Comparative Analysis of Surgical Working Corridors for Meckel Cave Trigeminal Schwannomas: A Quantitative Anatomic Study

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BACKGROUND AND OBJECTIVES: Volumetric analysis of the working corridors of the interdural approach to the Meckel cave may lead to a selection of routes which are anatomically more advantageous for trigeminal schwannoma resection. The herein-reported anatomic study quantitively compares the infratrochlear (IT) transcavernous, anteromedial (AM), and anterolateral (AL) corridors, highlighting their feasibility, indications, advantages, and limitations.

METHODS: Anatomic boundaries and depth of Meckel cave, porus trigeminus, IT transcavernous, AM, and AL corridors were identified in 20 formalin-fixed latex-injected cadaveric heads and were subsequently measured. The corridor areas and volumes were derived accordingly. Each opening angle was also calculated. Angles and volumes were compared using analysis of variance. Statistical significance was set at a *P*-value <.05.

RESULTS: The IT transcavernous corridor volume was greater than that of the AM and AL. The opening angle of the AM middle fossa triangle was wider than the other 2.

CONCLUSION: The IT corridor can be advantageous for Meckel cave schwannomas invading the cavernous sinus and those with a notable extension into the posterior fossa because the transcavernous approach maximizes the working space into the retrosellar area. The AM middle fossa corridor is strategic in schwannomas confined to the Meckel cave with a minor extension into the posterior fossa. It raises the chance of total resection with a single approach involving the porus trigeminus opening.

KEY WORDS: Cavernous sinus, Meckel cave, Parkinson triangle, Transcavernous approach, Trigeminal schwannomas

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Trigeminal schwannomas (TSs) account for approximately 0.1%–0.4% of intracranial tumors and 1%–8% of all intracranial neurinomas.[1-10] The trigeminal ganglion is involved in 78%–93% of cases.[3,7,11,12] However, each trigeminal nerve segment along its course can be affected, as reported by Jefferson in 1955.[3] The Meckel cave is a classic site of volumetric expansion of these tumors, which may also extend into the posterior fossa, orbit, and pterygopalatine and infratemporal fossa. The multicompartmental development of TSs justifies their frequent dumbbell shape appearance on MRI. However, the cavernous sinus invasion through the lateral wall is quite rare.

ABBREVIATIONS: ACP, anterior clinoid process; **AL,** anterolateral; **AM,** anteromedial; **AMT,** anteromedial middle fossa triangle; **ANOVA,** analysis of variance; **BP,** basilar plexus; **C4,** cavernous segment of the internal carotid artery; **C5,** clinoid segment of the internal carotid artery; **C6,** ophthalmic segment of the internal carotid artery; **CS,** cavernous sinus; **DDR,** distal dural ring; **DP,** dura propria of the middle fossa; **ES,** epineural sheath; **FO,** foramen ovale; **FR,** foramen rotundum; **GG,** Gasserian ganglion; **GSPN,** greater superficial petrosal nerve; **IAC,** internal acoustic canal (unroofed); **III,** third cranial nerve; **ILT,** inferolateral trunk; **IT,** infratrochlear; **IV,** trochlear nerve; **LW,** lateral wall of the cavernous sinus; **M,** midbrain; **MWMC,** medial wall of the Meckel cave; **OC,** roof of the optic canal; **ON,** optic nerve; **Oph,** ophthalmic artery; **OS,** optic strut; **P,** pons; **PCP,** posterior clinoid process; **PLT,** posterolateral middle fossa triangle (Glasscock triangle); **PMT,** posteromedial middle fossa triangle (Kawase triangle); **PT,** porus trigeminus; **SOF,** superior orbital fissure; **SPS,** superior petrosal sinus; **TE,** tentorial edge; **TN,** trigeminal nerve (cut and reflexed); **TP,** trigeminal plexus; **TS,** trigeminal schwannomas; **V1,** first trigeminal division; **V2,** second trigeminal division; **V3,** third trigeminal division; **VI,** sixth cranial nerve.

Several approaches and technical notes have been reported for TSs, mainly based on the topographic regions involved and their growth pattern rather than size.[4,6,11-26] Based on the double-layer dural architecture of the middle cranial fossa, in the 90s, Dolenc popularized the so-called "epidural" approach for lesions arising within the Meckel cave, which was implemented for TS.[17,27] The term "epidural" was later converted to "interdural," which better delineates the steps underlying the surgical exposure of the lateral sellar compartment.[28,29] This approach converts a multicompartment tumor into a monocompartmental parasellar one, spanning from the superior orbital fissure to the porus trigeminus, which is extradurally resectable through a single approach in most cases. Owing to the anatomic overlap of the upper third of the trigeminal ganglion with the inferior third of the lateral wall of the cavernous sinus,[30] the posteromedial part of the Meckel cave is the most difficult to be accessed, even with the expansion of the Meckel cave secondary to the growing tumor. To reach the posteromedial part of the Meckel cave, 3 working corridors related to specific cavernous sinus triangles are suggested during the interdural approach, namely the infratrochlear (IT) transcavernous, anteromedial (AM), and anterolateral (AL) corridors. The IT transcavernous corridor is delimited by the trochlear nerve and the first trigeminal division, the AM corridor by the first and second trigeminal division, and the AL corridor by the second and third trigeminal division.

Dimensional studies on the working corridors related to the interdural approach to the Meckel cave are limited. However, these studies could provide evidence-based selection of specific volumetrically advantageous routes for trigeminal schwannoma resection while considering the distortion produced by the growing tumor.

The herein-described anatomic study summarizes the data of a quantitative comparative analysis between the working corridors, IT transcavernous, AM, and AL, inherent in the interdural approach to the Meckel cave. The anatomic description, feasibility, indications, advantages, and limitations of each corridor have been reported as they relate to Meckel cave TSs.

METHODS

The study was approved by the Internal Review Board, and patients' consent was obtained.

A total of 20 formalin-fixed cadaveric heads were used. The heads were injected with colored latex, red for arteries and blue for veins. The brain was removed, and the skull base was exposed. The peeling of the lateral wall of the cavernous sinus was performed bilaterally under microscopic vision (3×–40×), and the temporal dura was removed. The lateral wall of the cavernous sinus, Meckel cave, IT triangle, and middle fossa triangles[30] were exposed (Figure 1). Thereafter, a progressive stepwise dissection of the Meckel cave and cavernous sinus was completed. Through specific landmarks reported in Table 1, the anatomic boundaries of all these regions were identified and measured using a digital caliper. The thin arachnoid layer forming the lateral wall of the Meckel cave was then peeled off to skeletonize the trigeminal ganglion and the proximal part of the first, second, and third trigeminal divisions. The outer layer of the lateral wall of the cavernous sinus was also removed, thus exposing the oculomotor and trochlear nerve and the distal part of the first trigeminal division. The angle between the trochlear nerve and the first trigeminal division was measured (Figure 2). The angle formed by the first, second,

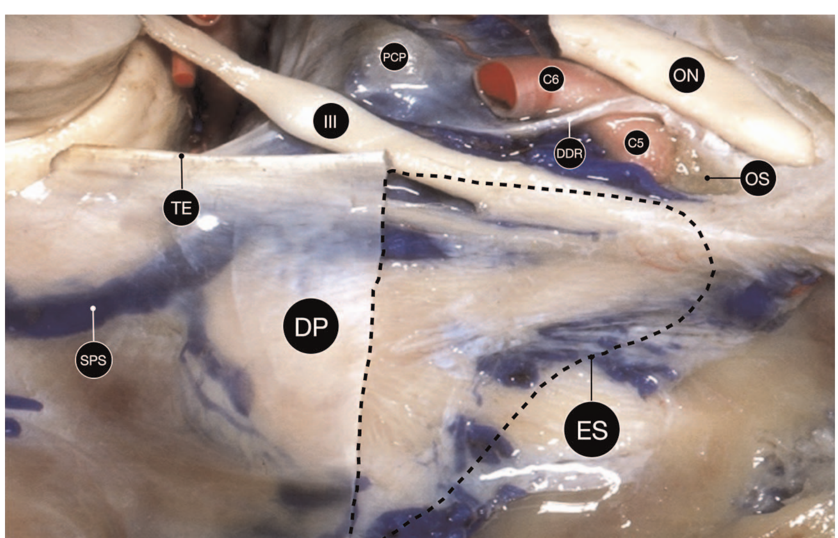

FIGURE 1. *Lateral wall of the cavernous sinus. DP, dura propria of the middle fossa; ES, epineural sheath (inner layer of the lateral wall of the cavernous sinus); C5, clinoid segment of the internal carotid artery; C6, ophthalmic segment of the internal carotid artery; OS, optic strut; ON, optic nerve; TE, tentorial edge; SPS, superior petrosal sinus; PCP, posterior clinoid process; DDR, distal dural ring; III, third cranial nerve.*

