urgent decompressive craniectomy was performed. The postoperative course was uneventful, with rapid improvement in GCS of 15 one hour after surgery. On the six-month follow-up, the patient reported no further attacks of seizure.

Conclusion. TGSWs are associated with good GCS and favourable prognosis in most cases unless the patient has been deteriorating or has an associated ICH. Moreover, in our case, the history taking, mechanism of the injury, rapid evolution, and radiological imaging have an essential effect on the outcome.

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INTRODUCTION

Gunshot injuries to the head represent a driving cause of 6,000 deaths in the United States annually [17]. The majority of all these injuries are deadly, as two-thirds of them die immediately [10]. Tangential gunshot wounds (TGSW) to the head were first described by Sir Geo H. Makins, a British surgeon involved in the army from 1899-1902 [5,9]. Moreover,

In TGSW to the head, the high-velocity bullet does not penetrate the cranium. However, it passes through the tissue adjoining the cranial cavity, creating a "gutter" wound and indirectly causing cerebral injury [5]. The absence of intracranial metallic parts of the bullet gives the possibility of a single entry-exit wound in the form of a continuous abrasion, and the presence of underlying intracranial damage on radiological evaluation without direct penetration by the missile is the most characteristics of TGSWs. Furthermore, TGSWs usually present with multiple degrees of brain contusion with or without skull fractures, which, if present, can sometimes contain in-driven bone parts, with or without evidence of skull fracture in imaging studies [5]. This article presents an illustrative case of TGSW to the head, discusses the mechanism underlying this traumatic injury and its possible complications, and reviews the literature.

Case scenario

A thirteen-year-old schoolboy was admitted to the emergency department of the neurosurgery teaching hospital in Baghdad, Iraq, with a tangential gunshot to the head of an unknown source during civilian protests in Baghdad. The patient underwent a primary survey and was immediately sent to take a computed tomography (CT) scan. However, he was aware of the time, place, and date, but he and his escort could not remember the way of the injury. On examination, a grazing head wound was recognized alongside a depressed fracture of the right frontal part of the head with no CSF leak. In addition, the patient was fully conscious and aware, obeying commands with a Glasgow coma score (GCS) of 15, and no further findings were noticed on neurological examination.

Along with wound cleaning, the bone fragments were removed, and the patient was kept under observation. After one hour, his condition began to deteriorate, becoming drowsy with a GCS of 13 (eye-opening 4, verbal response 3, and motor response 6). The patient developed multiple attacks of tonic-clonic seizures. Besides, an urgent non-contrast CT scan of the brain revealed multiple bilateral brain contusions and interhemispheric hemorrhage (figure 1. A) and partial depressed fracture of the frontal bone midline, and a Paramedian to the left with a significant depressed skull fracture (figure 1. B). He received prophylactic antiepileptic drugs to control the attacks of seizures and prepare for urgent decompressive craniectomy to restrain rising intracranial pressure and relieve brain swelling. The underlying dura was intact, and no intraoperative complications were encountered. Postoperatively the patient rapidly improved with a GCS of 15 one hour after surgery. The patient was discharged one week later with no seizures reported during hospitalization. The patient reported no further seizure attacks during the six-month follow-up appointment, and the radiological evaluation did not show any new abnormalities.

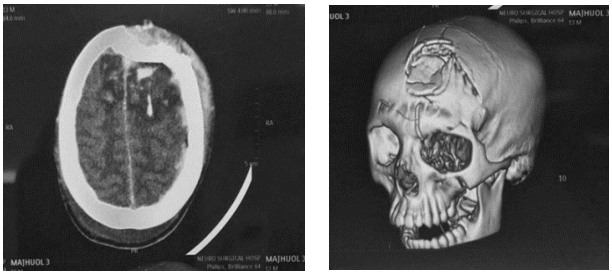

Figure 1. A: non-contrast CT scan shows an axial section of the brain and bone window Showing depressed left frontal skull fracture with underlying multiple bilateral brain contusion and interhemispheric hemorrhage, **B**: 3D reconstruction brain CT scan showing partial depressed fracture of the frontal bone midline and Paramedian to the left with multiple Comminution reveals the presence of significant depressed skull fracture.

Discussion

Gunshot head injuries are the second leading cause of post-traumatic mortality in the United States [12]. They are categorized into perforating, penetrating, and tangential injuries with different mechanisms and prognoses [5]. However, the TGSW of the head represents a moderate-severe blunt injury with a high-velocity missile that does not penetrate the cranial cavity with/without intracranial damages [1,10,17].

The penetrating gunshot wound (PGSW) has no meaningful differences according to age and education from the TGSWs to make them demographically comparable [15]. However, there is little difference between these two groups. PGSW holds high severity compared with TGSW as the PGSW mortality rate is equal to 78% compared with TGSWs, which are approximately 18% [6,12]. Although Hotz GA et al. found in their study that the duration of hospitalization was longer in PGSW than in TGSW, they both have a significant neurological deficit. Furthermore, it is necessary to mention that

if the patient survives the severe stage, which has a higher incidence in the PGSW, they will have the same prognosis [12,14].

Patients with TGSWs commonly present with a good GCS ranged from13 to 15 in most cases with loss of consciousness which is relatively uncommon [1,6,7,14]. Moreover, in typical cases, the bullet does not breach the skull, and no significant fracture is present. Furthermore, there is a considerable force directed into the brain that has the potential of causing brain pathologies such as intracranial hematoma (ICH) and cerebral contusions which result from disrupted vessels that following the primary damage, site of hematoma related to site TGSWs can be temporal, parietal or posterior fossa [1,4,8,16]. On the other hand, some cases may present with forced depressed fracture and tissue loss according to the distance and the missile velocity. In both of the previous presenting categories, many cases are associated with a neurological deficit that requires rehabilitation facilities [7,8].In contrast, the presentation can be only a foot drop as Atac et al. [3].

It should be noted that the severity and the prognosis of each patient depend on several factors; the type of the used gun, the velocity of the bullet, and the distance from the target, which is demonstrated clearly in I. B. COPLEY et al. report. Accordingly, a very high-velocity missile passes through the adjacent tissue and produces brain damage without penetrating it, while low velocity is associated with tissue loss [1,4]. Also, the injured area has a special role anatomically, as ADELOY et al. demonstrate the association between the TGSWs in the frontoparietal areas of the brain and the features of "longitudinal sinus syndrome" which is a misnomer since the main underlying cause is a cortical injury in which patients presented with limbs paresis and also a cortical form of sensory impairment was noted without venous any occlusion or thrombosis (8, 14).

Consequently, in the emergency department, the initial management goes with immediate resuscitation and urgent brain CT scan. Prophylactic antibiotics and antiepileptic drugs have a unique role in the management. Besides that, repeated neurological assessment and radiological imaging are very important [4,14]. It is essential to mention that history taking in such injuries is the mechanism; the rapid evolution and management play a crucial role in the outcome and prognosis of such patients. Moreover, the prognosis is also affected by the presence or absence of depressed fracture and intracranial hemorrhages such as subdural (SDH), epidural hematoma (EDH), traumatic SAH, and ICH [13].

However, Anglin D et al. found that approximately 25% of patients with TGSW have ICH. That means there is a case of ICH in every four cases of TGSW. Many authors try to generate criteria to predict the presence of ICH along with TGSW, but obviously, no clear association is stated. However, if the patient present with one or more of the following conditions along with TGSW, he will have an increased risk of developing ICH. The condition is; GCS less than 15 on a presentation or/and if he has a history of a loss of consciousness [4,7,13,14].

