Subtemporal "Interdural" Surgical Approach for "Giant" Facial Nerve Neurinomas

Atul Goel[1,2], Shashi Ranjan[1], Abhidha Shah[1], Survendra Rai[1], Sandeep Gore[1], Pralhad Dharurkar[1]

■ OBJECTIVE: **The management issues of 15 cases of giant and dumbbell-shaped facial neurinomas that extended both in the middle and posterior cranial fossa are reported.**

■ MATERIAL AND METHODS: **During the period 2002 to June 2017, we surgically treated 15 cases of giant and dumbbell shaped facial neurinomas: 10 males and 5 females ranging from 17–59 years (average 34.2 years). Average duration of facial nerve weakness before seeking surgical relief was 49.46 months. Fourteen patients had varying degrees of hearing disturbance. Seven patients had ataxia. The sizes of the tumor ranged from 5.2–8 cm (average being 6.2 cm). The tumors were in an "interdural" location, both in the middle and in the posterior cranial fossa. An extradural subtemporal "interdural" approach was used to resect the tumor in both compartments. The dural cover of the tumor provided a well-defined surgical plane of dissection. Tumor recurrence was observed in 3 cases. The tumor was interdural even at the time of recurrence.**

■ CONCLUSIONS: **Understanding the fact that the facial nerve neurinomas are interdural in nature and soft and necrotic in character can allow quick and safe surgery with a relatively small surgical exposure.**

INTRODUCTION

Facial nerve neurinomas are relatively rare. Only a few reports that detail the surgical strategy to these tumors are available in the literature. We report our 15-year experience with 15 giant and dumbbell-shaped facial nerve neurinomas that had a significant component of tumor in both the middle and posterior cranial fossae. Facial nerve neurinomas that were located predominantly in the cerebellopontine angle, mimicked acoustic neurinomas in their morphology, had relatively small petrous extension, and were operated by retrosigmoid approach were excluded. It was observed that the entire tumor, in both the middle and posterior cranial fossa, was confined within the layers of dura or was "interdural" in its location. A dural layer that circumferentially covered the tumor was relatively thick and provided a reliable, safe plane for surgical dissection.

MATERIAL AND METHODS

During the years 2002 to June 2017, the authors encountered 15 patients having "giant" (maximum dimension at least 5 cm in any perspective) and dumbbell-shaped facial neurinomas with a significant presence in both the middle and posterior cranial fossa, and a subtemporal operation route was used to resect both components of the tumor in a 1-stage operation (Figures 1–4). The 10 males and 5 females ranged in age from 17–59 years (average 34.2 years). Essentially, all patients presented with long-standing symptoms of progressive facial nerve weakness. Fourteen patients had ipsilateral hearing loss. There was relatively recent onset of ataxia in 7 patients, and this symptom was the primary problem that forced the patients to seek medical assistance.

All patients underwent computed tomography scan and magnetic resonance imaging examination. The tumor size measured 5.2–8 cm in their maximum dimension. There were cystic and necrotic changes in all cases. The solid portion enhanced on contrast administration. In 2 cases, there was a fluid level within the cystic component of the tumor. The petrous ridge and superior wall of the internal auditory meatus were eroded in all cases.

Surgery

A basal subtemporal approach was adopted in all patients during the first stage of surgery.[1,2] In 2 cases, the recurrence of the tumor following subtemporal surgery was treated by surgery by retrosigmoid approach. In 1 case recurrence following the subtemporal surgical approach was reoperated using the same surgical route.

For the subtemporal approach, the patient was placed in lateral surgical position and a lumbar drainage was set up before starting

Key words
- Acoustic neurinomas
- Facial neurinomas
- Geniculate ganglion
- Interdural tumor

From the [1]Department of Neurosurgery, K. E. M. Hospital and Seth G. S. Medical College, Parel; and [2]Lilavati Hospital and Research Centre, Bandra (E), Mumbai, India

To whom correspondence should be addressed: Atul Goel, M.Ch. [E-mail: atulgoel62@hotmail.com]

Citation: World Neurosurg. (2018) 110:e835-e841.
https://doi.org/10.1016/j.wneu.2017.11.127