TABLE 1. Anatomic Boundaries of the Regions

Anatomic region	Border	Landmarks	
Infratrochlear triangle	Superior	Anterior	Posterior
		Oculomotor nerve-V1 intersection point	Apex of the PCP
	Inferior	Anterior	Posterior
		Oculomotor nerve-V1 intersection point	Medial most point of the PT
	Posterior	Superior	Inferior
		Apex of the PCP	Medial most point of the PT
Lateral wall of the Meckel cave	Posterior	Lateral	Medial
		Lateral most point of the PT	Medial most point of the PT
	Superior	Anterior	Posterior
		V1-V2 apex angle	Medial most point of the PT
	Anterior	Lateral	Medial
		GSPN-V3 intersection point	V1-V2 apex angle
	Inferior	Anterior	Posterior
		GSPN-V3 intersection point	Lateral most point of the PT
Medial wall of the Meckel cave	Posterior	Lateral	Medial
		Lateral most point of the PT	Medial most point of the PT
	Superior	Anterior	Posterior
		Trochlear nerve-V1 intersection point	Medial most point of the PT
	Anterior	Lateral	Medial
		GSPN-V3 intersection point	V1-V2 apex angle
	Inferior	Anterior	Posterior
		Lateral most point of the foramen lacerum	Lateral most point of the PT
AM triangle	Superior	Anterior	Posterior
		Lateral most point of the SOF	V1-V2 apex angle
	Inferior	Anterior	Posterior
		Medial most point of the FR	V1-V2 apex angle
	Anterior	Superior	Inferior
		Lateral most point of the SOF	Medial most point of the FR
AL triangle	Superior	Anterior	Posterior
		Lateral most point of the FR	V2-V3 apex angle
	Posterior	Superior	Inferior
		V2-V3 apex angle	Medial most point of the FO
	Anterior	Superior	Lateral
		Lateral most point of the FR	Medial most point of the FO

TABLE 1. Continued.

Anatomic region	Border	Landmarks	
Posterolateral triangle	Posterior	Medial	Lateral
		GSPN-V3 intersection point	Hiatus for GSPN
	Anterior	Medial	Lateral
		Lateral most point of the FO	Hiatus for GSPN
	Medial	Anterior	Posterior
		Lateral most point of the FO	GSPN-V3 intersection point
Posteromedial triangle	Medial	Anterior	Posterior
		GSPN-V3 intersection point	Lateral most point of the PT
	Lateral	Anterior	Posterior
		Hiatus for GSPN	Lateral most point of the PT
	Anterior	Medial	Lateral
		GSPN-V3 intersection point	Hiatus for GSPN

FO, foramen ovale; FR, foramen rotundum; GSPN, greater superficial petrosal nerve; PCP, posterior clinoid process; PT, porus trigeminus; SOF, superior orbital fissure; V1, first trigeminal division; V2, second trigeminal division; V3, third trigeminal division.

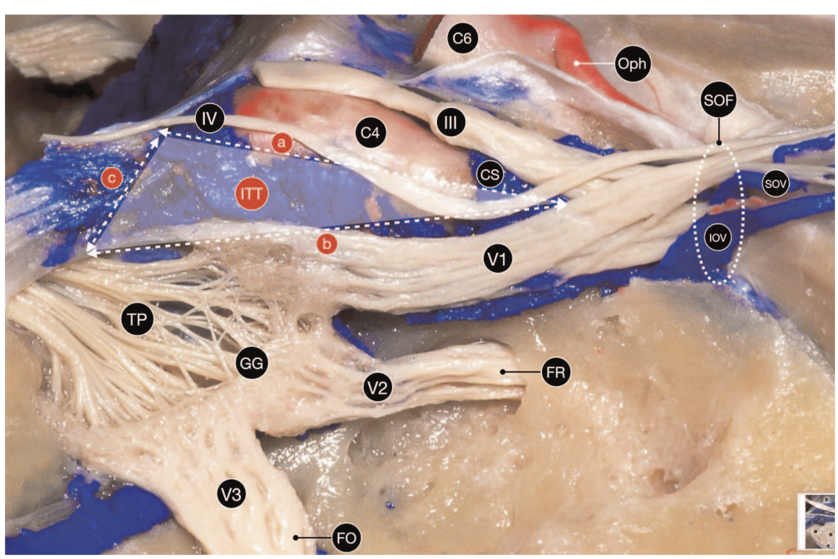

FIGURE 2. *Content of the Meckel cave and infratrochlear triangle. TP, trigeminal plexus; IV, trochlear nerve; GG, Gasserian ganglion; V1, first trigeminal division; V2, second trigeminal division; V3, third trigeminal division; FO, foramen ovale; FR, foramen rotundum; C6, ophthalmic segment of the internal carotid artery; C4, cavernous segment of the internal carotid artery; III, third cranial nerve; CS, cavernous sinus; Oph, ophthalmic artery; SOF, superior orbital fissure; SOV, superior ophthalmic vein; IOV, inferior ophthalmic vein; ITT, infratrochlear triangle; a, medial border of the infratrochlear triangle; b, lateral border of the infratrochlear triangle; c, posterior border of the infratrochlear triangle.*

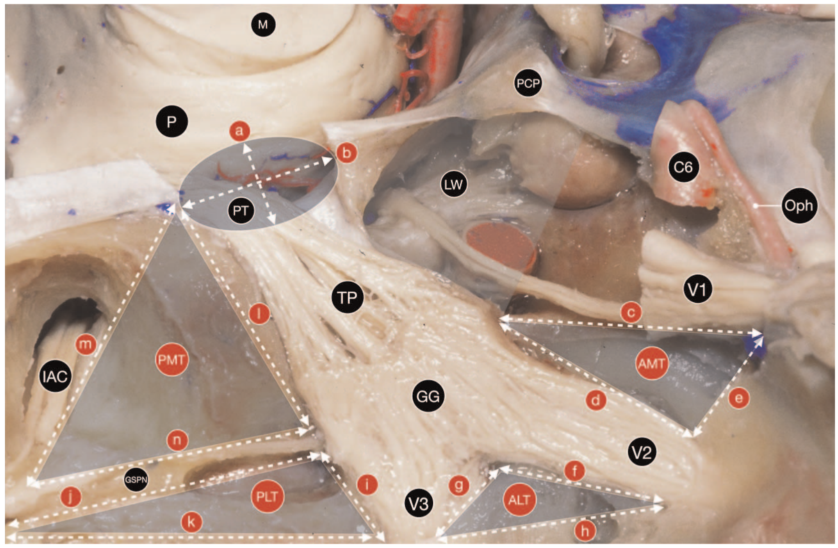

FIGURE 3. *Middle fossa triangles. TP, trigeminal plexus; GG, Gasserian ganglion; LW, lateral wall of the cavernous sinus; V1, first trigeminal division; V2, second trigeminal division; V3, third trigeminal division; GSPN, greater superficial petrosal nerve; P, pons; M, midbrain; PCP, posterior clinoid process; C6, ophthalmic segment of the internal carotid artery; Oph, ophthalmic artery; PT, porus trigeminus (unroofed); a, height of the porus trigeminus; b, width of the porus trigeminus; AMT, anteromedial middle fossa triangle; c, medial border of the anteromedial middle fossa triangle; d, lateral border of the anteromedial middle fossa triangle; e, anterior border of the anteromedial middle fossa triangle; ALT, anterolateral middle fossa triangle; f, medial border of the anterolateral middle fossa triangle; g, lateral border of the anterolateral middle fossa triangle; h, anterior border of the anterolateral middle fossa triangle; PLT, posterolateral middle fossa triangle (Glasscock triangle); i, medial border of the posterolateral middle fossa triangle; j, lateral border of the posterolateral middle fossa triangle; k, anterior border of the posterolateral middle fossa triangle; PMT, posteromedial middle fossa triangle (Kawase triangle); l, medial border of the posteromedial middle fossa triangle; m, lateral border of the posteromedial middle fossa triangle; n, anterior border of the posteromedial middle fossa triangle; IAC, internal acoustic canal (unroofed).*