According to the mentioned findings, if there is no intracranial pathology, a 12-24h repeated CT scan is a must; as stone et al. demonstrate in their study, a late ICH in some cases could be present [1,3,4]. While if there is any acute brain pathology, the time should be less, and the repeated scan should be done in 6h or less if there is any change during the neurological assessment [4]. The line of management and treatment depends on patient status and associated risk. To a much lesser extent, if the patient is alert and oriented about the time and the place, non-operative management with prophylactic antibiotics and antiepileptic are preferable besides wound cleaning and debridement [1,14]. While in more severe cases with a significant hemorrhage that needs an urgent decompression, surgery will be an option [4,16].

Accordingly, In our case, the patient was fully conscious with 15 GCS, then deteriorated to 13 with multiple seizure attacks. The urgent scan show findings necessitate operative management. A craniectomy managed the patient with an elevation of depressed fracture; the superior sagittal sinus (SSS) was intact intraoperatively. In addition, the operation went well without complications, and no neurological deficits were documented in the follow-up period.

In general, the overall prognosis in the TGSWs is good; Özkan Ü et al. found in their study that's nearly 60% of patients achieve a good prognosis while the mortality rate less than 19% in other studies, according to the previously mentioned factors and the severity of such cases [1].

Without a doubt, we highlight the importance of the history taking in such injures, the mechanism of the injury, the immediate evolution and management and its effect on the outcome.

Conclusion

TGSWs are associated with good GCS and favorable prognosis in 60% of cases unless the patient has been deteriorating or has an associated ICH.

Moreover, in our report, the history taking, mechanism of the injury, the immediate evolution, and radiological imaging have an important effect on the outcome. Furthermore, the management line and treatment are individualized and dependable on the patient's status and the associated risk factors. All Patients of TGSWs need close observation in a medical facility for at least the first 24 hours post-trauma.

Table 1 Literature review for Tangential gunshot wound to the head (Case Series)

No	Authors	Year of publication	Number of cases	Insinuation	Major finding
1	**Adeloye A** [8]	1971	6	Nigeria	Fronto-praitial region of the brain is most likely associated with superior sagittal sinus syndrome
2	**Copley, I. B.** [1]	1991	27	Southern Africa	1- Mortality =18.5% 2- Tangential bullets (especially high velocity) are associated with considerable brain damage, and their effect may delay from a few hours to days 3- Brain damage can occur in the absence of a skull fracture 4- fracture of the inner table may go unnoticed.
3	**Anglin D** [13]	1998	240	Los Angeles County + University of Southern California Medical Center	1- 25% of all patients With TGSWs to the head had ICHs. 2- There is a higher risk of having ICH if the patient has GCS < 15 on presentation or/and a history of a loss of consciousness.
4	**Hotz GA** [12]	2000	11	USA	1- penetrating gunshot wound is a more severe and costly injury than a T-GSW to the head 2- TGSW possesses significant deficits, and, if the patient survives past the acute phase of recovery 3- TGSW has less length of stay compared with penetrating gunshot wounds.
5	**Özkan Ü** [15]	2002	39	Turkey	1- ***59***% of them have a good prognosis 2- Importance of Periodical followed up with CT scans. 3- In ICU, patients' vital functions should be closely monitored. 4- Immediate follow-up if an infection is suspected

TGSW; Tangential gunshot wound to the head, ICH; Intracerebral hemorrhage, GCS; Glasgow coma scale, CT; Computed tomography, ICU; intensive care unit.

Table 2 Literature review for Tangential gunshot wound to the head (Case Reports)

Case	Type /Age/sex	Presentation	GCS*	Imaging	Management	Outcome
Hadas et al. 1990 [7]	Civilian 27 Y male	Wound in Lt Temprozygmatic region (Lt temporal); 15 minutes later,	15/15 15 minutes later, 8/15	CT scan / Lt temporal Subdural hematoma	Craniotomy with hematoma evacuation	GOS =5

		several vomiting spells				
Stone et al., 1991 [16]	Civilian 16 Y male	Wound over RT occipital	10/15 one hour later became less than 8/15	CT scan/Subdural hematoma in the posterior fossa with Rt cerebellar hematoma	Suboccipital craniectomy with hematoma evacuation	GOS =5
Atac K et al. 2004 [3]	Civilian 21 Y male	wound over the scalp with only weakness of left dorsiflexion	15/15	MRI/ hyperintense contusion of the Rt SFG with mild subdural hematoma	Conservative Management	GOS =5
Robles 2012 [14]	Military 22 Y male	Rt parietal, posterior linear wound about 12 cm; fracture was observed in the same area	15/15 after 1.5 hours 11/15	CT scan/Intracranial occipital hematoma bone fragment, hematoma causing mass effect	Evacuation of hematoma	GOS =5
Farhat 2012 [14]	19 Y male	Left Temple & near small midline wounds	15/15	Small Left SDH with traumatic SAH (small) minor temporal contusion, 8 hours later brain edema	Conservative Management	GOS =5
The present Case 2022	Civilian 13 Y male	Right frontal area with a depressed fracture	15/15, one hour later 13/15 with tonic-clonic seizure	multiple bilateral brain contusion and interhemispheric	urgent decompressive craniectomy	GOS =5

Glasgow Outcome Score (GOS)
1. Death, 2. Persistent vegetative state, 3. Severe disability, 4. Moderate disability, 5. Low disability
Glasgow Coma Scale (GCS) on initial presentation

Abbreviations

TGSW; Tangential gunshot wound to the head, PGSW; penetration gunshot wound,
ICH; Intracerebral hemorrhage,
GCS; Glasgow coma scale,
CT; Computed tomography.

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Mobilization of the temporal pole as integrated step in microsurgical clipping of pure posteriorly directed posterior communicating artery aneurysm

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Keywords
internal carotid artery, posterior communicating artery aneurysm, temporal lobe

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ABSTRACT

A pure posteriorly posterior communicating artery (PCoA) aneurysm represents a surgical challenge. This is mainly when there is a need for good exposure of the aneurysmal neck, sac, PCoA, and anterior choroidal arteries. Ruptured pure posteriorly directed PCoA aneurysm imposes significantly extra challenge as the surgeon undergoes dissection through a tight brain. Even with measures commonly used to attain brain relaxation like the lumbar drain and cisternal fenestration.

Here, we describe a technique for posterior temporal pole mobilization (TPM) as an integrated part of microsurgical clipping of ruptured pure posteriorly directed PCoA aneurysms. This technique is implicated in twenty-three successive cases of ruptured PCoA aneurysms in the neurosurgery teaching hospital in Baghdad, Iraq, with no reported complications.

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PERTINENT ANATOMY

The temporal pole is usually connected by bridging veins with the spheno-parietal sinus anteriorly and the cavernous sinus medially. These bridging veins are also known as the pre-uncal veins. These veins are neither described in the literature as a critical contributor to any of the essential surrounding veins (basal vein of Rosenthal and deep middle cerebral vein) nor described as a vital drainage pathway for the temporal parenchyma [3].

Technique

Following the steps of the pterional approach, which include,1) opening of the carotid cistern,2) dissection of the proximal Sylvian fissure then,3) identifying the pre-uncal veins, and,4) cutting the bridging veins between the spheno-parietal and the cavernous sinuses (pre-uncal veins) then,5) releasing of the temporal pole followed by,6) widening of the surgical corridor (at least 2 cm of free space posterior to the sphenoid ridge) [3,4]. To illustrate this technique, two cases of PCoA aneurysms approaches were described in the images below (Figure 1 and Figure 2).

A.

B.