*Journal homepage: **www.WORLDNEUROSURGERY.org***

*Available online: **www.sciencedirect.com***

1878-8750/$ - see front matter

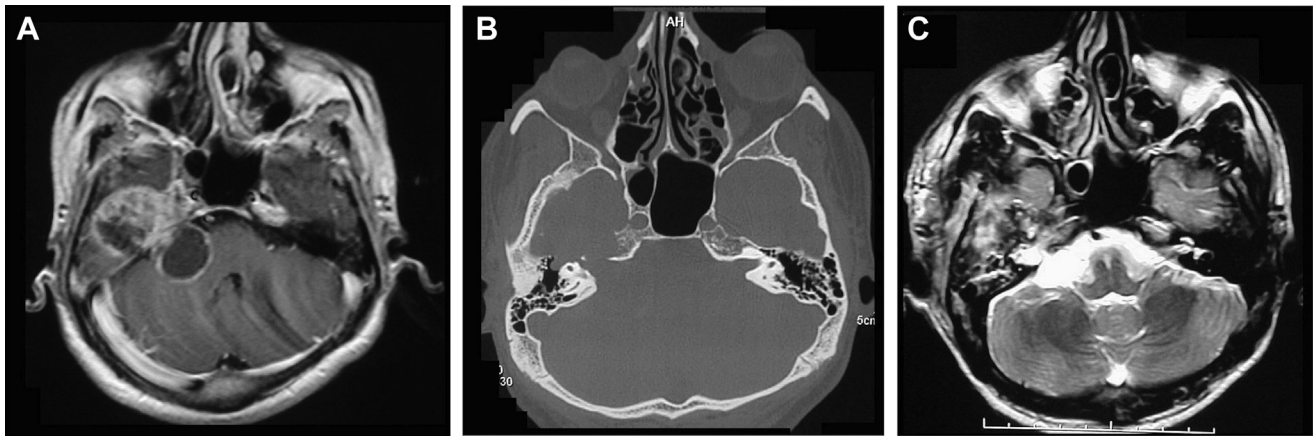

Figure 1. Images of a 26-year-old male patient. (**A**) T1-weighted contrast axial image showing the large dumbbell facial nerve neurinoma with middle and posterior cranial fossa extensions. (**B**) Axial computed tomography image showing the erosion of petrous bone. (**C**) Postoperative scan showing excision of the tumor through the subtemporal approach.

the operation. An extradural subtemporal approach was adopted to expose the tumor bulk that was centered on the rostral face of the petrous bone. A transverse incision was taken on the dura that covered the dome of the tumor. This dural membrane covered the tumor circumferentially and was distinct from subtemporal or middle fossa dura. The tumor was then debulked within the dural confines of the tumor or in the "interdural" plane. The relatively soft, necrotic, and cystic nature of the tumor allowed a quick tumor resection. The part of the tumor in the petrous bone and posterior cranial fossa was then resected through the large exposure obtained in the subtemporal region following tumor removal. Tumor resection in the posterior cranial fossa could be completed through the same exposure, or an intradural transtentorial approach was subsequently added to the exposure. The entire dissection in the middle fossa was conducted within the dural confines. Dura covered even the entire dome of the posterior fossa component of the tumor. Radical tumor resection was achieved in all cases. However, relatively little residue of tumor (<10% of original tumor volume) was inadvertently left behind in 3 cases. The carotid artery in the region of the petrous bone and other vital neural and vascular structures in the vicinity were not exposed as the dissection was conducted within the dural walls that displaced all these structures and formed a well-defined demarcation wall. Facial nerve could not be identified in continuity in its course in the vicinity of the tumor in any case.

RESULTS

Despite the fact that the facial nerve was not identified in continuity in any case, facial nerve function improved after surgery to a marginal extent in 5 patients. One patient underwent hypoglossal to facial nerve anastomosis. Although the facial nerve was severely paralyzed before and after surgery in all cases, only 2 patients needed lateral tarsorrhaphy for protection of the eye. Other patients did not need any other eye protection surgery. Moderate to severe hearing loss was present in 14 patients, both before and after surgery. Hearing improved to some degree following surgery in 6 cases.