and second and third divisions were also calculated (Figure 3). The trigeminal nerve was then cut at the level of the porus trigeminus and reflected anteriorly to reveal the posterior part of the medial wall of the Meckel cave and the suprameatal tubercle area (Figure 4). The area of the IT and middle fossa triangles, porus trigeminus, and lateral and medial walls of the Meckel cave were calculated.

The Meckel cave depth was assumed to be the distance between the lateral and medial walls. The AM, AL, and IT triangles were considered the main surgical corridors to access the medial aspect of the Meckel cave, and each volume was calculated. The AM and AL corridor volume was derived by the respective areas multiplied by the width of the Meckel cave (Figure 5). The IT triangle was then opened, and its depth was measured as the distance between the trochlear and abducens nerve on the coronal axis. The volume of the IT triangle was calculated as follows: area × depth (Figure 6). A *t*-test was used for the left-side and right-side measurements while analysis of variance was used to compare the volumes and the opening angles of the 3 surgical corridors analyzed. Statistical significance was set at a *P*-value <.05.

RESULTS

Regarding the parameters of the IT and middle fossa triangles, no differences were found between the left and right sides, apart from the 2 exceptions attributable to the interindividual anatomic variability (Table 2). The interquartile ranges of the opening angles of the working corridors, those of the area of the topographic regions, and those of the Meckel cave and the 3 surgical corridors are reported in Figures 7, 8, and 9, respectively. Table 3 summarizes data from the Meckel cave, where some significant differences produced a slight variability involving only specific linear parameters. The volume of the IT transcavernous corridor was significantly greater than that of the AM and AL, the latter showing similar data (Table 4, Figures 10 and 11). The opening angle of the AM middle fossa triangle was statistically wider than the other 2 (Table 5, Figure 12).

DISCUSSION

The quantitative comparative analysis between the working corridors, IT transcavernous, AM, and AL, inherent in the interdural approach to the Meckel cave resulted to 2 critical pieces of evidence: first, the IT corridor has the greatest volume and second, the opening angle of the AM middle fossa triangle is the widest among the 3 corridors. The volume and the opening angle of the

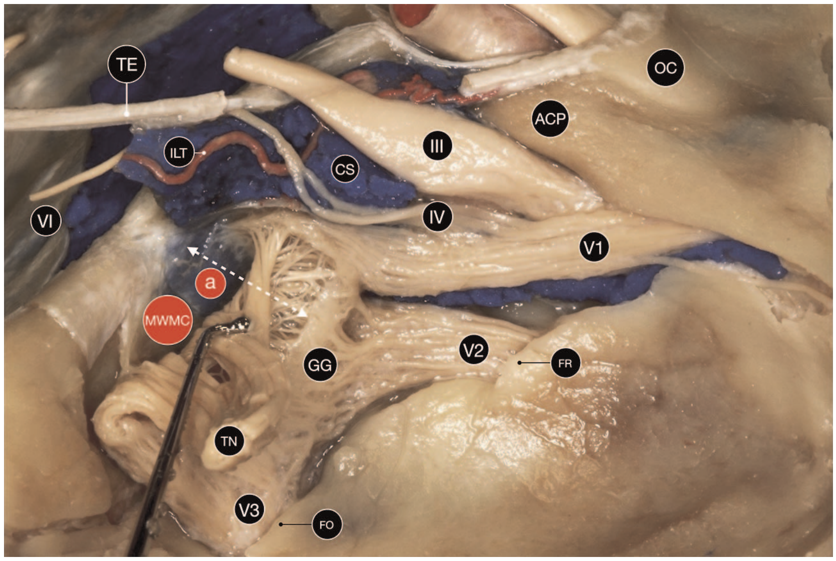

FIGURE 4. *Meckel cave. MWMC, medial wall of the Meckel cave; a, height of the Meckel cave; TN, trigeminal nerve (cut and reflexed); GG, Gasserian ganglion; V1, first trigeminal division; V2, second trigeminal division; V3, third trigeminal division; FO, foramen ovale; FR, foramen rotundum; TE, tentorial edge; VI, sixth cranial nerve; CS, cavernous sinus; ILT, inferolateral trunk; III, third cranial nerve; IV, trochlear nerve; ACP, anterior clinoid process; OC, roof of the optic canal.*

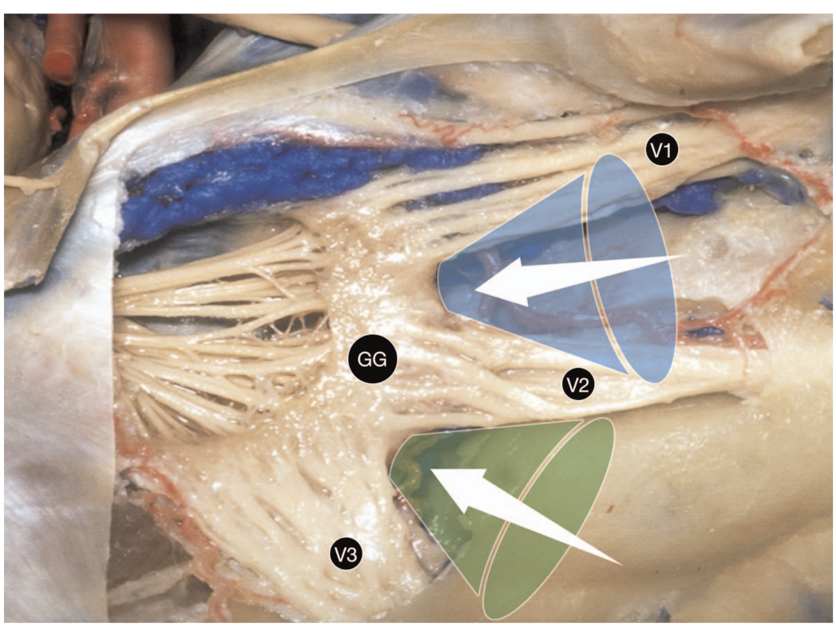

FIGURE 5. *Schematic view of the working space of the anteromedial and anterolateral corridor. Turquoise area, anteromedial corridor; green area, anterolateral corridor; GG, Gasserian ganglion; V1, first trigeminal division; V2, second trigeminal division; V3, third trigeminal division.*

