Sigmoid Sinus Patency following Vestibular Schwannoma Resection via Retrosigmoid versus Translabyrinthine Approach

Andrea Ziegler[1] Nadeem El-Kouri[2] Zaneta Dymon[3] David Serrano[3] Mariah Bashir[3] Douglas Anderson[4] John Leonetti[1]

[1] Department of Otolaryngology, Loyola University Medical Center, Maywood, Illinois, United States
[2] Loyola University Stritch School of Medicine, Maywood, Illinois, United States
[3] Department of Radiology, Loyola University Medical Center, Maywood, Illinois, United States
[4] Department of Neurosurgery, Loyola University Medical Center, Maywood, Illinois, United States

Address for correspondence Andrea Ziegler, MD, Department of Otolaryngology, Loyola University Medical Center, 2160 S 1st Ave, Maguire Building, Maywood, IL 60153, United States (e-mail: andrea.ziegler@lumc.edu).

J Neurol Surg B Skull Base 2021;82:461–465.

Abstract

Introduction The treatment options for acoustic neuromas are observation with serial imaging, stereotactic radiation, or surgical resection. The most common surgical approaches are the translabyrinthine (TL), the retrosigmoid (RS), and the middle cranial fossa. During the TL approach the sigmoid sinus is decompressed with bipolar cautery to allow greater medial exposure. It is unknown if this causes any long-term narrowing or thrombus of the sigmoid sinus.

Methods We performed a retrospective review of patients who underwent acoustic neuroma resection to determine if patients undergoing a TL approach for acoustic neuroma resection develop radiographic evidence of sigmoid sinus stenosis or thrombosis compared with patients undergoing a RS approach.

Results A total of 128 patients were included in this study, 56 patients underwent a TL approach and 72 patients underwent a RS approach. We compared the preoperative and postoperative diameter of the ipsilateral and contralateral sigmoid sinus at proximal, midpoint, and distal locations on magnetic resonance imaging examinations. There was no significant difference between the preoperative and postoperative diameter of the ipsilateral or contralateral sigmoid sinus based on surgical approach.

Conclusion Decompression of the sigmoid sinus during the TL approach does not have a significant postoperative effect on the dural venous sinus patency.

Keywords
- acoustic neuroma
- vestibular schwannoma
- resection approach
- sigmoid sinus
- dural venous sinus

Introduction

Acoustic neuromas (AN) or vestibular schwannomas (VS) are benign tumors that account for 85 to 90% of all tumors located in the cerebellopontine angle. Presenting symptoms typically include unilateral sensorineural hearing loss and tinnitus, but may also include vestibular dysfunction, facial numbness, facial weakness, or headaches. Treatment options include observation with serial imaging, stereotactic radiation, or surgical resection.[1]

Surgical resection approaches include the translabyrinthine (TL), the retrosigmoid (RS), or the middle cranial fossa

received
November 15, 2019
accepted
April 27, 2020
published online
August 5, 2020

Georg Thieme Verlag KG,
Rüdigerstraße 14,
70469 Stuttgart, Germany

DOI https://doi.org/10.1055/s-0040-1713773.
ISSN 2193-6331.

(MCF). The approach utilized is based on the patient's hearing, tumor location and size, and surgeon's preference.[2] In general, the RS approach is considered more versatile and is used in patients with serviceable hearing.[3] The TL approach is used in patients with nonserviceable hearing or in patients with large tumors who have a low probability of hearing preservation.[4] Patients with large tumors may require a combined TL and RS approach for adequate exposure. The MCF approach is generally reserved for patients with small to medium-sized tumors with serviceable hearing.

During a TL approach, the sigmoid sinus is uncovered and cauterized with a bipolar to allow for decompression and improved exposure. With an RS approach the majority of bone over the sigmoid sinus is left intact and the sinus itself is unaltered. The goal of this study is to determine if patients undergoing a TL approach for AN resection develop radiographic evidence of sigmoid sinus stenosis compared with patients undergoing an RS approach.

Materials and Methods

After approval from the Loyola University Medical Center institutional review board, a retrospective chart review was performed of all patients who underwent an RS or TL approach for the resection of a VS from 2007 to 2018. Pathology reports were reviewed to confirm a final diagnosis of VS. Patients who underwent a combined resection approach were excluded. The MCF approach does not involve exposure of the dural venous sinuses and was not included in this study. Intraoperative sigmoid sinus decompression and cauterization was typically achieved with bipolar cautery set between 20 and 30 W.

History and physical operative reports and postoperative clinic notes were reviewed. Patient variables collected included age, gender, and body mass index (BMI). Records were also reviewed to note the incidence of preoperative headache, postoperative headache at 1 month, and postoperative headache at 1 year. Also noted was the incidence of patients that developed new postoperative headaches that did not report headaches preoperatively.