The follow-up ranges from 3–174 months. Tumor recurrence was observed in 3 patients. In 1 patient the tumor recurred after 4 years, in the second patient it recurred after 3 years, and in the third patient it recurred after 15 years of first surgery. In all 3 cases, the tumor was radically resected and there was no demonstrated tumor residue on postoperative imaging. Two of these patients had tumors that were multicystic in nature and contained fluid level within the fluid of the cysts (**Figure 4B**). The tumor recurrence was also large and contained cystic areas with a fluid level within the fluid of cyst appearance (**Figure 4C**). The tumor continued to remain within the dural confines. The dural layer was significantly thicker at the time of recurrence than that observed at the time of initial surgery. The histology showed features characteristic of a benign neurinoma in all cases. The lesion was entirely benign even at the time of recurrence in all 3 cases.

DISCUSSION

Facial nerve neurinomas are relatively rare petrous bone tumors. The first report of facial neurinomas is credited to Schmidt in 1930.[3,4] Facial neurinomas account for <1% of all intrapetrous mass lesions.[3,5] Symon et al[6,7] reported that facial neuromas represented 1.9% of all intracranial neurinomas treated in their institution. In the year 2002, Shermon et al[7] reviewed the literature on the subject and identified 467 cases having facial neurinomas. The early and prominent symptom of facial nerve weakness and location along the course of the facial nerve differentiate facial nerve neurinomas from other tumors of the region like acoustic neurinomas or trigeminal neurinomas. Facial neurinomas can arise from any segment of the nerve during its course from the brainstem to the neuromuscular junction. However, origin from the region of the geniculate ganglion has been more often observed.[8-10] The predominant presence in the middle fossa and