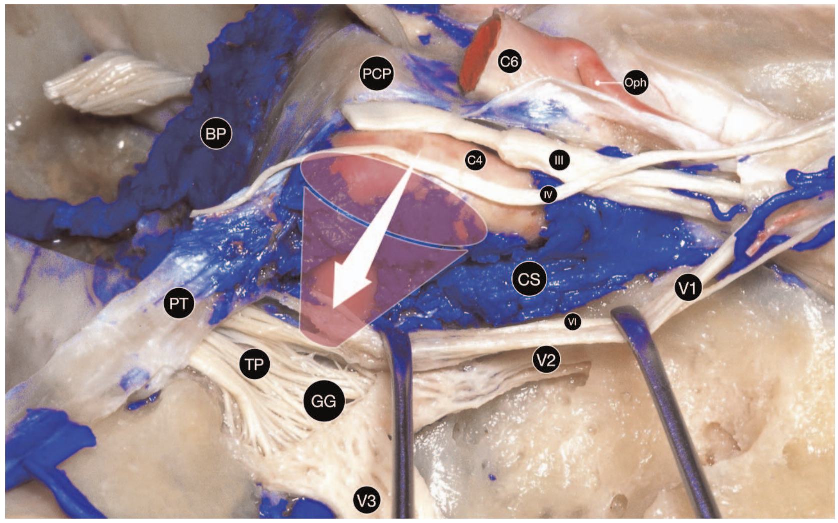

FIGURE 6. *Schematic view of the infratrochlear corridor working space. Purple area, expanded infratrochlear corridor; CS, cavernous sinus; IV, trochlear nerve; III, third cranial nerve; C4, cavernous segment of the internal carotid artery; VI, sixth cranial nerve; PT, porus trigeminus; TP, trigeminal plexus; GG, Gasserian ganglion; V1, first trigeminal division; V2, second trigeminal division; V3, third trigeminal division; BP, basilar plexus; PCP, posterior clinoid process; C6, ophthalmic segment of the internal carotid artery; Oph, ophthalmic artery.*

TABLE 2. Data of Infratrochlear and Middle Fossa Triangles

Anatomic region	Parameter	Side	Mean	SD	*P* value
Infratrochlear triangle	Angle (°)	L	14.9	2.2	.738
		R	15.2	1.6	
	Area (mm^2)	L	18.3	2.4	.347
		R	17.4	1.9	
	Depth (mm)	L	5	1.1	.223
		R	4.4	0.9	
AM triangle	Angle (°)	L	27.3	2.5	.082
		R	29.3	2.4	
	Area (mm^2)	L	35.1	2.6	.053
		R	32.2	3.7	
AL triangle	Angle (°)	L	116.5	7.1	.943
		R	116.7	5.3	
	Area (mm^2)	L	50.9	2.8	.868
		R	51.2	3.8	

AL, anterolateral; AM, anteromedial; L, left; R, right.

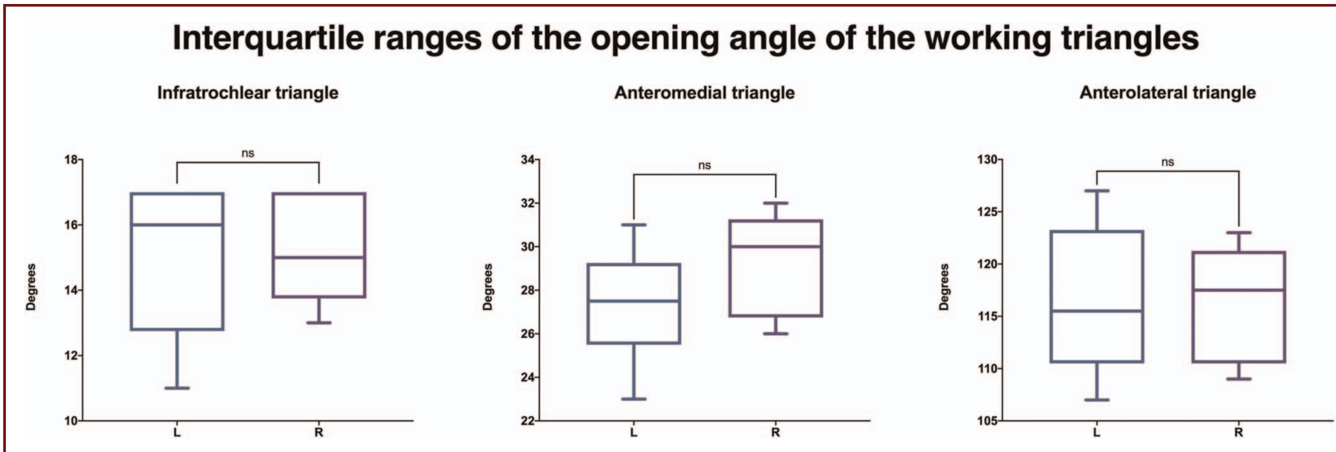

FIGURE 7. *Interquartile ranges of the working triangle opening angle. L, left; R, right.*

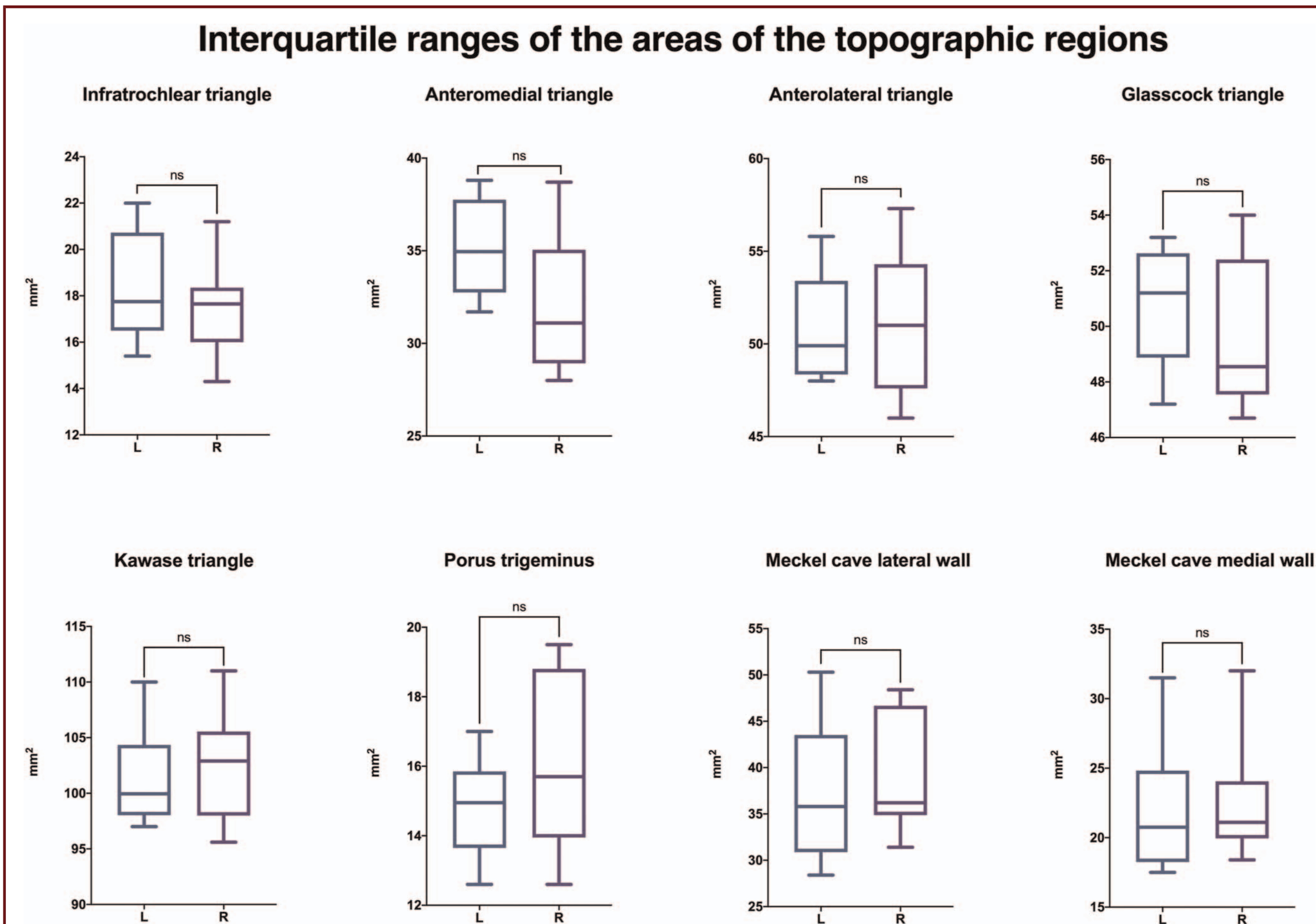

FIGURE 8. *Interquartile ranges of the areas of the topographic regions. L, left; R, right.*

