ISSN 1220-8841 (Print)
ISSN 2344-4959 (Online)

ROMANIAN
NEUROSURGERY

Vol. XXXX | No. 2 June 2026

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DOI: 10.33962/roneuro-2026-028

Romanian Neurosurgery (2026) XXXX (2): pp. 142-147
DOI: 10.33962/roneuro-2026-028
www.journals.lapub.co.uk/index.php/roneurosurgery

Clinical, radiological and surgical aspects of cerebellopontine angle tumors: insights from a single-centre series

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ABSTRACT

Objective: This study aimed to highlight the clinical and radiological profile of cerebellopontine angle (CPA) tumors and assess surgical outcomes, particularly in relation to tumor size.

Materials and Methods: Fifty patients with CPA tumors were prospectively studied in the Department of Neurosurgery, UPUMS Saifai, India, from June 2022 to May 2025. Preoperative assessment included CT and/or MRI. All patients underwent tumor excision through a suboccipital retrosigmoid approach.

Results: A female predominance was noted. Sensorineural hearing loss (92%) was the most common presenting symptom, followed by headache (66%). Most vestibular schwannomas showed heterogeneous enhancement with cystic changes. Large tumors (31-40 mm) were observed in 68% of patients. Facial nerve preservation was achieved in most medium-sized tumors (10-30 mm), whereas postoperative facial palsy was more frequent in giant tumors (>40 mm), suggesting a direct association between tumor size and facial nerve dysfunction. Postoperative complications included CSF leak in 8 patients, hydrocephalus in 3, and mortality in 4 (overall 8%).

Conclusion: CPA tumors were more common in middle-aged patients, with a slightly higher incidence in females. The majority were large at the time of diagnosis, and most patients presented with non-serviceable hearing. Vestibular schwannoma was the most common histopathological diagnosis, often showing heterogeneous and cystic features. Gross total excision was feasible in most cases. Facial nerve palsy was the leading postoperative complication, with larger tumors carrying greater risk. The overall mortality was 8%.

Keywords
Cerebellopontine angle tumors,
Vestibular schwannoma,
Facial nerve preservation,
Retrosigmoid approach

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ISSN 2344-4959 (online)
ISSN 1220-8841 (print)

First published
June 2026 by
London Academic Publishing
www.london-ap.uk

INTRODUCTION

CP angle tumors make up 5-10% of intracranial tumors [1,2]. The vast majority of cerebellopontine angle tumors are benign, with vestibular schwannomas accounting for more than 85%. Primary malignancies or metastatic lesions constitute fewer than 2% of neoplasia in the CPA.

CT and MRI are the radiological modalities most commonly used for imaging the cerebellopontine angle. The basic radiological diagnostic objective is to describe the tumor's relationship to the internal auditory meatus (IAM), brainstem, and cerebellar hemispheres. The second line of fundamental information is whether the lesion is extra-

or intra-axial. Management options include observation, surgery, stereotactic radiosurgery, and fractionated radiation; some patients may be eligible for a combination of these treatments. The most effective therapy remains complete tumor removal.

CPA tumors can be resected using a variety of approaches, including translabyrinthine, retrosigmoid, suboccipital, retrolabyrinthine, transcochlear, transotic, and middle fossa. Surgery improves patients' quality of life, but each approach carries a risk of postoperative complications such as death, hematoma, pneumocephalus, cranial neuropathies, cerebellar dysfunction, brainstem problems, infections, and CSF leaks. The suboccipital retrosigmoid technique is a common approach for removing CPA tumors, with a low complication rate, particularly with regard to facial nerve function, and complete tumor removal in the great majority of instances. The procedure is both safe and effective, even for the largest tumors. Technical advances in surgery and anesthesia have transformed outcomes for cerebellopontine angle lesions, resulting in lower mortality and morbidity, and the use of intraoperative nerve stimulators and evoked potentials has enabled resection of lesions while preserving cranial nerves.