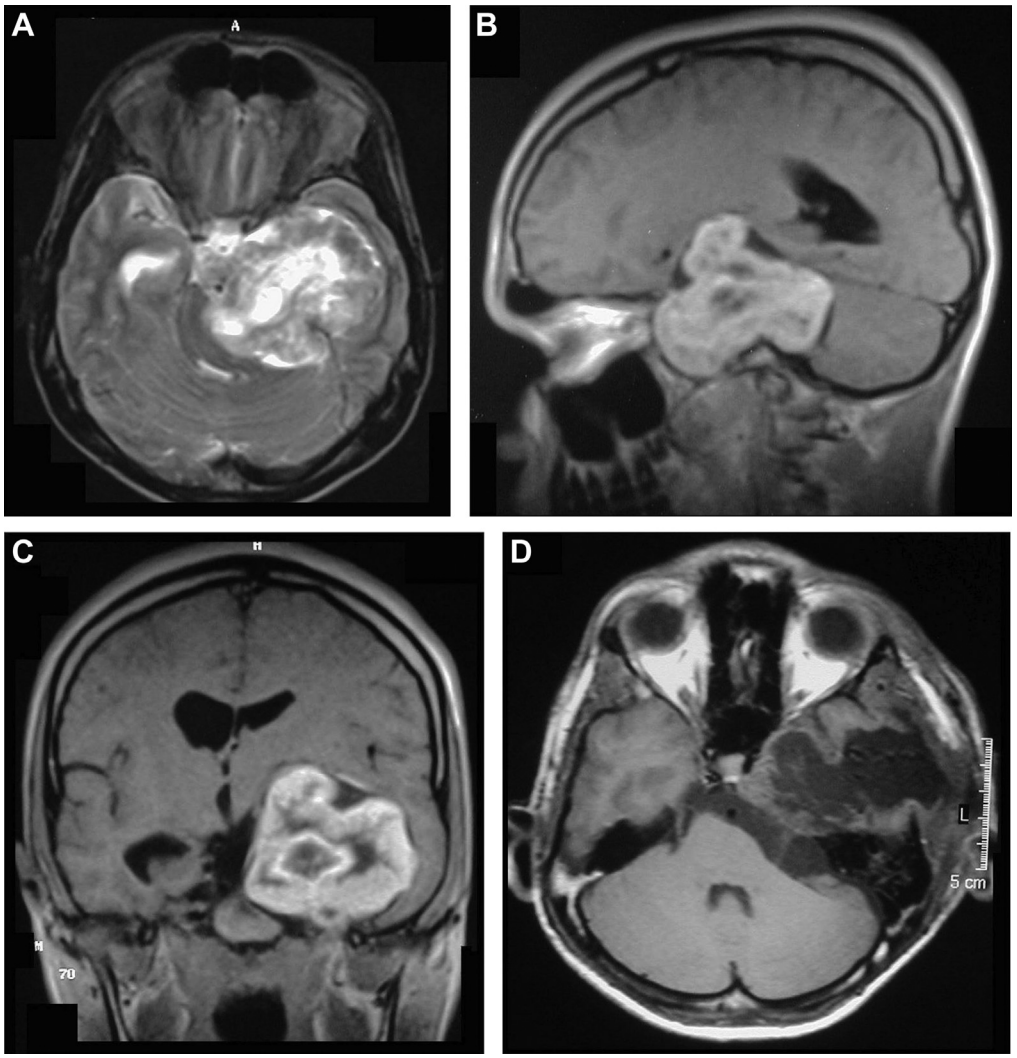

Figure 2. Images of a 17-year-old male patient. (**A**) T2-weighted axial image showing the variegated tumor extending into the middle and posterior cranial fossae. (**B**) Sagittal image showing the large facial nerve neurinoma. (**C**) Coronal image showing the tumor. (**D**) Postoperative image showing excision of the tumor.

extension in both middle and posterior cranial fossa compartments in our cases is clearly suggestive that the origin is in the region of geniculate ganglion. More often, facial neurinomas are located in the cerebellopontine angle and mimic acoustic neurinomas, and it may not even be possible to radiologically and physically differentiate between them. However, a more extensive extension of the tumor into the internal auditory canal and primary presentation as facial nerve paresis differentiates facial neurinomas from acoustic neurinomas. Such facial neurinomas where the tumors were primarily extending into the cerebellopontine angle and had a relatively small intrapetrous extension were not included in the study. We have included only giant facial neurinomas that had both middle and posterior fossa components and a dumbbell shape. Although it cannot be convincingly reported that primarily posterior fossa facial neurinomas are interdural in nature, giant facial neurinomas that have both middle and posterior fossa components were limited circumferentially by a dural cover. We have also excluded facial nerve neurinomas that were associated with neurofibromatosis.

Apart from headaches, facial nerve paresis/palsy is a major and early presenting symptom of facial neurinomas. The average duration of this symptom was 49.46 months (Table 1). The neglect of this crucial and disabling symptom of facial nerve weakness for long periods of time appears essentially related to illiteracy and inability to procure timely and specialized medical consultation. The delay in diagnosis provides an opportunity to learn the growth pattern and clinical course of neglected tumor. In 14 patients, the hearing was affected in varying degrees. Seven