Preoperative magnetic resonance images (MRI) were reviewed to obtain anterior–posterior and transverse measurements of the cerebellopontine angle mass. Contrast-enhanced coronal T1 sequences of preoperative and postoperative MRIs were reviewed to obtain measurements of the ipsilateral and contralateral proximal (at transition from transverse to sigmoid sinus), midpoint (midpoint of sigmoid sinus between proximal and distal measurements), and distal sigmoid sinus (at transition from sigmoid sinus to jugular bulb). Please see ►**Fig. 1**. The change in size for each measurement from preoperative to postoperative imaging was calculated. The MRI fluid attenuation inversion recovery (FLAIR) sequence was used to evaluate for the absence of flow voids in the sigmoid sinus suggestive of slow flow or thrombus.

The measurement technique and protocol was developed by a neuroradiologist who personally trained and observed three additional authors to perform the measurements. Preoperative and postoperative imaging for each patient was reviewed by a single author.

Statistical analysis was performed using a combination of chi-square, fisher exact test, and paired *t*-test. A *p*-value of <0.05 was defined as statistically significant.

Results

A total of 369 patients were identified who underwent an RS or a TL craniotomy for the resection of a vestibular neuroma at a single tertiary care academic medical center from 2007 to 2018. Patients were excluded from the study if both preoperative and postoperative MRI were not available for review leaving a total of 128 patients. There were 72 (56%) patients who had an RS approach and 56 (44%) patients who underwent a TL approach. The average age of patients undergoing an RS approach was 48.0 years compared with 53.7 years in the TL group ($p = 0.022$). Additional demographic data can be found in ►**Table 1**.

Postoperative imaging was obtained on average 13 months following the day of surgery. In the RS group, median time to imaging was 12 months (range 2–60 months) and in the TL group, median time to imaging was 13 months (range 2–57 months) which was not significantly different ($p = 0.098$). The patients with postoperative MRIs that were obtained at 57 and 60 months postoperatively were outliers and actually had MRIs closer to their surgical date, but those images were not available for review. Tumor size was slightly larger in the RS group (1.71×1.96 cm) compared with the TL group (1.59×1.74 cm); however, this was not statistically significant ($p = 0.23$ and 0.11, respectively).

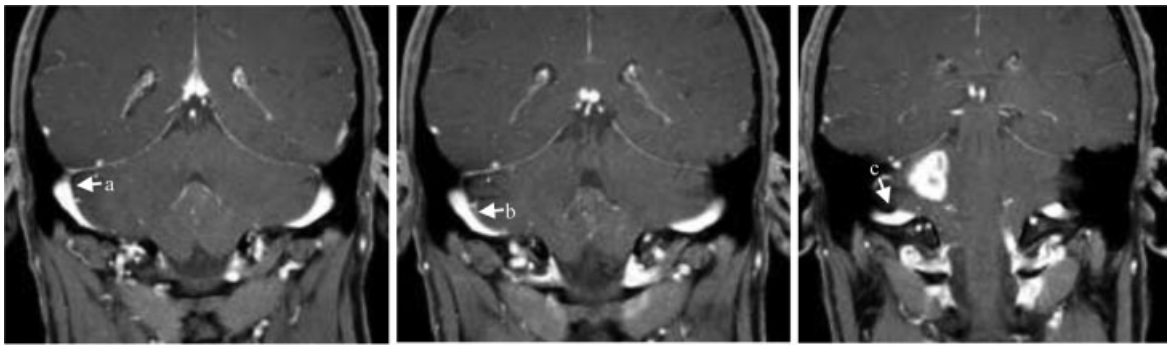

Fig. 1 Measurements of the ipsilateral and contralateral proximal (**a**—at transition from transverse to sigmoid sinus), midpoint (**b**—midpoint of sigmoid sinus between proximal and distal measurements), and distal sigmoid sinus (**c**—at transition from sigmoid sinus to jugular bulb) were taken on preoperative and postoperative T1-contrast-enhanced coronal MRI. MRI, magnetic resonance imaging.

Table 1 Patient demographics

	Total	Retrosigmoid	Translabyrinthine	*p*-Value
Number	128	72 (56%)	56 (44%)	
Gender (women)	73 (57%)	46 (64%)	27 (48%)	0.076
Average age (y)	50.4	48	53.7	0.022
Average body mass index	27.9	27.1	28.8	0.046
Laterality (left side)	67 (52%)	35 (49%)	32 (57%)	0.34

Measurements of the ipsilateral sigmoid sinus at proximal, middle, and distal points in patients that had an RS approach showed an average interval decrease in size of 0.030, 0.019, and 0.086 cm, respectively. The same measurements in patients that underwent a TL approach showed an average interval decrease of 0.033, 0.049, and 0.023 cm, respectively which was not significantly different from patients who underwent an RS resection ($p = 0.45$, $p = 0.11$, $p = 0.20$). Preoperative and postoperative measurements of the contralateral sigmoid sinus at proximal, middle, and distal points following the RS approach showed an average interval decrease in size of 0.0090, 0.0064, and 0.015 cm, respectively. In the TL group, the proximal caliber of the sigmoid sinus increased by 0.0064 cm, the midpoint decreased by 0.015 cm, and the distal point increased by 0.013 cm from preoperative to postoperative imaging which was not significantly different from patients that underwent an RS approach ($p = 0.26$, $p = 0.38$, $p = 0.12$). There was no significant change in the caliber of the ipsilateral or contralateral sigmoid sinus postoperatively based on surgical resection approach. See ►**Table 2** for details.