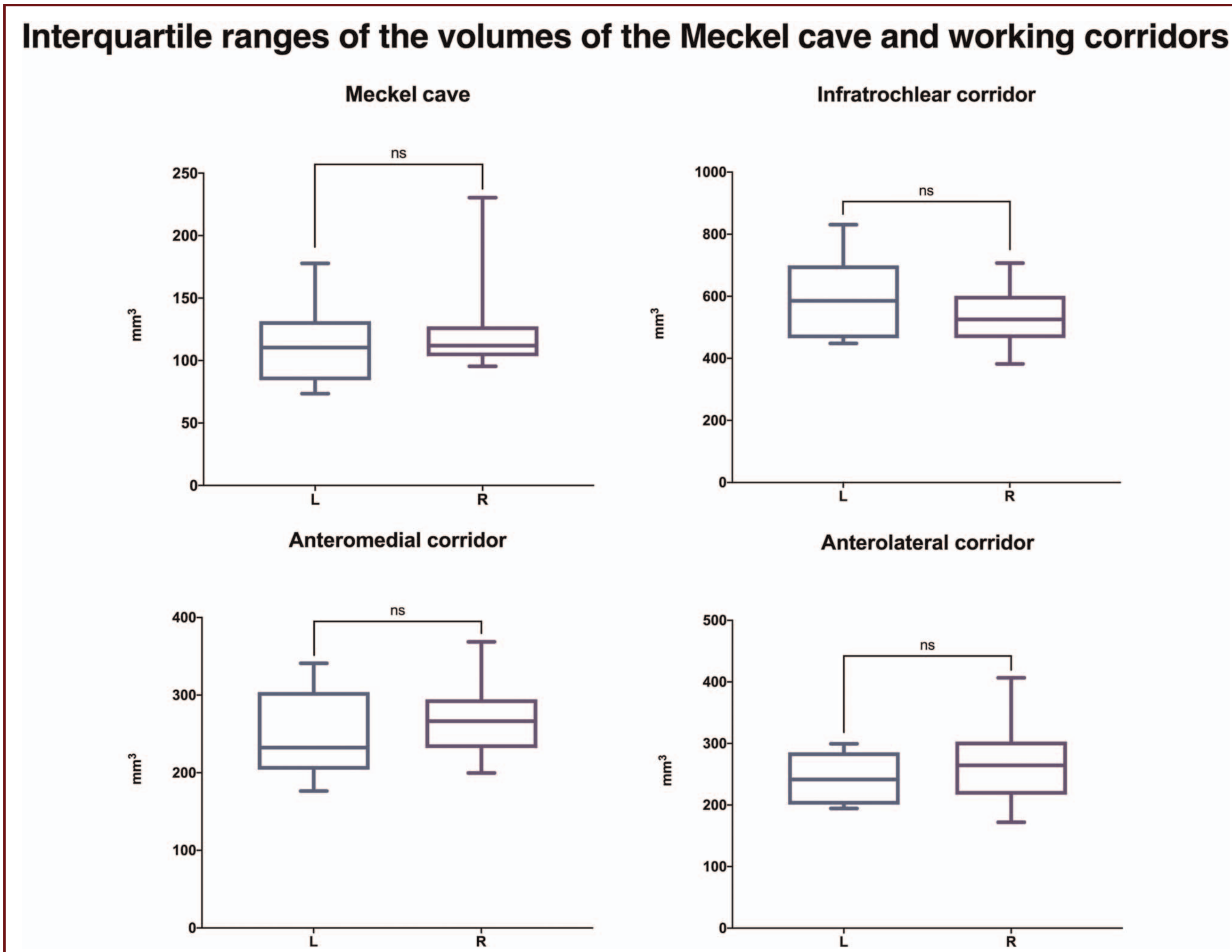

FIGURE 9. *Interquartile ranges of the Meckel cave and working corridor volumes. L, left; R, right.*

TABLE 3. Data of Meckel Cave

Anatomic region		Parameter	Side	Mean	SD	*P* value
Meckel cave	Lateral wall	Area (mm^2)	L	37.5	7.5	.666
			R	38.8	6.2	
	Medial wall	Area (mm^2)	L	22.1	4.4	.871
			R	22.4	4	
		Depth (mm)	L	5.1	1.1	.393
			R	5.5	1	
		Volume (mm^3)	L	113.2	32.4	.490
			R	230.4	38.8	

L, left; R, right.

TABLE 4. Volumetric Data of the Surgical Corridors

				P values		
Surgical corridors	**Side**	**Mean**	**SD**	**L vs R**	**AM vs AL**	**IT vs AM vs AL (ANOVA)**
IT (mm^3)	L	592.2	134.3	.3007		<.0001
	R	537.3	92.2			
AM (mm^3)	L	247.9	59.1	.4339	.9178	
	R	267.6	50.7			
AL (mm^3)	L	244.2	41.2	.3674		
	R	267.6	68.6			

AL, anterolateral; AM, anteromedial; ANOVA, analysis of variance; IT, infratrochlear transcavernous; L, left; R, right.

surgical working corridor affect the surgical freedom and the maneuverability of the instruments within the surgical field. Nevertheless, further considerations are warranted regarding IT and AM corridors, especially regarding the unavoidable mass effect produced by the growing tumor within the expanded Meckel cave.

IT Transcavernous Corridor

The IT corridor is a transcavernous corridor originally described by Dwight Parkinson in 1965 for treating traumatic carotid-cavernous fistula.[31] It can be further expanded through the opening of the oculomotor triangle, cerebrospinal fluid release from the oculomotor cistern, oculomotor nerve medialization, and trochlear nerve mobilization. For giant schwannomas, an intradural posterior clinoidectomy can even be performed. These adjoints are the basic maneuvers recommended by Dolenc and Krisht to maximize the working area of the Parkinson triangle during the transcavernous approach for the basilar tip and superior cerebellar artery aneurysms and, more broadly, the anterior upper third of the posterior fossa.[32-36] The same technique can be used to achieve the proximal control of the horizontal segment of the intracavernous internal carotid artery for temporary clipping during paraclinoid aneurysm surgery.[37]

The posterior portion of the cavernous sinus can serve as both a surgical target itself and a transition zone to reach the surgical target. Hence, the IT transcavernous corridor is indicated because of its 2 advantages: in cases where the schwannoma invades the lateral wall of the cavernous sinus through the weak orifices and for giant dumbbell-shaped Meckel cave TSs with a significant extension into the posterior fossa. In the latter case, the transcavernous approach maximizes the working space into the retrosellar area, increasing the chance of total resection using a single approach.

AM Middle Fossa Corridor

The AM working corridor is the most natural route to the medial wall of the Meckel cave and, for this reason, also the most used to reach the posteromedial part of those TS arising within the Meckel cave causing its progressive expansion.[12,13,17,28,29,38-42] In this study, the opening angle between the first and second trigeminal divisions was confirmed to be the widest, allowing direct access to the medial side of the trigeminal ganglion.