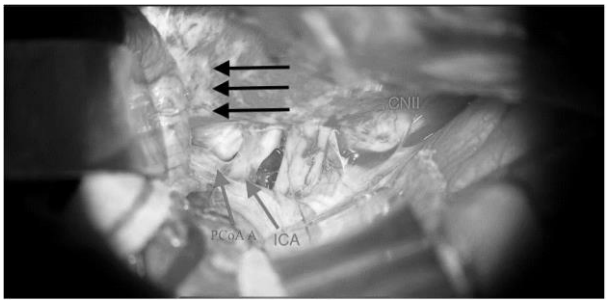

Figure 1. Intraoperative images of case 1, through the left pterional approach (**A**) shows cutting and releasing by cauterization of the anterior temporal veins before temporal pole mobilization. (**B**) is showing the superficial retraction of the temporal lobe with TPM and now we can more appreciate the space lateral to the supracliniold Internal carotid artery which widens the surgical field for safe and easy microsurgical clipping of the PCoA aneurysm. CNII: optic nerve, PCoA A: Posterior communicating artery aneurysm, ICA: Internal Carotid Artery.

Advantage

The requirement for temporal lobe traction is minimized or even absent (the retractor will hold the released temporal pole), which leads to easy identification of the PCoA aneurysm, wide exposure to the retro-carotid space, and may provide more dissection and clipping angles. The mobilization will render the temporal pole free as it does not disturb the medial (mesial) temporal cortex that usually adheres to the aneurysm. It is technically an easy and time-preserving technique.

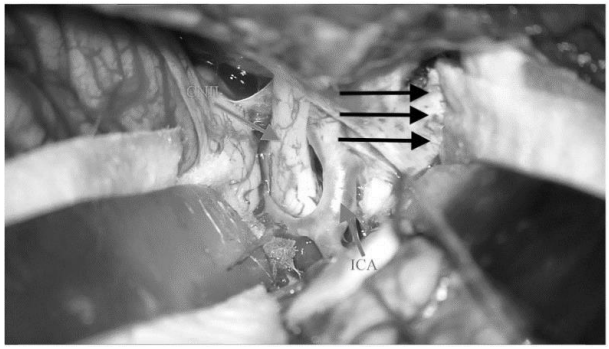

Figure 2. Intraoperative view of case 2, through right pterional approach, showing more appreciated and widen surgical space lateral to supra clinoid ICA after TPM was performed (Balck arrows). CNII: optic nerve, ICA: Internal Carotid Artery.

Limitations

Generally, the temporal lobe mobilization (usually it used to be retracted) should not be encouraged for all ruptured PCoA aneurysm cases. However, TPM has a peculiar advantage in pure posteriorly directed PCoA aneurysm cases. Here, we describe mobilization of the temporal pole only, and no distribution of the mesial temporal cortex is required. Also, the TPM technique includes the sacrifice of the bridging veins connecting the temporal tip. Thus, there is at least a theoretical risk of venous congestion and subsequent infarction [1]. Here, our technique depends on the size of the bridging veins and knowing the pattern of drainage, including a physiological principle that governs the venous drainage in the brain. If the vein is small, its counterpart or alternative pathway will be large and dominate venous drainage. This will lessen the possibility of the development of consequences. When the scarification of the temporal veins is not possible, which may be due to the larger in size, it's critical to dissect enough of the superficial Sylvian vein from the temporal lobe, especially around the temporal tip, to retain temporal veins [2,3]. Our patients had not developed such complications, and

the literature showed no report of venous complications after sacrificing the temporal veins. However, a larger series is required before approving this additive surgical step.

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Endoscopic third ventriculostomy. Complications and avoidance

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Keywords
endoscopic third ventriculostomy, ETV complications, hydrocephalus

ABSTRACT

Introduction. Endoscopic third ventriculostomy (ETV) is the treatment of choice in obstructive hydrocephalus. It has become the main standard choice in management since 1962. However, there is scant data regarding the complications from clinical or multi-centre trials. This study highlights the specific complications and prevention methods related to ETV in Neurosurgical Teaching Hospital, Baghdad, Iraq.

Methods. It is a prospective case series study conducted on cases in the Neurosurgical Teaching Hospital in Baghdad, Iraq, from January 2014- October 2019. We selected ninety patients. The sample selection was convenient as any patients admitted in the study period who met the selection criteria were included. All included patients underwent a Computerized Tomography scan or Magnetic Resonance Imaging in the periprocedural management.

Results. Ninety cases have 59 (65.5%) females and 31 (34.5%) males. The most common cause of hydrocephalus is congenital causes (51 cases (56.6%), especially within the first decade of life. Aqueduct stenosis is the leading cause in 37 cases (72%). ETV complications were found in 32 cases (35.5%). The most common cause of complications is congenital cases of 14 (15%). Intraoperative complications include bleeding (mild, moderate, and severe) in 18 cases (20%). Mild bleeding constitutes 15 cases (16.6%) of all complicated cases.

Conclusion. ETV is a standard procedure in the management of obstructive hydrocephalus. The complication rate is found in around one-third of the cases in our study. Surgeons' selection of indicated patients and better surgical experience decrease the failure rate of ETV and complications.

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INTRODUCTION

Endoscopic third ventriculostomy (ETV) is considered to be the treatment of choice in obstructive hydrocephalus [1, 16, 17, 19, 21, 25]. Since 1962, the first ETV procedure was done by Gerard Guiot, ETV has become the primary standard option in obstructed hydrocephalus, but it has specific indications [9]. It is indicated in any patients with

obstructed hydrocephalus who exhibit signs and symptoms, and the anatomical features are allowed for procedure success [26]. However, there is scarce data from clinical or multi-centre trials regarding the complications and their efficacy. This study highlights the specific complications and prevention methods related to ETV in Neurosurgical Teaching Hospital, Baghdad, Iraq.

Methods

It is a prospective case series study carried out on cases in the Neurosurgical Teaching Hospital in Baghdad, Iraq, during the period January 2014-October 2019. We selected ninety patients. The sample selection was convenient as any patients admitted in the study period who met the selection criteria were included.

The selection criteria are patients with different etiologies of obstructive hydrocephalus, all had a Computerized Tomography (CT) scan or Magnetic Resonance Imaging (MRI), and all had ETV. We used Microsoft EXCEL sheets to conduct our data analysis.

Procedure

The endoscope device used is the GAAB® system by STORZ®. It was introduced through a burr hole in the Kocher point, but it may need to change laterally and anteriorly when there was a large fontanel to involve the frontal bone. After that, we introduce the endoscope through foramen Monro, with fenestration of the floor of the third ventricle by monopolar probe or forceps. Then it is easy to direct visualization of the basilar artery. The irrigating wash used was Ringer®, and its pressure was controlled through wash-in and wash-out valves. All cases had postoperative day-zero CT scan checking for hemorrhage. Follow-up CT scans two months later, checking for the function of the stoma and late complications.

We gained consent from all ninety patients (Children from the parents or guardians). The patients' data were put in a password-protected computer.

Results

The total number of patients was 90 cases, with 59 (65.5%) females and 31 (34.5%) males. The most common age group was 70% in the first decade. And all age groups are illustrated in Table 1. The most common cause of hydrocephalus is congenital causes (51 cases (56.6%), especially within the first decade of life. Aqueduct stenosis is the most common cause within the congenital 37 cases (72%). We found Tumors 25 cases (27.7%), Arachnoid cyst 8 cases (8.8%), Infections 3 cases (3.3%), Vascular 2 cases (2.2%), and Trauma 1 case (1.1%).

Table 1. The age groups of the patients and their percentages

Age group	No.	Percentage
1day-12 months	31	34.4%
2-10 years	31	34.4%
11-50 years	25	27.7%
51-above	3	3.3%
Total	90	100%

ETV complications were found in 32 cases (35.5%). Eight 8 of them (8.8%) had severe complications, which failed the ETV. The most common cause of complications is congenital cases which are 14 (15%), Tumor 8(8.8%), Arachnoid cyst 6 (6.6%), Vascular 2 (2.2%), and infections also 2 (2.2%).