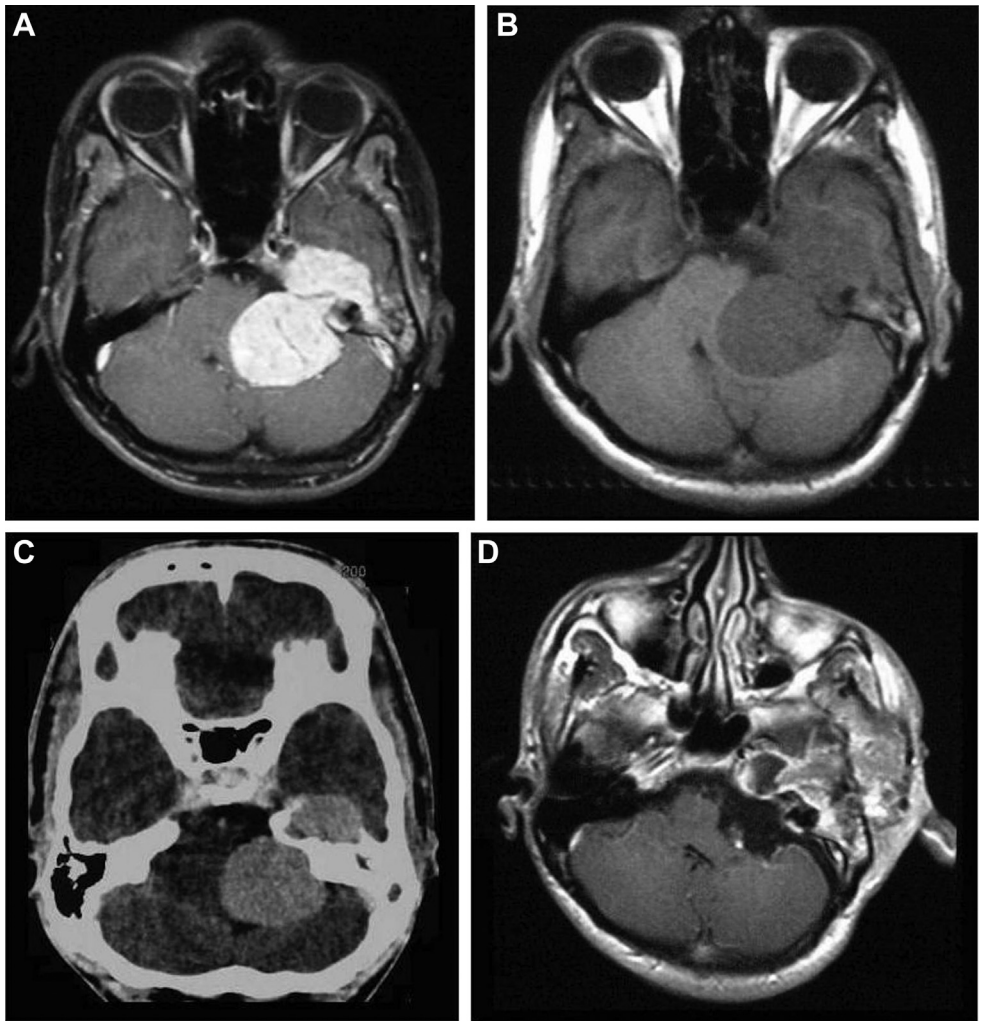

Figure 3. Images of a 16-year-old male patient. (**A**) T1-weighted axial contrast image showing the facial nerve neurinoma. (**B**) T1-weighted axial scan showing the tumor. (**C**) Axial computed tomography image showing the erosion of the petrous bone by the tumor. (**D**) Postoperative image showing excision of the tumor.

patients had ataxia as the major symptom that forced them to seek medical assistance. In 2 patients the vision was affected. Other reported symptoms include tinnitus, hemifacial spasms, convulsions, otalgia, and decreased lacrimation. The tumor is "contained" within the dural compartment, the pressure effect on the adjoining cerebral parenchyma and other neural structures is limited, symptoms are longstanding, and presentation is delayed. Despite the large tumor size, there was only limited evidence of an increase in intracranial pressure–related symptoms.

The average maximum dimension of the tumor was 6.2 cm. The tumor had cystic and necrotic changes in all cases. Such changes are generally suggestive of a more aggressive nature of the tumor. In 2 cases, there was a fluid level within the fluid or necrotic compartment of the tumor. We earlier identified fluid level within the cyst of trigeminal neurinomas, pituitary tumors, and spinal neurenteric tumor.[11-13] Such fluid level within the tumor cyst is suggestive of high protein content of the cyst material or old bleeding within the tumor confines. We identified that tumors with fluid level within the tumor cysts have a more aggressive clinical course and high recurrence rate.[11] Although other tumors can mimic facial neurinomas, long-standing history of facial weakness and characteristic imaging features can help diagnosis such that appropriate planning of the surgical strategy can be done.