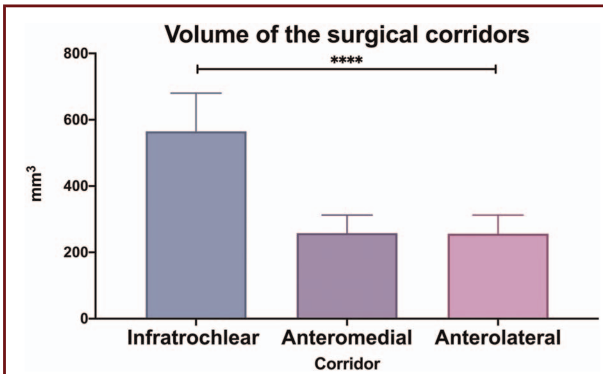

FIGURE 10. *Comparison of the surgical corridor volume.*

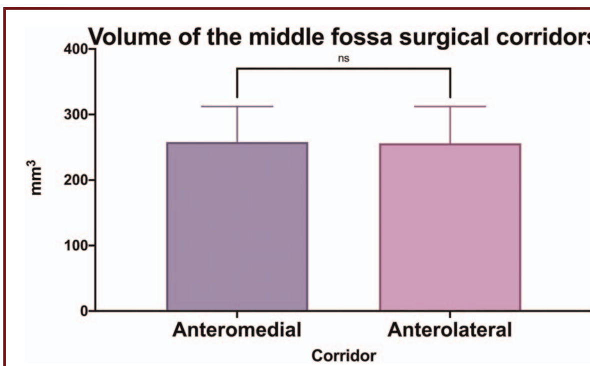

FIGURE 11. *Comparison of the middle fossa corridor volume.*

TABLE 5. Data of Angular Opening of the Surgical Corridors

Surgical corridors	Side	Mean	SD	*P*-value (ANOVA)
IT (°)	L	14.9	2.2	<.0001
	R	15.2	1.6	
AM (°)	L	27.3	2.5	
	R	29.3	2.4	
AL (°)	L	116.5	7.1	
	R	116.7	5.3	

AL, anterolateral; AM, anteromedial; ANOVA, analysis of variance; IT, infratrochlear transcavernous; L, left; R, right.

Compared with the IT, the AM corridor is more tangential to the posterior part of the medial wall of the Meckel cave, trigeminal ganglion, and lateral wall of the cavernous sinus. Accordingly, there is a lower chance of accidental injury into the lateral wall of the cavernous sinus with the AM corridor. Moreover, it allows a more direct line of sight to the suprameatal tubercle area and easier resection of the small infratentorial part of the tumor, as reported in illustrative case #1. In TSs confined to the Meckel cave, without invasion of the lateral wall of the cavernous sinus and with a small extension into the posterior fossa through the porus trigeminus, an AM middle fossa corridor is more advantageous and therefore indicated. Among Meckel cave TS, these cases are the most frequent. The likelihood of achieving a gross total tumor resection with a single extradural extracavernous approach involving the opening of the porus trigeminus is very high **(illustrative case #1)**. Conversely, the main limitation of the AM operative corridor is that it cannot be easily expanded unless anterior clinoidectomy is performed, there is opening of the foramen rotundum and release of the second division, or there is anterior petrosectomy and tentorial incision.

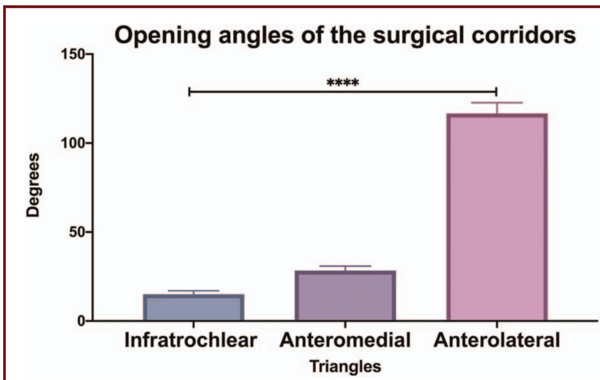

FIGURE 12. *Comparison of the surgical corridor opening angles.*

Two illustrative cases from the institutional series are reported below to highlight the versatility of the AM middle fossa corridor.

Case #1

A 62-year-old female patient suffering from a long history of left facial pain refractory to medical therapy was diagnosed with a left Jefferson type C TS. The tumor portion involving the posterior fossa was relatively small (Figure 13). Accordingly, a pretemporal interdural approach to the Meckel cave was planned. Intraoperatively, only the AM corridor was used to achieve a gross total resection of the middle fossa component of the schwannoma through the expanded Meckel cave. The tumor was resected to visualize the posterior part of the lateral wall of the cavernous sinus, which was intact.

Moreover, because of the bone scalloping induced by the tumor, the suprameatal tubercle area was enlarged, and the resection of the posterior fossa portion of the schwannoma was successful (Figure 14). A postoperative magnetic resonance (MR) demonstrated the gross total resection of the tumor (Figure 15). Video describes the key surgical steps of the surgery (Video).

Case #2

A 34-year-old male patient underwent brain MR because of progressive gait imbalance, hearing loss, headache, and left-sided facial pain. A diagnosis of giant dumbbell TS was established, mainly involving the cerebellopontine angle causing severe brainstem compression (Figure 16A-16C). A staged tumor resection was then planned. A retrosigmoid approach allowed us to remove the infratentorial component of the schwannoma (Figure 16D-16F). Two months later, a pretemporal interdural approach was accomplished, and the middle fossa component of the lesion was removed through the AM working corridor comprised of the first and second trigeminal divisions (Figure 17). On the fourth postoperative day, the patient was discharged without deficits. Postoperative MR confirmed the gross total resection of the schwannoma (Figure 18).

Pretemporal vs Subtemporal Route

The pretemporal vs subtemporal perspective requires further discussion. The pretemporal route is preferred by most groups.[12,13,17,28,38-41] However, for both TS and meningiomas, the anterior subtemporal approach has been proposed by others because of the presumed lesser need for extensive drilling of the sphenoid ridge.[29,42] We believe that the pretemporal route is the natural and most tangential corridor to the Meckel cave for both the IT transcavernous and AM middle fossa corridor. The advantages of the pretemporal perspective also come from the potential adjoint of an orbito-zygomatic, or only zygomatic, osteotomy in the case of giant tumors, thus eliminating the need for brain retraction.[13,43-48] Al-Mefty stressed that zygomatic osteotomy contributes to increasing the volume of the transsylvian corridor and the exposure of Meckel cave and lateral wall of the