Intraoperative complications include bleeding (mild, moderate, and severe) in 18 cases (20%). Mild bleeding constitutes 15 cases (16.6%) of all complicated cases. It was managed intraoperatively with wash and/or coagulation, stopping the bleeding. On the other hand, severe bleeding, 3 cases (3.3%) which was managed with extraventricular drain (EDV), Ommaya reservoir, and wash tamponade. The case that was managed with EDV ended in death, but the latter two patients survived.

Other intraoperative complications include bradycardia, the most commonly encountered complication in 20 cases (22.2%). The management stopped the shunt's wash-in and opened the wash-out.

Early complications include Diabetes insipidus (DI) in 11 cases (12.2%), cerebrospinal fluid (CSF) leak in 5 cases (5.5%), subdural collection in 1 case (1.1%), hemiparesis in 1 case (1.1%), and Fornix injury in 1 case (1.1%).

The success rate in our study is 96.6%. There are only three failed cases; one died, and the other two cases, one ends with VDS and the other with Ommaya.

Discussion

Obstructive hydrocephalus management includes different methods, and they have been established as a challenge in various studies [7,12,14]. ETV is the

preferred option in managing obstructive hydrocephalus, performed in different neurosurgical centers in the developing world with enough surgical experience [20]. ETV has growing popularity in management because it is safe, shunt-free, and treats the condition regardless of the etiology [20].

The overall complication rate is mainly related to the center experience and the surgeon in each procedure [23]. Most case series report rates range from 5% to 15% [6,11]. In recent meta-analysis showed that the overall complication rate was 8.5 %. In our study, the complication rate is 35.5%. Because we mentioned the significant complications of ETV in our research, we may have this lower rate number. As there are case series [5,24] reporting just major complications, their rate is 0%, and with series, even the minor complications, e.g., fever, are reported to be 31.2% [5].

In our study, we have a success rate of 96.6%. In Rahman et al. study of 34 cases, they had an overall 79% success rate ([20]. Duru et al. reported an 80% success rate in the overall 51 cases of children (<16 years) of all ages and etiologies [10]. Regarding specific complications, the rate of bleeding intraoperatively ranges from 0% to 8.5% in the literature [2-4,8,13,22]. The rupture of the basilar artery was reported in <0.2% of the cases [2,4,15,18]. Still, in this study, we report 20% of the cases complicated with intraoperative bleeding and 0% of cases of basilar artery rupture. In our study, one patient with medulloblastoma died due to severe bleeding intraoperatively. The counter-effort to stop the bleeding by EDV has been established, but he deteriorates postoperatively and ends with death. Another complication is CSF leak which is the most frequent encounter complication [6,8], and it ranges from 0% to 5.2% of the cases, with an overall complication rate of 1.7% [5]. Our CSF complication rate is 5.5%. We also had CSF leak as early complications, which were severe in 3 cases due to Aqueduct stenosis that was managed with ventriculoperitoneal shunt and survived without a sequalae. Otherwise, patients who were complicated with DI, Bradycardia (4 cases due to craniopharyngioma), and hemiparesis had an excellent outcome in our study.

The predisposing factors to ETV failure include the closure of ventriculostomy stoma by arachnoid granulation tissues, failure of CSF absorption, infection, and patients' improper selections [20].

The outcome from ETV may include CSF, leak, infection, hematoma, and bradycardia. The complications of ETV can happen. Good surgical experience and early intervention following the surgeon's selection of the patients can ensure the procedure's success and low complication rate.

Conclusion

ETV is a standard procedure in the management of obstructive hydrocephalus. But it has complications, including bradycardia, bleeding, CSF leakage, and infection. The complication rate is found in around one-third of the cases in our study. Surgeons' selection of indicated patients and better surgical experience decrease the failure rate of ETV and complications.

Abbreviations

Cerebrospinal fluid (CSF), Computerized Tomography (CT), Diabetes insipidus (DI), Extraventricular drain (EDV), Endoscopic third ventriculostomy (ETV), Magnetic Resonance Imaging (MRI).

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Surgical outcome of pineal region lesions in paediatric population

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ABSTRACT

Introduction. Pineal region pathologies are heterogenous, spectrum ranging from benign, infective to malignant in nature such as parenchymal, germ cell, glial, melanomas, metastatic, tubercular, etc. These lesions are commoner in the pediatric age group and have a variable outcome. The goal of this study is to present our experience regarding the surgical outcomes of pineal region lesions in the paediatric population.

Objective. The objective of this study is to access the surgical outcome of pineal region lesions in the paediatric population

Methods and Material. Eighty cases of pineal region lesions in the paediatric population (up to 15 years of age) operated in the neurosurgery department, G.B Pant Hospital New Delhi via either Occipital transtentorial or Supracerebellar Infratentorial approaches were retrospectively analysed.

Results. There were four main groups of lesions with pineal parenchymal tumours (35 cases) being the commonest. Glial tumours were the next most common contributing 29 cases. Germ cell tumours comprise 7 and miscellaneous 9 cases.

The outcome showed graded improvement with the extent of tumour removal and 57 patients (71.25%) improved following surgery. The clinical status of 20 patients (25%) remained unchanged and 3(3.75%) deteriorated from their pre-operative status. 3 patients (3.75%) died in the immediate post-operative period and 11(13.75%) died due to recurrent disease.

Conclusion. A graded increase in survival was noted with increasing the degree of resection and postoperative adjuvant therapy in malignant pineal tumours whereas benign pineal lesions can be managed with surgery. Pure germinomas are the only tumour for which the survival rate was unrelated to extent of tumour resection.

Keywords
paediatric population,
pineal region lesions,
surgical outcome

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INTRODUCTION

The pineal region lesions are heterogenous in nature such as germ cell tumours, glial tumours, pineal parenchymal tumors, primary melanoma, metastasis,cysts, infective, etc.[1,2,3]

These tumours are common in children comprising of more than 10% of all pediatric tumours with common presentation of raised intracranial pressure secondary to obstructive hydrocephalous due to close relation with posterior third ventricle.[4,5,6]

With better microsurgical skills, the surgical outcome is associated with less morbidity and mortality, however the long term surgical and functional outcome depends on various factors such as age, extent of resection of tumour, pathological grade, distant seedling at the time of presentation, neurological condition, visual status, possibility of giving adjuvant therapy .[8,9,10, 11,12,13,14,15,16].

In the present study, we retrospectively analyzed the surgical outcome of pineal region lesion in children treated over last 15 years.

Material and methods

Eighty cases of pineal region lesions in children operated via two approaches i.e occipital transtentorial and supracerebellar infratentorial (Fig1A,B) in the Department of Neurosurgery, GIPMER, New Delhi were retrospectively analyzed. The techniques for both the approaches were as standards described in the literature. Postoperatively clinical and radiological outcome was analyzed. Postoperative tumour excision was graded as gross total, near total, subtotal or biopsy when >99%, >90%, 51-90% or <50% tumour was resected respectively based on MRI study.

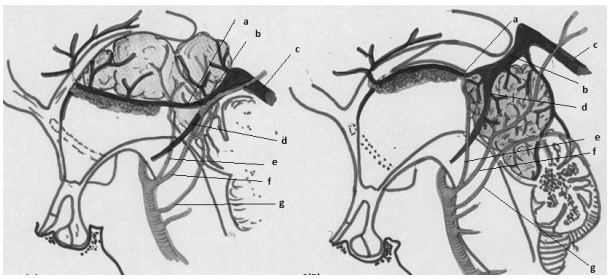

Figure 1. **A.** Occipital transtentorial; **B.** Supracerebellar Infratentorial.
a-inferior saggital sinus,b-great cerebral vein of Galen, c-transverse sinus, d-internal cerebral vein, e-posterior cerebral artery, f-superior cerebellar artery, g-anterior inferior cerebellar artery.