In 1995 we discussed the infratemporal fossa "interdural" surgical approach to trigeminal neurinomas.[14] In our article, we discussed that the middle fossa component of the tumor remains confined to the dural compartment of the lateral wall of the cavernous sinus or is "interdural" in location, while the

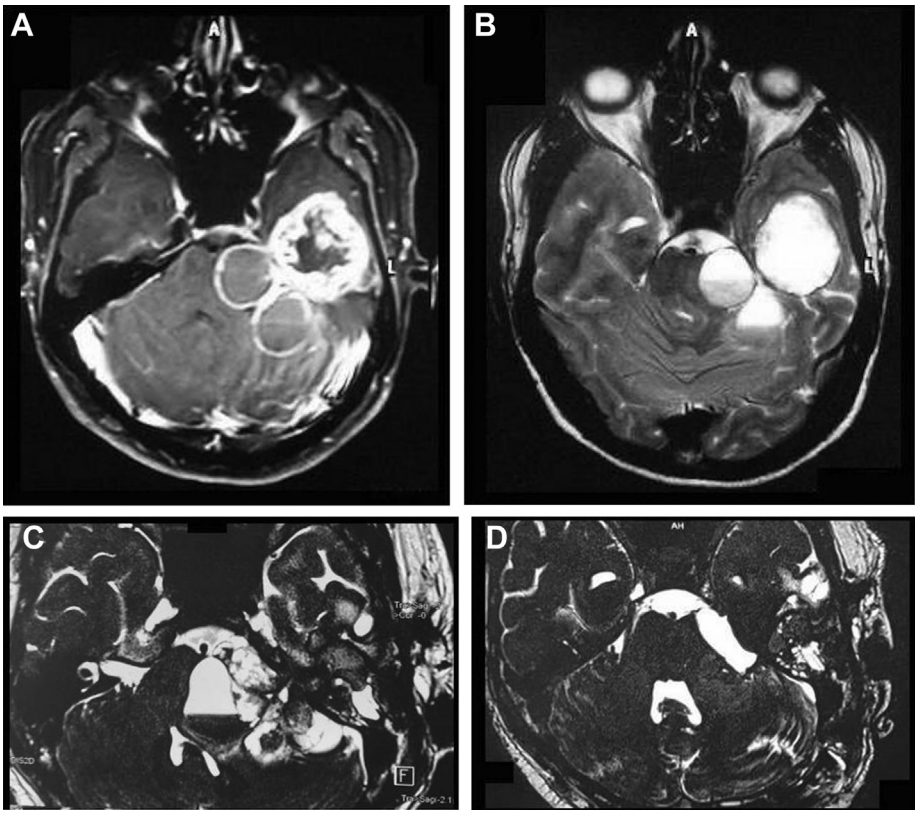

Figure 4. Images of a 20-year-old male patient. (**A**) Axial contrast image of magnetic resonance imaging showing the multiloculated solid cystic tumor. (**B**) T2-weighted axial image showing the fluid–fluid level within the tumor. (**C**) Axial T2-weighted images showing the recurrence 3 years after surgery. The recurrent tumor also exhibits multiple fluid–fluid levels. (**D**) Postoperative image after the second surgery showing excision of the tumor.

posterior cranial fossa component is located in the "intradural" or subarachnoid compartment. It was observed that despite the fact that some tumors achieve a large size, they remain confined to their dural compartment and do not transgress it. We further discussed that the extracranial component of multicompartment trigeminal neurinomas also has a defined "dural" layer that covers it and this layer provides a safe plane of surgical dissection.[13] It was observed that in some large dumbbell-shaped trigeminal neurinomas, even the posterior cranial fossa component of the tumor is covered circumferentially by dura.[13] We discussed similar interdural relationships of occulomotor neurinomas and neurinomas related to the C2 spinal nerve.[15,16] On the basis of these observations, we limited the surgical exposure and resected even large trigeminal neurinomas essentially without opening the skull[13,17] and large C2 spinal neurinomas without laminectomy.[16] According to our observations regarding the location of the facial neurinomas within the defined dural layers, it appears that the surgery on these tumors can be remarkably straightforward. To understand the fact that the so-called capsule of the tumor is actually a normal and stretched dural layer and need not be surgically resected provides an opportunity to limit the exposure and resect the tumor within the defined dissection plane. Kawase et al[18] reported 4 cases of facial neurinomas probably arising from the greater superficial petrosal nerve in the region of petrous bone. They identified the "interdural" nature of these tumors.