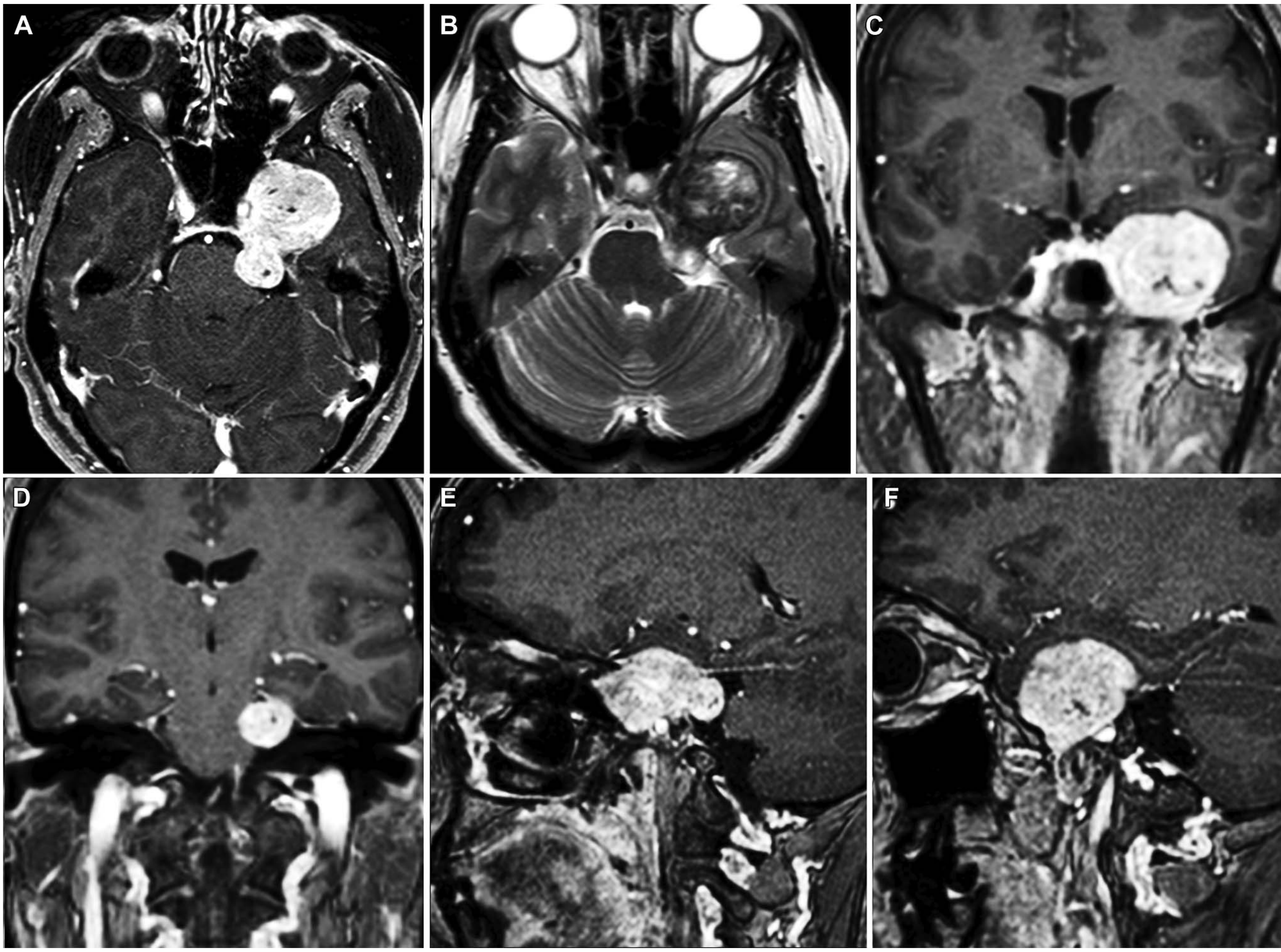

FIGURE 13. *Preoperative **A** and **B**, axial, **C** and **D**, coronal, and **E** and **F**, sagittal gadolinium contrast-enhanced T1-weighted brain MRI.*

cavernous sinus by allowing gravity-assisted lateralization of the temporal lobe.[13,43-46] We also believe that anterior petrosectomy, if necessary, can be performed more straightforwardly and, above all, without any brain retraction, or preventive lumbar drainage. The pretemporal perspective can also be easily associated with the transsylvian corridor in case an intradural becomes necessary, for example, to accomplish a posterior clinoidectomy. There is an option for tailored and more limited exposure of a single corridor for Jefferson type A and C tumors.

Distortion of Anatomic Corridors Because of the Growing Tumor

The progressive growth of the tumor within the expanded Meckel cave inevitably affects the size of each corridor and should be considered when selecting the most appropriate route. Nevertheless, given the existence of fixed points in the parasellar compartment, namely the anterior clinoid process, superior orbital fissure, foramen rotundum, and foramen ovale, it may be reasonable to consider that the tumor growth may occur along some vectorial forces that expand some corridors in coherence with normal anatomy.

Study Limitations

This study has several limitations. First, the number of specimens was relatively limited. Second, the working corridors were considered rectangular solids because they were presumed to be the most similar to the actual anatomic conditions, and the volume was derived accordingly. Nevertheless, this shape could not fit perfectly to the absolute surgical volumes of the routes. Third, the measurements were achieved in the formalin-fixed skulls. Still, in the pathologic scenario, these data should be related to the mass effect of the tumor, which, however, might affect the overall volume of the surgical corridors rather than the opening angles. Fourth, a risk of measurement error should be considered depending on the operator.

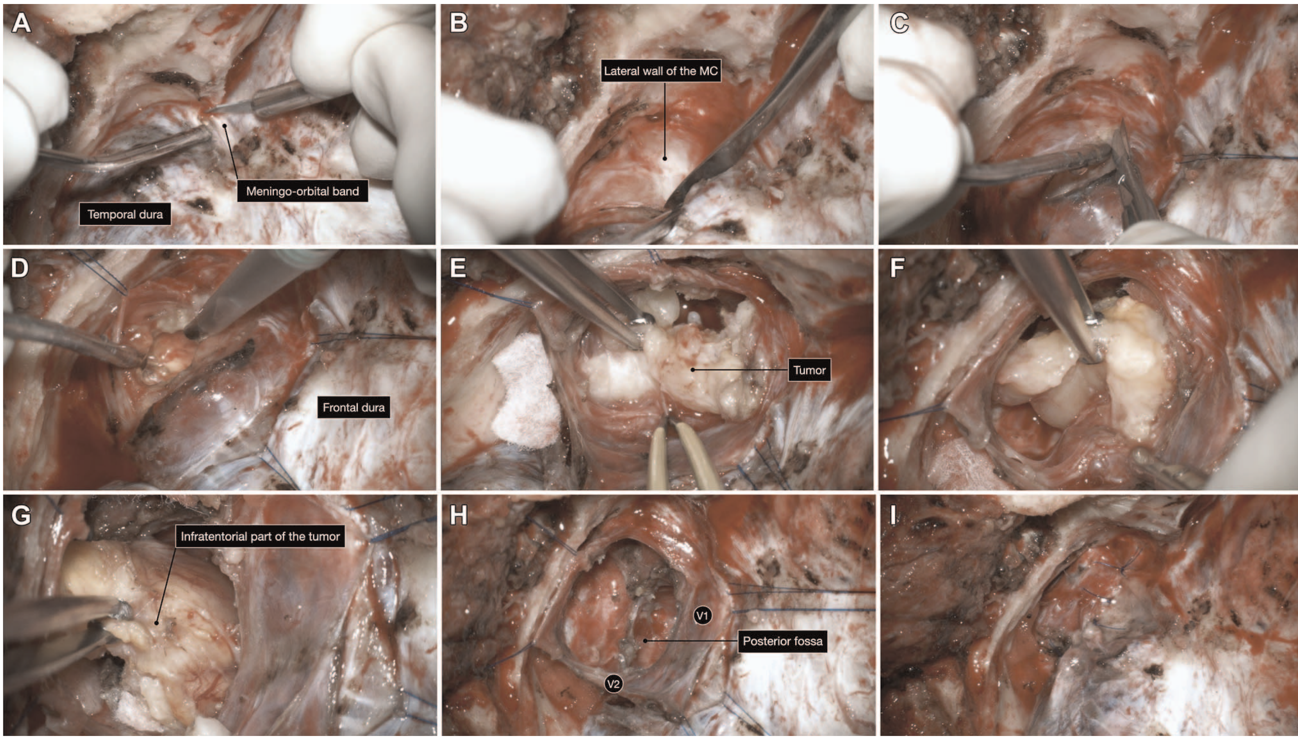

FIGURE 14. **A-I**, *Intraoperative picture series demonstrating the pretemporal interdural middle fossa approach and the progressive schwannoma resection accomplished through the anteromedial surgical corridor.*

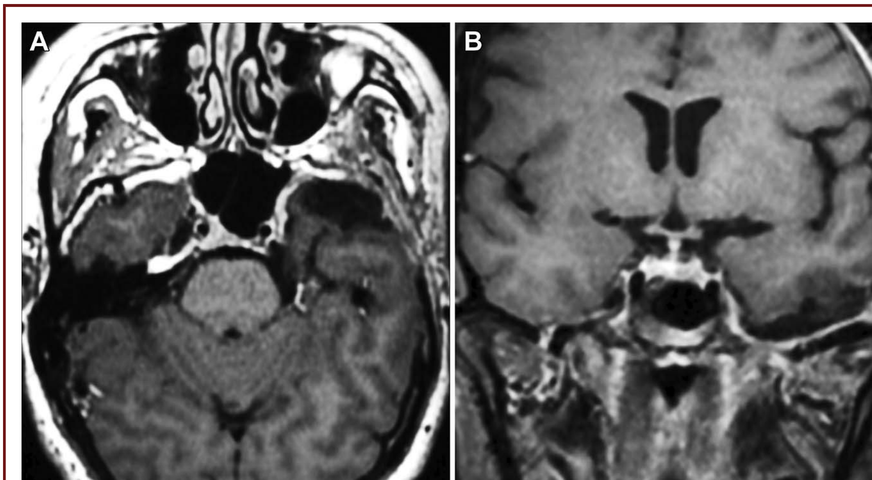

FIGURE 15. *Postoperative T1-weighted* **A**, *axial and* **B**, *coronal gadolinium contrast-enhanced brain MRI.*