Results

Eighty children were followed up for 1-5 years depending upon the pathology. Twenty children (25%) were in the age group of 4-6 years and 16 cases (15%) were 8-10 years old; the youngest patient being 2 years and oldest was14 years old with a mean age of 7.5 years. There were 39 males (48.75%) and 41females(51.25%) with the M:F ratio of 0.95:1(Table 1)

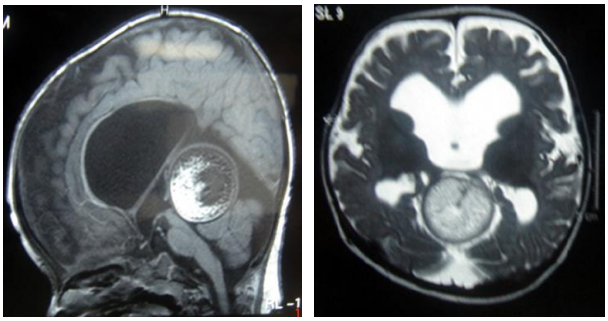

Figure 2A. Pre-operativeT1 saggital & T2 axial images of pineal region teratoma

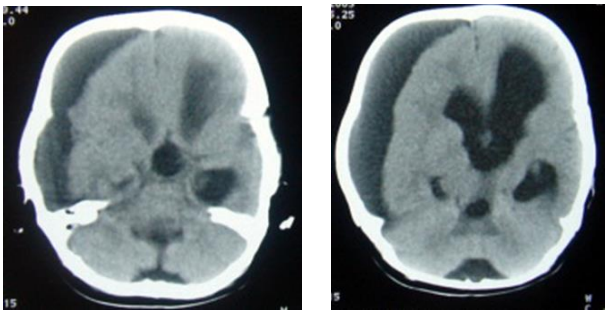

Figure 2B. Post-operative CT showing complete removal of Teratoma

Histopathologically pineal parenchymal tumors was constituting 43.75%, out of which pinealoblastoma(21.25%) constituted the major portion followed by glial tumours (36.25%), germ cell tumours(8.75%). Remaining lesions like meningioma, choroid plexus papilloma, epidermoid cyst and tubercular abscess and cysticercosis were uncommon. (Table 2).

Headache was the most common presenting symptom observed in all cases followed by vomiting in 41.25%, visual disturbance in 41.25%, diplopia in 31.25%, papilloedema 46.25%. Parinauds syndrome was present in 38.75%, weakness in upper or lower extremity was common in glial tumors infiltrating surrounding structures, 15% had cerebellar signs, 6.25% hormonal imbalance and 3.75% were in altered sensorium at the time of presentation.

Eighteen cases underwent HCG or AFP level assessment in CSF and 3 cases showed elevated levels in germinoma & teratoma.

Out of 80 cases,57 (71.25%) improved, 20 (25%) remained unchanged and 3(3.75%) patients deteriorated in postoperative period. Three patients (3.75%) died in immediate post-operative period and 11(13.75%) died in the follow up due to recurrent disease.

Surgical outcome based on extent of resection is given in table 4.Based on extent of resection, total removal led to improvement in 75-100 % cases irrespective of pathology. Improvement in pilocytic astrocytomas was 90%, pineocytoma 57%, pineoblastoma 47%, intermediate pineal tumor was 45% and 60% in germinoma cases. Improvement was almost 100% in benign lesions such as meningioma, epidermoid cyst, oligodendroglioma, choroid plexus papilloma, infective pathologies (Figure 3,5) Near total removal showed 47% improvement in pineoblastoma whereas patients with pathologies such as fibrillary astrocytoma, anaplastic astrocytomas, germinomas showed 100% improvement even after near total excision.

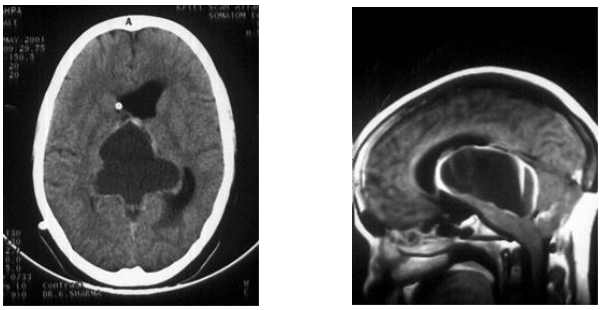

Figure 3A & 3B. Pre- operative axial & saggital images of pineal region epidermoid.

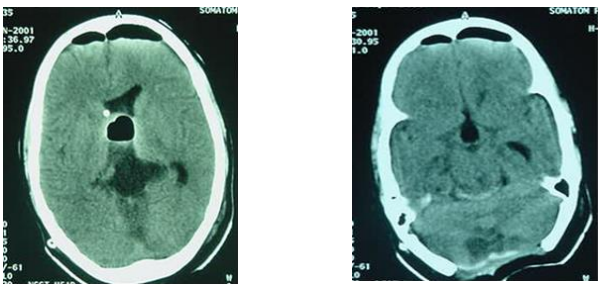

Figure 3C & 3D. Post-operative axial CT showing excision of pineal region epidermoid.

Except for germinoma subtotal removal of tumours showed no improvement in postoperative period. In the biopsy group out of 2 patients,50% remained unchanged and 50% deteriorated with one immediate and one delayed mortality. All cases of ependymoma improved after gross and near total resection. Out of 5 patients of germinoma, 3 patients improved after gross total removal, near total and subtotal resection and radiotherapy (Figure 4), 2 patients underwent biopsy out of which one remained unchanged and one deteriorated and died in post operative period due to disseminated disease. Out of 2 cases of immature teratoma (Figure 2A,B), 1 patient improved and one remained unchanged after near total excision.(Table 3 & 4). A CSF diversion procedure as ventriculoperitoneal shunt was needed in 31 patients(38.75%) of pineal tumour patients .

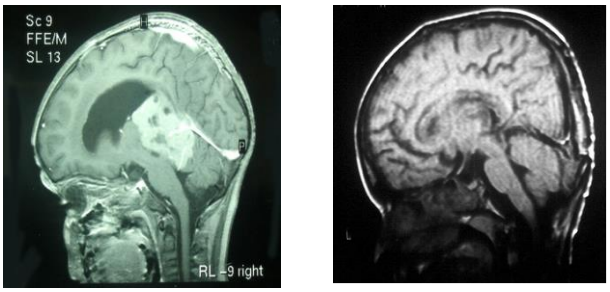

Figure 4A & 4B. Pre-operative saggital MR image in T1 contrast of pineal region germinoma & post operative saggital T1 MR after excision and radiotherapy.

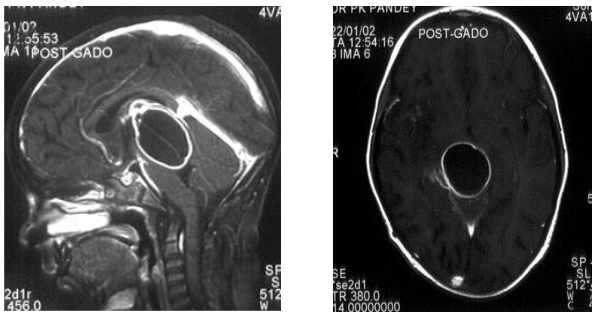

Figure 5A & B. Pre-operative saggital & axial T1 contrast MR images of tubercular abscess.