Materials and Methods

This is a prospective study of 50 patients at the Department of Neurosurgery, UPUMS Saifai, Etawah, undergoing surgical removal of CPA tumors utilizing the suboccipital retrosigmoid technique. All patients were pre-operatively examined using non-enhanced and/or enhanced computed tomography (CT), magnetic resonance (MR) imaging, or both. Tumor density and homogeneity, the presence and type of contrast enhancement, and calcifications were examined using computed tomography. MRI examinations were performed on several imaging devices with field strengths ranging from 0.5 to 1.5 tesla. The MR imaging characteristics assessed in this study comprised signal homogeneity and intensity (T1- and T2-weighted images), the presence and type of contrast enhancement, calcifications, and lesion borders, along with findings on diffusion-weighted (DWI) and apparent diffusion coefficient (ADC) sequences.

Preoperatively, all patients had their hearing assessed using pure tone audiometry (PTA) and were classified as serviceable or non-serviceable using the Gardner-Robertson Hearing Classification Scale. Speech discrimination of less than 50% and PTA values greater than 50 dB were classified as non-serviceable hearing. All patients underwent fundoscopy with a direct ophthalmoscope to examine for papilledema prior to surgery, assessed using the modified Frisen scale.

In all cases, radical excision was attempted, and every case was examined using an operating microscope. Steroids were administered to patients both during and after surgery. Operative data were assessed, including surgical strategy, extent of removal, morbidity, and mortality. Tumor removal was evaluated both during surgery and thereafter using CT and MR imaging. The extent of removal was classified into three categories: gross total removal, near-total removal, and subtotal removal.

Results and Discussion

In general, CPA tumors are classified as acoustic or non-acoustic. The primary factor influencing the need for accurate preoperative diagnosis is the difference in surgical technique between vestibular schwannomas and other tumors. The primary neurosurgical goals are generally agreed to be complete tumor excision and facial nerve preservation. Understanding the microarchitecture of the vascular and cranial nerves, as well as the interactions between neurovascular structures and the tumor, is critical for achieving the best surgical outcomes.

In our study, the majority of patients were between 31 and 40 years old (32%; Table 1). Fifty-eight percent of participants were female, and 42% were male. Arismendi et al. found a 2:1 female-to-male ratio with a median age of 49±12.1 years. Memari et al. found that the average age was 49 years, with a slight male preponderance of 55% [3]. Joarder et al. found that the highest incidence occurred between the ages of 30 and 50, with a 55% female preponderance [4]. Maheswararao and Baru reported the highest incidence of extra-axial cerebellopontine angle tumors in the 51-60 age range, with 70% of cases being female [5].

Table 1. Distribution of cases according to age and sex.

Age (yrs)	Total patients	Percentage
0-20	4	8%
21-30	5	10%
31-40	16	32%
41-50	12	24%
51-60	9	18%

61-70	4	8%
Male	21	42%
Female	27	58%

Table 2. Distribution of cases according to tumor type and sex.

	Vestibular Schwannoma	Meningioma	Epidermoid	Abscess
Female (27)	17	8	2	0
Male (21)	16	1	2	2

Sensorineural hearing loss was found in 92% of cases, cerebellar signs in 58%, headache in 66%, trigeminal dysfunction in 46%, facial nerve dysfunction in 46%, papilledema in 26%, tinnitus in 38%, pyramidal signs in 24%, and 9th/10th/11th cranial nerve dysfunction in 16% (Table 3). Joarder et al. and Memari et al. reported similar clinical presentations [3,4].

Table 3. Distribution of cases according to clinical presentation.

Clinical Findings	Vestibular Schwannoma	Menin gioma	Epidermoid cyst	Abscess	Total patients	%
Sensorineural hearing loss	35	7	2	1	46	92%
Cerebellar signs	25	3	1	0	29	58%
Headache	28	3	1	1	33	66%
Trigeminal dysfunction	20	3	0	0	23	46%
Facial dysfunction	20	2	1	0	23	46%
Papilledema	10	3	0	0	13	26%
Tinnitus	17	2	0	0	19	38%
Pyramidal signs	11	1	0	0	12	24%
9th/10th/11th nerve dysfunction	7	1	0	0	8	16%

Our pure tone audiometry results showed that 26% of patients had serviceable hearing and 74% had non-serviceable hearing (Table 4). Joarder et al. and Memari et al. reported similar findings [3,4].