The dural cover over the dome of the facial neurinomas displaced all the adjoining critical neural and vascular structures that included the internal carotid artery and cochlea and vestibule in the region of the petrous ridge and adjoining cranial nerves in the posterior cranial fossa. The dural cover was significantly thick in nature. It was thicker at the time of recurrence and provided a reliable plane for surgical dissection. The surgical exposure could be reduced, and there was no need to have any control, proximal or distal, of the internal carotid artery. The extensive venous plexuses in the region were displaced by the growing tumor mass. Although the exact cause of improvement in the facial nerve function after surgery cannot be clearly hypothesized, it appears that retaining of the dural wall of the tumor and tumor resection by blunt dissection without any major tumor coagulation helped to retain the function of the nerve. The situation was similar to preservation

Table 1. Table Showing Clinical and Radiologic Features and Outcome After Surgery

Sex/Age	Duration of Facial Weakness	Size of Tumor (cm)	Outcome of Facial Function and Hearing	Recurrence
F/33	1 year	6.2	Facial function improved	Recurrence after 4 years—reoperated by retrosigmoid route
M/30	2 and half years	5.4	Facial and hearing improved	—
M/26	3 months	5.2	Tarsorrhaphy done	—
M/35	1 year	6.6	Tarsorrhaphy done	—
F/30	3 years	5.9	Facial function improved	—
M/42	2 years	5.9	Faciohypoglossal anastomosis performed	Recurrence after 15 years—reoperated by subtemporal route
M/59	28 years	6.3	Hearing improved	—
M/35	3 years	5.3	Hearing improved	—
F/30	2 years	5.6	Hearing improved	—
F/35	5 years	6.5	Hearing improved	—
M/20	3 years	6	Facial and hearing unchanged	Recurrence after 3 years—reoperated by retrosigmoid route
M/16	3 years	6.5	Facial and hearing unchanged	—
F/59	5 years	8	Facial and hearing unchanged	—
M/47	1 month	6	Facial and hearing improved	—
M/17	3 years	7	Facial improved	—

of third nerve function in oculomotor neurinomas following preservation of the dural wall. Preservation of the dura in the vicinity of the petrous bone appears important in this respect. Identification and preservation of the facial nerve are possible and must be necessarily pursued during surgery for smaller facial nerve neurinomas. Conley and Janecka first reported the technique of preservation of the facial nerve in such tumors.[19] However, facial nerve identification and preservation are difficult even in cases with small tumors as the nerve is widely splayed over the tumor. In several earlier reports, saving of anatomic continuity was not possible during surgery.[5,20-22] Although theoretically possible, restoring facial nerve function when it has been severely affected before surgery has never been convincingly demonstrated. Isolation of the facial nerve in the posterior cranial fossa and in its course distal to the tumor is possible. However, no attempts were made in this regard. In 6 patients we identified improvement in hearing after surgery. Preservation and improvement of hearing in such giant tumors also appears to be related to preservation of dura around the dome of the entire tumor.

In none of the cases in the presented series did the histologic examination show any evidence of malignancy. Despite the fact that tumor resection was incomplete in 3 patients, none underwent radiation treatment.[22,23] In 2 of the tumors that recurred in the series there was a fluid level within the cyst of the tumor. The recurrent tumor also demonstrated fluid level within the cyst cavity. The histologic examination did not reveal any evidence of aggressiveness or malignant transformation. The validity of up-front radiation treatment in such select group of patients cannot be concluded.