Figure 5C & D. Post-operative axial CT of tubercular abscess after excision of tubercular abscess.

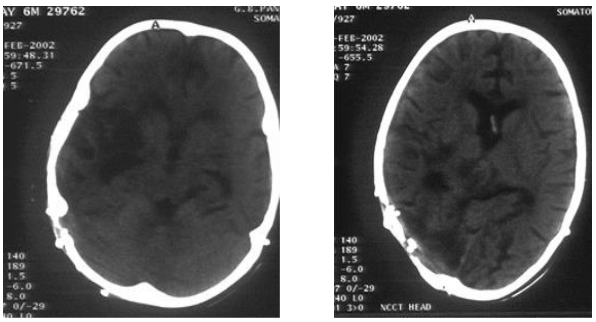

Table 1. Age and sex distribution

Sr. No.	Age Group	No. of Females	No. of Males	Total No. of cases
1	0-2	1	0	1
2	2-4	6	7	13
3	4-6	9	11	20
4	6-8	9	5	14
5	8-10	7	9	16
6	10-12	5	3	8
7	12-14	4	4	8
8	14-15	0	0	0
	Total	41	39	80
		51.25%	48.75%	

Table 2. Histopathology of 80 cases of pineal region tumours

Diagnosis	No. of Cases
• Pineal parenchymal tumors • Pineocytoma • Pineal parenchymal tumor of intermediate differentiation • Pineoblastoma	35 (43.75%) 7 (8.75%) 11 (13.75%) 17 (21.25%)
Gliomas • Pilocytic astrocytoma • Fibrillary astrocytoma • Anaplastic astrocytoma • Glioblastoma • Oligodendroglioma • Ependymoma • Subependymal giant cell astrocytoma	29 (36.25%) 10 (12.50%) 4 (5%) 3 (3.75%) 1 (1.25%) 3 (3.75%) 6 (7.50%) 2 (2.5%)
Germ cell tumors • Germinoma • Immature teratoma	7 (8.75%) 5 (6.25%) 2 (2.5%)
Miscellaneous • Meningioma • Choroid plexus papilloma • Epidermoid cyst • Tubercular abscess • Cysticercosis	9 (11.25) 2 (2.25%) 3 (3.75%) 2 (2.25%) 1 (1.25%) 1 (1.25%)
Total	**80 (100%)**

Table 3. Surgical outcome according to histopathology

Diagnosis	No. of cases (n)	Outcome			Mortality (%)
		Improved (%)	Unchanged (%)	Deteriorated (%)	
Pineocytoma	7	4(57.14%)	3(42.85%)	0	0
Pineal parenchymal tumor of intermediate differentiation	11	5(45.45%)	6(54.54%)	0	4(36.36%)
Pineoblastoma	17	8(47.05%)	7(41.17%)	2(11.76%)	8(47.05%)
Pilocytic astrocytoma	10	9(90%)	1(10%)	0	0

Fibrillary astrocytoma	4	4	0	0	0
Anaplastic astrocytoma	3	3	0	0	0
Glioblastoma	1	0	1	0	1
Oligodendroglioma	3	3	0	0	0
Ependymoma	6	6	0	0	0
SEGA	2	2	0	0	0
Germinoma	5	3(60%)	1	1(20%)	1(20%)
Immature teratoma	2	1	1	0	0
Meningioma	2	2	0	0	0
Choroid plexus papilloma	3	3	0	0	0
Epidermoid cyst	2	2	0	0	0
Tubercular abscess	1	1	0	0	0
Cysticercosis	1	1	0	0	0
Total (%)	**80 (100%)**	**57 (71.25%)**	**20 (25.00%)**	**3 (3.75%)**	**14 (17.5%)**

Table 4. Surgical outcome based on extent of tumour removal

Diagnosis	**No. of cases**	**Extent of tumour removal**	**No of cases**	**Outcome**			**Mortality**
				Improved	**Unchanged**	**Deteriorated**	
Pineocytoma	7	GT	4	3(75%)	1(25%)	0	0
		NT	1	1	0	0	0
		ST	2	0	2	0	0
Pineal parenchymal tumor of intermediate differentiation	11	GT	6	5(83.33%)	1(16.67%)	0	0
		NT	2	0	2(100%)	0	1
		ST	2	0	2(100%)	0	2
		Biopsy	1	0	1(100%)	0	1
Pineoblastoma	17	GT	5	4(80%)	1(20%)	0	0
		NT	7	4(57.14%)	3(42.85%)	0	3
		ST	3	0	2(66.66%)	1(33.33%)	3
		Biopsy	2	0	1(50%)	1(50%)	2
Pilocytic astrocytoma	10	Excision	2	2(100%)	0	0	0
		GT	6	6(100%)	0	0	0
		NT	1	1(100%)	0	0	0
		ST	1	0	1(100%)	0	0
Fibrillary astrocytoma	4	GT	3	3(100%)	0	0	0
		NT	1	1(100%)	0	0	0
Anaplastic astrocytoma	3	GT	2	2(100%)	0	0	0
		NT	1	1(100%)	0	0	0
Glioblastoma	1	ST	1	0	1(100%)	0	1
Oligodendroglioma	3	GT	3	3(100%)	0	0	0
Ependymoma	6	GT	5	5(100%)	0	0	0
		NT	1	1(100%)	0	0	0
SEGA	2	Excision	1	1(100%)	0	0	0
		GT	1	1(100%)	0	0	0
Germinoma	5	GT	1	1	0	0	0
		NT	1	1	0	0	0
		ST	1	1	0	0	0
		Biopsy	2		1(50%)	1(50%)	1
Immature teratoma	2	NT	2	1(50%)	1(50%)		0
Meningioma	2	Simpson's Grade III Excision	2	2(100%)	0	0	0

Choroid plexus papilloma	3	GT	3	3(100%)	0	0	0
Epidermoid cyst	2	Excision	2	2(100%)	0	0	0
Tubercular abscess	1	Excision	1	1(100%)	0	0	0
Cysticercosis	1	Excision	1	1(100%)	0	0	0

GT, gross total resection; NT, near total resection; SEGA, subependymal giant cell astrocytoma; ST, subtotal resection

Upgaze palsy was present in 3 which persisted in post-operative period. Subdural effusion was present in 4 cases & was self limiting. Most severe complication was postoperative haemorrhage in 2 cases due to incomplete resection of tumor. In Infratentorial supra-cerebellar approach venous air embolism & hypotension was noted in 8 cases. Venous air embolism was treated with rapidly packing the operative field with wet sponges,waxing bony edges, air aspiration from right atrium via CVP catheter, ventilation of patients with 100% O2, use of vasopressor & volume expanders.Postoperative hemianopia was the most common complication following suboccipital transtentorial approach and was encountered in 7 cases due to prolonged retraction of occipital lobe. Meningoencephalitis was noticed in one case.

Suitable candidates were referred for adjuvant treatment.

Five-year survival rate of the patients is shown in Table 5.

Table 5. Survival rates for patients with pineal tumours

	5 Year Survival
Pineocytoma (PC)	71%
Pineal parenchymal tumour of intermediate differentiation (PID)	63%
Pineoblastoma(PB)	46%
High grade glial tumours	80%
Germ cell tumours (GCTs)	90%

Discussion

Transcallosal approach for pineal lesions was first described by Dandy18 in 1921, however all patients died initially and first successful excision was performed in 1931. The operative mortality of pineal region lesions was as high as 90% as per reported by Russel and Sachs 19 in 1943. Thereafter with more refined surgical skills and knowledge of anatomy, increasing sophistication of stereotactic surgery and the high morbidity and mortality rates of open operation on the pineal region, neurosurgeons advocated stereotactic biopsy for pineal region masses. However with recent advances, surgery on the pineal region has became increasingly safer & is now the treatment of choice as it allows significant debulking of lesions and adequate specimen to identify the pathology of lesion. We are also in favor of surgery to radically remove the lesion to avoid unnecessary radiation to benign lesions and radiation associated significant morbidity particularly in children. Radiation can cause arachnoid thickening, adhesions and which can be troublesome especially for recurrent tumours. Hoffman et al.20 also recommended open surgery in order to establish accurate histological diagnosis to guide the adjuvant therapy indications.