Table 4. Distribution of cases according to pure tone audiometry.

Class	Vestib ular Schwa nnoma	Menin gioma	Epidermoid cyst	Abscess	Total	%
I & II (Serviceable)	5	4	2	2	13	26 %
III & IV (Non-Serviceable)	30	5	2	0	37	74 %

Our study found medium-size (10-30 mm) tumors in 14%, large-size (31-40 mm) tumors in 68%, and giant (>40 mm) tumors in 18% of cases (Table 5). Memari et al. reported a mean tumor size of 24 mm (range up to 35 mm) [3]. Joarder et al. reported medium-size tumors in 15%, large-size tumors in 58%, and giant tumors in 27% [4]. Anatomical preservation of the facial nerve was achieved in the present study for large-size tumors in 41% of cases and for giant-size tumors in 11%. Joarder et al. reported facial nerve preservation in 75% for large-size tumors and in 55% for giant-size tumors [4]. In our study, structural preservation of the facial nerve was achieved in 80.6% of vestibular schwannoma patients. Samii and Matthies reported a 93% preservation rate for vestibular schwannoma regardless of tumor size [8]. Jain et al. reported facial nerve preservation of 84.3% [6].

Table 5. Distribution of cases according to size of lesion and anatomical preservation of facial nerve.

Size	Total patients	Patients with anatomically preserved facial nerve
Medium (10-30 mm)	7 (14%)	7
Large (31-40 mm)	34 (68%)	14
Giant (>40 mm)	9 (18%)	1

Our findings indicate a clear relationship between tumor size and the frequency of postoperative facial nerve palsy. After surgery, 1 patient developed facial palsy among medium tumors (14%), 21 among large tumors (61.7%), and 7 among giant tumors (77.7%) (Table 6). As tumor size increased, so did the risk of postoperative facial nerve palsy. Memari et al. similarly found a strong relationship between tumor size and facial nerve outcome, with larger tumors producing worse results [3].

Table 6. Distribution of cases according to size of lesion and incidence of postoperative facial nerve palsy.

Size	Total Patients	Facial nerve palsy
Medium (10-30 mm)	7	1 (14%)
Large (31-40 mm)	34	21 (61.7%)
Giant (>40 mm)	9	7 (77.7%)

Our series included 29 patients with pre-operative facial palsy: 22 with Grade 2, and 7 with Grades 3 and 4. Of the 22 patients in Grade 2, seven progressed to Grades 3 and 4, and three progressed to Grades 5 and 6. Seven patients from Grades 3 and 4 progressed to Grades 5 and 6 (Table 7). Samii and Matthies reported postoperative Grade 1-2 facial nerve function in 64% of patients, Grade 3-4 in 21%, and Grade 5-6 in 15% [8].

Table 7. Distribution of cases according to facial nerve functional grading (pre-op, post-op, and 6-month follow-up) in already-involved facial nerve on admission.

Pre-op Grade	n	Post-op 2	Post-op 3,4	Post-op 5,6	FU 2	FU 3,4	FU 5,6
2	22	12	7	3	10	7	3

3 & 4	7	0	0	7	0	1	6
5 & 6	0	0	0	0	0	0	0

Our radiological review in vestibular schwannoma demonstrated homogeneous enhancement in 4 instances, heterogeneous enhancement in 31 cases, and a cystic component in 31 cases; hyperostosis was not observed on any radiological imaging. In meningioma, 9 instances exhibited homogeneous enhancement, 2 had hyperostosis, and none had a cystic component. In epidermoid cysts, two cases showed heterogeneous enhancement and two had cystic components, while in abscesses, two cases had both heterogeneous enhancement and cystic components (Table 8). Maheswararao and Baru performed VP shunt followed by definitive surgery in 24% of patients and direct tumor surgery in 76% [5].

Table 8. Distribution of cases according to imaging findings (MRI).