REFERENCES

1. Goel A, Nadkarni T. Basal lateral subtemporal approach for trigeminal neurinomas: report of an experience with 18 cases. *Acta Neurochir (Wien)*. 1998;141:711-719.
2. Goel A. Splitting of temporalis muscle for basal exposure—technical note. *Neurol Med Chir (Tokyo)*. 1997;37:59-62.
3. Pulec JL. Facial nerve neuroma. *Ear Nose Throat J*. 1994;73:721-752.
4. Kirazli T, Oner K, Bilgen C, Ovul I. Midilli. Facial nerve neurinoma: clinical, diagnostic and surgical features. *Skull Base*. 2004;14:115-120.
5. Lipkin AF, Coker NJ, Jenkins HA, Alford BR. Intracranial and intratemporal facial neuroma. *Otolaryngol Head Neck Surg*. 1987;96:71-79.
6. Symon L, Cheesman AD, Kawauchi M, Bordi L. Neuromas of the facial nerve: a report of 12 cases. *Br J Neurosurg*. 1993;7:13-22.
7. Shermon J, Dagnew E, Pensak M, van Loveran H, Tew J. Facial nerve neuromas: report of 10 cases and review of the literature. *Neurosurgery*. 2002;50:450-456.
8. Ito H, Hoshino T, Okawa Y, Asai Y, Nozue M, Yokoyama T, et al. Preoperative diagnosis of intratemporal facial nerve tumor: high-resolution CT and otoscopic findings in 4 cases. *Auris Nasus Larynx*. 1996;23:75-82.
9. Karagiannidis K, Noussios G, Morre T, Xanthopoulos J, Sakellariou T, Preponis C. Intraparotid facial nerve neurilemmoma: a case report. *Acta Otorhinolaryngol Belg*. 1998;52:37-39.
10. Dort J, Fisch U. Facial nerve schwannomas. *Skull Base Surg*. 1991;1:51-56.

11. Goel A, Shah A, Jhawar S, Goel N. Fluid—fluid level in pituitary tumors: analysis of management of 106 cases. *J Neurosurg*. 2010;112:1341-1346.

12. Jhawar S, Mahore A, Goel A. Intramedullary spinal neurenetric cyst with fluid-fluid level. *J Neurosurg Pediatr*. 2012;9:542-545.

13. Goel A, Shah A, Muzumdar D, Nadkarni T, Chagla A. Trigeminal neurinomas with extracranial extension: analysis of 28 surgically treated cases. *J Neurosurg*. 2010;113:1079-1084.

14. Goel A. Infratemporal fossa interdural approach for trigeminal neurinomas. *Acta Neurochir (Wien)*. 1995;136:99-102.

15. Goel A, Shah A. "Interdural" oculomotor neurinoma: report of two surgically treated cases. *Acta Neurochir (Wien)*. 2010;152:1721-1724.

16. Goel A, Muzumdar D, Nadkarni T, Desai K, Dange N, Chagla A. Retrospective analysis of peripheral nerve sheath tumors of the second cervical nerve root in 60 surgically treated patients. *J Neurosurg Spine*. 2008;8:129-134.

17. Goel A, Muzumdar D, Raman C. Trigeminal neuroma: analysis of surgical experience with 73 cases. *Neurosurgery*. 2003;52:783-790.

18. Ichimura S, Yoshida K, Sutiona A, Horiguchi T, Sasaki H, Kawase T. Greater petrosal nerve schwannomas—analysis of four cases and review of the literature. *Neurosurg Rev*. 2010;33:477-482.

19. Chung J, Ahn J, Kim J, Nam S, Kim C, Lee K. Facial nerve schwannomas: different manifestations and outcomes. *Surg Neurol*. 2004;62:245-252.

20. O'Donoghue GM, Brackmann DE, House JW, Jackler RK. Neuromas of the facial nerve. *Am J Otol*. 1989;10:49-54.

21. Saleh E, Achilli V, Naguib M, Taibah AK, Russo A, Sanna M, et al. Facial nerve neuromas: diagnosis and management. *Am J Otol*. 1995;16:521-526.

22. Ross L, Drazin D, Eboli P, Lekovic G. Atypical tumors of the facial nerve: case series and review of the literature. *Neurosurg Focus*. 2013;34:E2, 1-9.

23. Kida Y, Yoshimoto M, Hasegawa T. Radiosurgery for facial schwannoma. *J Neurosurg*. 2007;106:24-29.

Conflict of interest statement: The authors have no conflicts of interest to disclose.

Received 6 October 2017; accepted 22 November 2017

Citation: World Neurosurg. (2018) 110:e835-e841.
https://doi.org/10.1016/j.wneu.2017.11.127

Journal homepage: ***www.WORLDNEUROSURGERY.org***

Available online: ***www.sciencedirect.com***