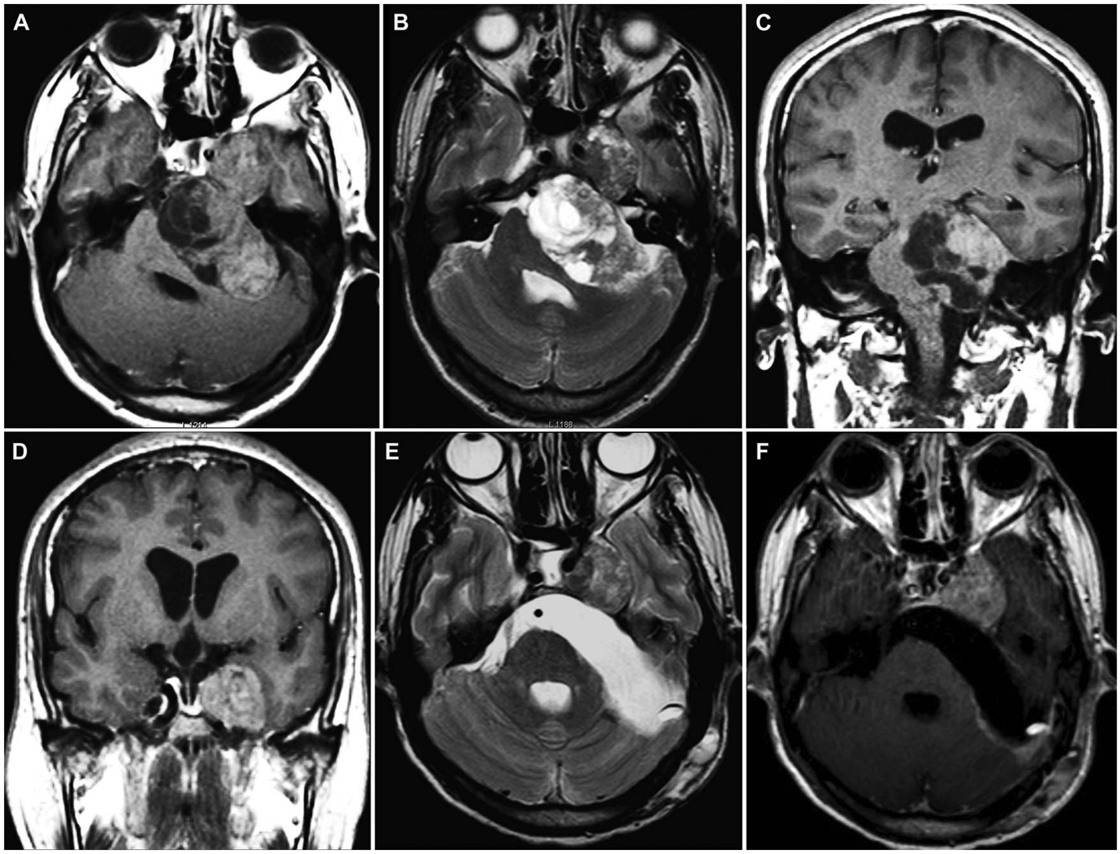

FIGURE 16. *Preoperative axial* **A**, *T1-weighted and* **B**, *T2-weighted and* **C** *and* **D**, *coronal T1-weighted brain MRI.* **E**, *T2-weighted and* **F**, *T1-weighted brain MRI after the retrosigmoid approach.*

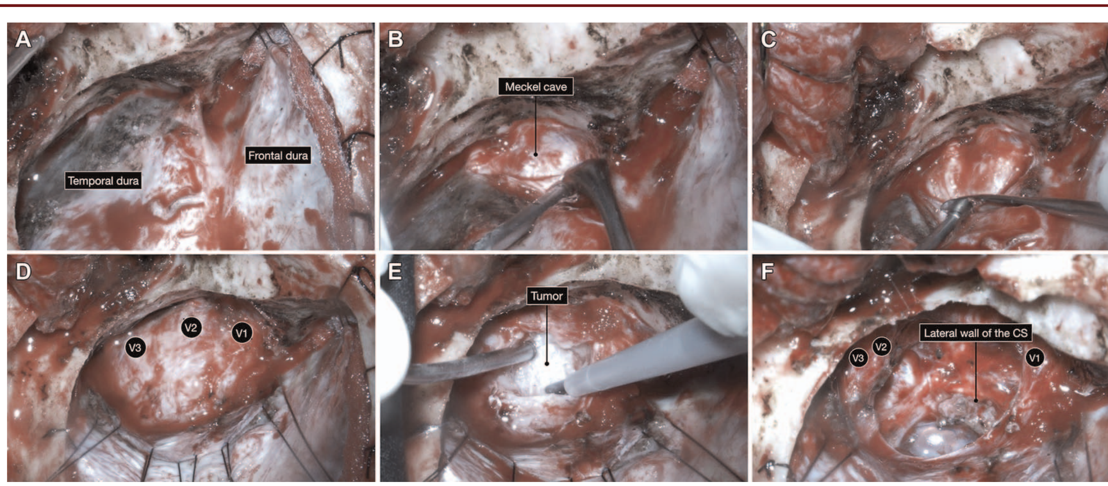

FIGURE 17. **A**-**F**, *Key surgical steps of the schwannoma resection through the anteromedial surgical corridor. CS, cavernous sinus. V1, first trigeminal division; V2, second trigeminal division; V3, third trigeminal division.*

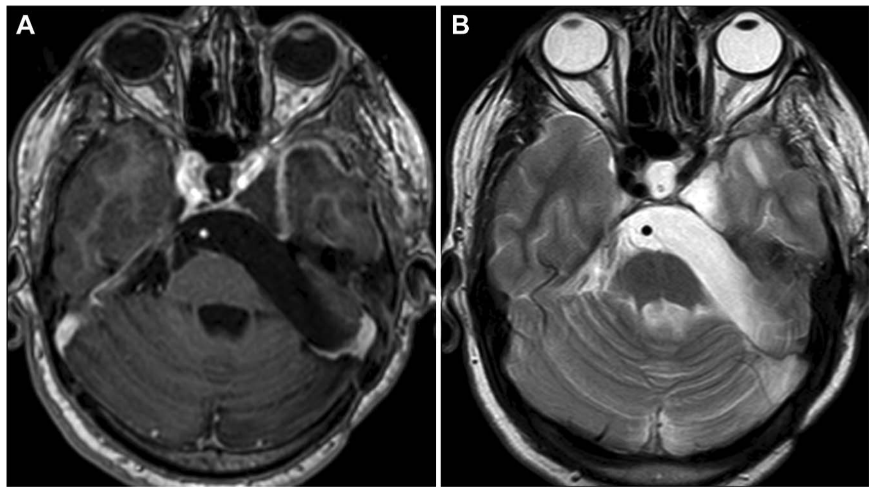

FIGURE 18. *Axial contrast enhanced* **A**, *T1-weighted and* **B**, *T2-weighted magnetic resonance after the interdural middle fossa approach.*

CONCLUSION

Among the surgical working corridors of the interdural approach to the Meckel cave, the IT transcavernous volume was significantly greater than that of the AM and AL. Conversely, the opening angle of the AM middle fossa triangle was wider than the other two.

The IT corridor can be advantageous for Meckel cave schwannomas invading the cavernous sinus with a significant extension in the posterior fossa because the transcavernous approach maximizes the working space to the retrosellar area.

The AM middle fossa corridor may be strategic in schwannomas confined to the Meckel cave with a minor extension into the posterior fossa because it increases the chance of total resection using a single approach.

However, the distortion of the neurovascular structures induced by the growing tumor should be considered, and the choice of the most suitable corridor must be based on the individual characteristics of each lesion.

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VIDEO. Surgical video of the Case #1: Pretemporal interdural approach to the Meckel cave for resection of a trigeminal schwannoma through the anteromedial corridor. Min. 00:16, clinical presentation. Min. 00:35, surgical position. Min. 00: 52, key surgical steps. Min. 02:25, postoperative MRI.