	Vestibular Schwannoma (35) (70%)	Meningioma (9) (18%)	Epidermoid cyst (4) (8%)	Abscess (2) (4%)
Homogeneous enhancement	4	9	0	0
Heterogeneous enhancement	31	0	2	2
Cystic component	31	0	2	2
Centered on IAM	26	1	0	0
Broad-base dural tail	0	9	0	0

Table 10. Distribution of cases according to surgical procedure.

Surgical Procedure	No. of Patients (%)
VP shunt + tumor surgery	12 (24%)
Direct tumor surgery	37 (76%)

In our series of vestibular schwannoma, we performed gross total excision in 77% of patients, near-total excision in 14.2%, and subtotal excision in 8.5%. In meningiomas, we achieved gross total excision in 66% and near-total excision in 33%. In epidermoid cysts, we performed gross total excision in 75% and near-total excision in 25%. In abscesses, we achieved gross total excision in 100% of patients (Table 9). Overall, 38 patients had gross total resection (76%), 9 had near-total resection (18%), and 3 had subtotal resection (6%). In all 50 cases, the procedure was performed using a suboccipital retrosigmoid approach, and we detected no position-related clinically evident complications, intraoperative or postoperative. IAC drilling was performed in 31 of the vestibular schwannoma patients (92%). Dixit et al. reported gross total resection in 84.61% of patients, with subtotal resection in 15.38% [10].

Table 9. Distribution of cases according to resectability.

Tumor	Gross Total Excision 38 (76%)	Near-Total Excision 9 (18%)	Sub-Total Excision 3 (6%)
Vestibular Schwannoma (35)	27 (77.1%)	5 (14.2%)	3 (8.5%)
Meningioma (9)	6 (66.6%)	3 (33.2%)	0
Epidermoid (4)	3 (75%)	1 (25%)	0
Abscess (2)	2 (100%)	0	0

Memari et al. achieved gross total tumor excision in 70% of cases, meningioma in 18%, epidermoid cyst in 8%, and abscess in 4% [3]. Our study found CSF leaks in 16% of all patients; all were initially treated conservatively with lumbar drains and medication. Meningitis occurred in 10% of instances; two patients recovered with adequate treatment, while the remaining three, who also had concomitant CSF leak, deteriorated and died. Memari et al. found that in CP-angle patients, the retrosigmoid technique resulted in approximately 18% CSF leakage and 10% meningitis [3]. Lower cranial nerve palsy was observed in 20% of patients (8 deteriorated cases plus 2 new-onset cases) and was managed with nasogastric tube feeding; at 6 months, two patients showed partial improvement. In the vestibular schwannoma subgroup, 47.5% of patients had facial nerve palsy, while 22.5% had lower cranial nerve palsy. Jain et al. found a 6.8% incidence of lower cranial nerve paresis in their vestibular schwannoma series [6], while Dixit et al. found that 46.15% of patients experienced transient lower cranial nerve paresis, which eventually recovered [10]. The reported incidence of lower cranial nerve paresis in the wider literature ranges between 1.5% and 5.5%.

In our preoperative assessment, 74% of cerebellopontine angle tumor patients had no usable hearing (>50 dB). Of the 13 patients with functional hearing preoperatively, three (2 epidermoid cyst and 1 abscess patient) retained it postoperatively, giving an overall hearing preservation rate of 23%. In the vestibular schwannoma subgroup, hearing preservation was 0%. Hearing status at 6-month follow-up remained unchanged from the immediate postoperative period. Samii and Matthies observed hearing preservation in 23.6% of vestibular schwannoma