The median age of presentation in this study was 7.5years (range 1-15) and male to female ratio was 0.95:1 (Table 1).

In the present study pineal parenchymal tumours(PPT) were most common constituting 43.75% followed by glial tumors comprising 36.25% and germ cell tumours<9%.In Indian population PPT is commoner than germ cell tumours(Table 2). TatkeM et al. reported 42% of tumours to be PPT in Indian population.24 In contrast to this, Cho BK et al. reported even higher incidence of both PPT and germ cell tumours i.e. 69% and 19% respectively in Far East population22. Aal-Hussaini M et al collected data from 17 SEER registries (these data included a total of 5306606 tumors diagnosed from January 1973-December 2005) and reported germ cell tumors as most common histological type followed by pineal parenchymal tumors23. Rosenstock17 et al and reported 32% pineal parenchymal tumors and 26% glial tumours respectively in their series.

In this study headache was present in all cases followed by vomiting and diplopia in 41.25% and 38.75%respectively. Papillodema was observed in 46.25% with Parinauds syndrome in 38.75%.Various studies by Hoffman et al,20, Villa et al, 25Konovalov and Pitskhelauri3 et al , Cho B.K et al also found signs and symptoms of raised intracranial pressure in 80-

90% and Parinaud's syndrome in 25%-50% of cases.

Al-Hussaini M et al collected data from 17 SEER registries (these data included a total of 5306606 tumors diagnosed from January 1973-December 2005) and concluded that amoung malignant tumours of pineal region germ cell tumours had best outcome, which was further improved by radiotherapy use but not by total excision23.

Konovalov AN and Pitskhelauri DI3 et al reported pure germinomas having 95% and 88% 5 year and 10 year survival; high grade glial tumors as 80% and 50%, 5 year and 10 year survival rate; malignant pineal parenchymal tumours as 44% and 0% 5 year and 10 year survival rate; malignant GCTs as 20% and 0% 5 year and 10 year survival rates respectively. In our study highest mortality was noted in cases of pineoblastoma(47.05% mortality), which is the most malignant tumour of pineal region followed by pineal parenchymal tumor of intermediate differentiation(36.36%). In our study pineal parenchymal tumor of intermediate differentiation had 70% overall 5 year survival rate; pineoblastoma having 70.58% overall 5 year survival rate; germinoma having 75% overall survival rate. There is 34.28% mortality in pineal parenchymal group followed by 20% mortality in germ cell tumor group and 3.44% mortality in glial tumor group without any mortality in bening lesions of pineal region, correlating mortality with the histopathological diagnosis.

Konovalov AN and Pitskhelauri DI3 found an association between the extent of tumor removal and survival in patients with all types of malignant tumors except pure germinoma. The 5 year survival rate was 70% for patients who had a total tumor resection and 30% for patients who had a biopsy or partial resection. Pure germinomas was the only tumor for which survival rate was not associated with the extent of tumor resection. Tatke M et al reported a graded increase in survival with increasing degree of resection (5 year survival rate:84% for GTR vs 53% for STR vs 29% for debulking in case of pineoblastomas. (Table4,5).

Konovalov AN and Pitskhelauri DI3 found an association between the extent of tumor removal and survival in patients with all types of malignant tumors except pure germinoma. The 5 year survival rate was 70% who had a total tumor resection and 30% who had a biopsy or partial resection. Pure germinomas was the only tumor for which survival rate was not associated with the extent of tumor resection perhaps these are the tumours which responds best to radiotherapy. Tatke M24 et al also reported a graded increase in survival with increasing degree of resection in pineoblastomas.

Clark AJ et al suggested that aggressive surgical resection provides a survival benefit over subtotal resection for patients of pineocytomas 26. In our study, 75% of pineocytomas improved after gross total removal , 83.33% of pineal parenchymal tumors improved after gross total removal and 80% of pineoblastomas improved after gross total removal. In cases of pilocytic astrocytoma all cases of gross total and near total removal improved with one case of subtotal removal remained unchanged.

All cases of fibrillary astrocytoma, anaplastic astrocytoma, ependymomas and SEGA showed improvement after gross and near total excision. One case of glioblastoma expired after subtotal removal. All cases of germinomas showed improvement regardless of extent of removal except one case of disseminated germinoma which died in post op period and one case remained in unchanged status. All other miscellaneous lesions improved after excision, gross total or near total removal(Table3,4)

Konovalov AN and Pitskhelauri DI3 described the principles of treatment of the pineal region tumours on the basis of total 287 operations done over a period from 1976 to 1999. It included 161 males and 126 females with a mean age of 20 years at presentation. They used occipital transtentorial approach in 138(54%) and infratentorial supracerebellar approaches in 87(34%) of patients. Total removal was achieved in 58% patients, subtotal removal in 29% and partial removal in 13% patients. 58% patients had obstructive hydrocephalus that underwent craniospinal fluid shunting before radiotherapy or with tumour removal. Features of raised intracranial pressure and eye movement disorders were among the most common presentation. Present study, includes 80 patients with pineal region lesions. A CSF diversion procedure as ventriculoperitoneal shunt was needed in 31 patients(38.75%) of pineal tumour patients .

Two approaches were commonly used: Supracerebellar infratentorial approach was used in 62(77.5%) and occipital transtentorial in 18(22.5%) patients of pineal tumours. Stein BM 27 reported their experience of 6 cases of pineal lesions,

operated using Krause's Supracerebellar Infratentorial approach. They had no operative mortality. Operative morbidity was negligible and except for a varying degree of meningeal reaction managed effectively with steroids, their pateints had uneventfull postoperative courses.

Suzuki and Iwabuchi have reported the largest series of successfully treating lesions of the pineal region using the direct surgical approach. 17 of 19 cases underwent total or near total removal via a supratentorial approach.

In our study post operative complications according to surgical approach were as follows;

Infratentorial supracerebellar approach: Ocular abnormality in the form of upgaze palsy was present in 3 which lasted for few weeks in post-operative period. Subdural effusion was present in 4 cases & was self limiting. Most severe complication was postoperative haemorrhage in 2 cases due to incomplete resection of tumor.

Occipital transtentorial approach: Postoperative hemianopia was the most common complication in this approach encountered in 7 cases due to excessive retraction of occipital lobe. Gentle & gradual retraction of occipital lobe is necessary to avoid this complication. Meningoencephalitis was noticed in one case.

Clark AJ et al reported that patients receiving subtotal tumor resection (STR) versus those undergoing STR plus External beam radiotherapy (XRT), the addition of adjuvant radiation does not yield a survival benefit when compared to STR alone. In the light of the superiority of gross total resection (GTR) to STR, it appeared that pineocytomas are relatively radioresistant and are optimally treated with aggressive surgery rather than XRT.

Stoiber EM et al reported that fractionated local radiotreatment of pineocytomas seems to be safe and effective method with a local recurrence control rate of 100%, intensification of therapy in aggressive variants of intermediate pineocytomas as well as pineoblastomas seemed necessary28. The CCG-921(Childrens cancer group) report suggested that radiation therapy has a significant impact on survival with a 3-year survival of 61% in paediatric pineoblastoma population. Konovalov AN and Pitskhelauri DI et al reported that radiation therapy should be administered to all patients with pineal region tumors other than meningioma, mature teratoma and some rare bening tumors or cysts3.Germinoma is chemotherapy & radiosensitive. For intracranially arising germonimas radiation therapy is the primarily curative. Radiation therapy is best avoided in young children & many centres advocate few cycles of chemotherapy followed by radiation therapy as well. More aggressive tumors of pineal region like malignant germ cell and pineal parenchymal tumors tend to invade surrounding cerebellar structures and have a high risk of spinal dissemination and commonly cannot be totally resectable, so radiation therapy and chemotherapy play a crucial role in the treatment3.

Schild S.E et al. reported that pineoblastomas and pineal parenchymal tumor of intermediate differentiation, it is possible to obtain better results with surgical resection and relatively high doses of radiation (50 to 55 Gy)29. According to Tate M et al the addition of radiotherapy to gross total removal did not improve survival; however, the addition of radiotherapy to subtotal removal did yield a survival benefit in cases of pineoblastoma19. In our study total 30(37.5%) patients received radiotherapy and 12(15%) patients received chemotherapy. In patients with pineoblastomas, pineal parenchymal tumors of intermediate differentiation, germinomas, immature teratomas, anaplastic astrocytomas, patients who received post-operative radiotherapy have better overall and progression free survival. Chemotherapy as part of treatment for pineal tumors(cisplatin-etoposide combination) was used.

Many of our patients were in the advanced stage of their illness bearing large tumours which is an additive factor to the morbidity and mortality of our patients. In patients with bening lesions, surgical removal is curative. In malignant tumours, satisfactory decompression of tumour improve response to postoperative adjuvant therapy.

Conclusion

Pineoblastoma is the most common histological type among pineal region tumours in children.A graded increase in survival noted with increasing the degree of resection and post-operative adjuvant therapy in malignant pineal tumors.Pure germinomas are the only tumor for which survival rate was not associated with the extent of tumor resection. Selection of the surgical approach (Supra/infra-tentorial) according to the extension of the tumor (above or below the

tentorium) may give window to the greater surgical resection and reflect the improved outcome.

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Letter to Editor

Contusion index - a diagnostic and treatment algorithm for neurointensive care

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Globally, traumatic brain injury is one of the major causes of death in developed countries, with a massive social and economic impact [1]. The majority of these traumatic brain injuries (80%) are considered mild (Glasgow 14–15), 10% are moderate (Glasgow 9–13), and the rest are severe (Glasgow less than 9). These injuries range from mild concussions to extensive bleeding, fractures, and parenchymal injuries. Among the primary traumatic brain injuries are contusions, which need close neurological examination, clinical monitoring, serial brain CT scans, and any changes in the Glasgow coma score.

Traumatic cerebral contusion with single or multiple presentations is frequently found in these patients. This type of injury can be found in coexistence with acute intracerebral, extradural, or subdural hematomas [2]. It is important to clarify that brain parenchymal injury with dura mater integrity is defined as a contusion, as opposed to a laceration, where there is a tangential disruption of bone tissue and the meninges [3]. Biomechanically, contusions are related to multiple kinetic mechanisms such as acceleration and deceleration, with the subsequent development of cerebral edema that can be local or progressive [2].

The pathobiology of cerebral contusions is heterogeneous in its initial stages, characterized by alterations such as punctate

hemorrhage, swelling, edema, and areas of necrosis in the initial stages. The pathophysiology of contusions includes changes in cerebral and local blood flow [4].

The pathobiology of cerebral contusions is heterogeneous in its initial stages, characterized by alterations such as punctate hemorrhage, swelling, edema, and areas of necrosis in the initial stages. The pathophysiology of contusions includes changes in cerebral and local blood flow [4].

The term "contusion index (CI)" was first described by Adams et al in 1982 [5,6]. These results were obtained in pathological specimens by determining the extent and depth of the lesions. The depth of the contusion was measured based on a 0-3 scale; 0: no contusion seen, 1: contusion not involving the full thickness of the cortex, 2: contusion involving the full thickness of the cortex, 3: contusion extending to the white matter [6]. The extent of the contusion was measured based on the 0-3 scale: 0: no contusion, 1: localized contusion, 2: moderately extensive contusion, and 3: extensive contusion [6]. The CI score (0–9) equals the depth of contusion multiplied by the extent of contusion. Patients with CI with a CI of 0 to 4 were treated conservatively. Patients with a CI of 6 were treated surgically, and patients with a CI of 9 were treated conservatively or surgically depending upon the Glascow coma score. In the field of neuroradiology, an index of contusions has been used in clinical series in an interesting way [7,8].

A further modification was suggested by postmortem analysis, where a two-tier system is proposed based upon superficial or deeper injury. Gray matter injury is assigned a 0-3 scale while parenchymal injury is given a scale of 0-4 based on the extensión and depth of the bleed [9].

We consider that cerebral contusions, due to their dynamic pathogenetic nature and varied evolution process, can hardly be evaluated with the Glasgow scale [10,11] alone. Many patients with cerebral contusions find themselves in the universe of patients categorized as "moderate head trauma" using the Glasgow scale. We believe that patients with cerebral contusions without other structural injuries (hematomas that need to be treated by neurosurgery) need to get a case-based decision making and treatment plan.

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Letter to Editor

The practice of empathy in neurocritical care - an important aspect

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The dehumanization of medicine has been a subject of debate in recent years with its implications. The dehumanization of medicine has repercussions for the patient, the doctor, and the health team. For the doctor-patient relationship to be successful, it requires an empathetic neurointensivist to the patient's needs. Physicians have to communicate and understand patients' needs, directions, beliefs, and expectations in order to help them therapeutically. Through empathy, physicians manage to make adequate professional judgments with an understanding of patient experiences and develop moral behaviors. Empathy is defined as a process of the cognitive order with positive repercussions for the doctor [1]. Neurocritical care practice is firmly supported by numerous scientific and technological advances. Scientists hypothesized that empathy is based on the interaction of its affective and cognitive components [2].It is basically, how to perceive others' emotions, mentalize the perceived input, and execute mature functions [3].

While treating patient in neurocritical care units particularly in emergency scenarios for example a patient with severe brain injuries, the patient not only the patient himself might be in a position to make decision also many a times family members may not be immediately to make decisions for the patient. In these situations, team members need training, experience, and direction in order to demonstrate empathy for the needs of patients. For treatment consent, neurointensivists

must describe, with empathy, in the patient's file the reason for every therapy or operation requiring permission for which consent cannot be acquired. Waiting for formal permission may delay therapy, care effects, and the end result. To provide effective therapy direction to families with a language barrier, it is necessary to comprehend their thinking. Empathy teaches us those patients are highly intelligent in their languages and cultures, regardless of the severe neurological crisis they are experiencing. In contrast, physician burnout is an enduring condition that will likely worsen over time. Neurointensivists have the same difficulty, and the current COVID-19 epidemic has not improved the situation. There is a greater need for experienced intensivists to be reminded of the need for empathy in neurocritical care and for novice intensivists to get training in this area.

A formal patient survey has aided in providing input for the empathy evaluations and development programs [4,5] On the medicolegal side of medical practice, there is a quantifiable effect. Since it is a cognitive process, doctors must be multipliers of empathetic behaviors, as empathy can be taught. Our ICUs and neurosurgical teams have a tremendous duty to foster an attitude of empathy. Formal workshops [6] and educational seminars may be of assistance. A system to include and impart culture of empathy reated training in education needs to be in place, also more research needs to be performed particularly address the issues faced in critical care settings to find out what can make involved professionals more empathetic.

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