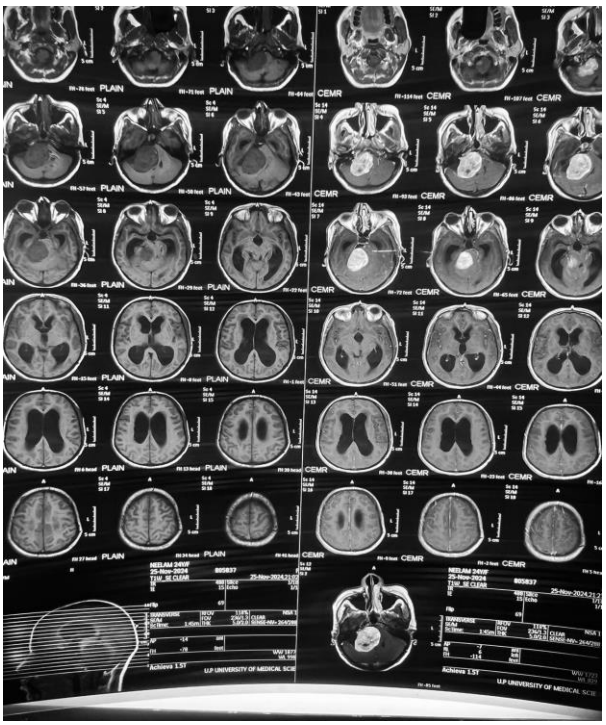
patients with large tumors [8], while Jain et al. found hearing preservation in 29.6% of patients with useful preoperative hearing [6].

In our series, three patients (two vestibular schwannomas and one meningioma) had recurrence and were managed conservatively, as neither was suitable for reoperation nor referral for stereotactic radiosurgery. Memari et al. found persistent or recurrent tumor in 7% of cases using the retrosigmoid technique [3]; in our series, the vestibular schwannoma subgroup experienced two recurrences. Gormley et al. reported complete tumor excision in 99% of vestibular schwannoma patients, with no indication of recurrence in their series [7]. Jain and Mehrotra reported complete tumor removal in 96.5% of their vestibular schwannoma patients [6].

In our study, overall mortality was 8%, primarily due to postoperative CSF leak and meningitis (Table 11). Memari et al. found a 2% mortality rate with the retrosigmoid technique in their CP angle series [3].

Table 11. Distribution of cases according to postoperative complications.

Complication	Patients
CSF leak	8
Hydrocephalus	3
Mortality	4
Recurrence	3
Meningitis	5
Lower cranial nerve palsy	10



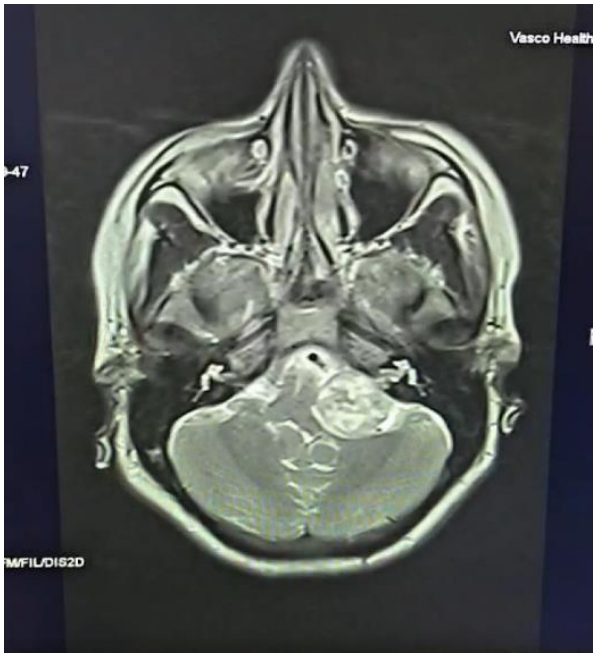


Figure 1-2. Representative preoperative imaging from the case series.

Conclusion

CPA space-occupying lesions were prevalent in the middle-age group, with females having a slightly higher frequency than males. The most commonly reported concerns were hearing loss and cerebellar abnormalities. The majority of lesions were large (31-40 mm). Most patients on admission had non-serviceable hearing. The majority of lesions showed heterogeneous enhancement with cystic components. Most patients had gross total excision, with vestibular schwannoma being the most frequent histopathological diagnosis. The most common complication was facial nerve palsy, and the risk of postoperative facial nerve palsy increased with tumor size. Overall mortality was 8%, primarily due to postoperative meningitis and CSF leakage.

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