One patient in the TL group had an absent ipsilateral flow void of the sigmoid sinus on preoperative and postoperative FLAIR imaging suggestive of dural venous thrombus or very slow flow. There were no patients with evidence of new sigmoid sinus thrombus postoperatively in the TL patients. One patient in the RS group developed an absence of flow void on postoperative imaging suggestive of new dural thrombus.

Review of the incidence of subjective headaches showed no significant difference in the incidence of preoperative headaches or postoperative headaches at 1 month and 1 year between patients that had an RS or TL approach. There were 17 patients who developed new postoperative headaches and denied headaches preoperatively all of which underwent an RS approach ($p < 0.0001$; ►**Table 3**).

Discussion

The incidence of dural venous thrombosis following AN resection has been well described previously. Rates of postoperative dural sinus thrombosis range from 0.9 to 11.6% in the literature.[5–9] Keiper et al reported on 5 of 107 patients who developed ipsilateral transverse sinus thrombosis and increased intracranial pressure following AN resection via an RS or TL approach. These patients developed headache, vision disturbances, and papilledema despite confirmation of a patent contralateral transverse and sigmoid sinus on postoperative imaging.[5] Crocker et al reported a case of extensive dural venous thrombosis due to bone wax used to control bleeding from a large emissary vein that migrated into the sigmoid sinus during an RS craniectomy for an AN.[10] Abou-Al-Shaar reported on 7 of 116 patients who developed venous sinus thrombosis following AN resection, three following an RS approach (9.7%) and four following a TL approach (7.7%).[6] In our study, one patient developed postoperative ipsilateral thrombosis of the transverse sinus following an RS approach (1.8%). A potential explanation for the lower incidence of thrombosis noted in our population is likely related to the majority of imaging occurring 12 to 13 months following the initial surgery. This likely misses a small subset of patients that have acute thrombosis or stenosis of the sigmoid sinus that resolves over time.[11]

We acknowledge that MR imaging is not the ideal method for detecting a dural venous thrombus, but a study by Sari

Table 2 Imaging results

	Total	Retrosigmoid	Translabyrinthine	*p*-Value
Average tumor anterior–posterior dimension (cm)	1.66	1.71	1.59	0.23
Average tumor transverse dimension (cm)	1.86	1.96	1.74	0.11
Average change in ipsilateral proximal SS (cm)	0.031	0.030	0.033	0.45
Average change in ipsilateral mid SS (cm)	0.032	0.019	0.049	0.11
Average change in ipsilateral distal SS (cm)	0.058	0.086	0.023	0.2
Average change in contralateral proximal SS (cm)	0.0022	0.009	−0.0064	0.26
Average change in contralateral mid SS (cm)	0.01	0.0064	0.015	0.38
Average change in contralateral distal SS (cm)	0.0025	0.015	−0.013	0.12

Abbreviations: cm, centimeter; SS, sigmoid sinus.

Table 3 Clinical symptoms

	Total	Retrosigmoid	Translabyrinthine	*p*-Value
Preoperative headache	37	22	15	0.64
Postoperative headache at 1 mo	19	14	5	0.97
Postoperative headache at 1 y	22	17	5	0.29
New headaches (not present preoperatively)	17	17	0	<0.0001

et al found the sensitivity, specificity, and accuracy of conventional MR sequences at detecting dural venous thrombus to be 83.6, 95.3, and 92.7%, respectively.

No prior studies have specifically evaluated the caliber of the dural sinuses following AN resection-based on approach. Our results showed a small decrease in the postoperative diameter of the ipsilateral sigmoid sinus at all three measurements with both surgical approaches. Potential explanations include direct injury to the sinus, retraction of the sinus, desiccation of the partially or completely exposed sinus, direct heat conduction from bone drilling, or thermal exposure from the operating microscope.[5,8,9] Another potential explanation for the decreased caliber of the ipsilateral sigmoid sinus is secondary to compression of the fat graft placed in the mastoidectomy defect. We also found a very subtle change in caliber of the contralateral sigmoid sinus. The average change per ipsilateral and contralateral measurement ranged from 0.064 to 0.86 mm. The submillimeter changes we observed are likely secondary to the inherent variability in the size of the dural venous sinuses based on imaging techniques and positioning, and not due to any significant physiological changes.

Higgins et al reported on a patient with intractable headache following excision of an . Imaging revealed acquired stenosis of the sigmoid sinus, and the patient underwent endovascular stent placement which provided significant relief of headaches.[12] There is no objective definition of sigmoid sinus stenosis based on caliber of the vessel and diagnosis is based on impaired flow through the sinuses. The fraction of a millimeter change in diameter of the sigmoid sinus from preoperative to postoperative observed with both approaches appears to be inconsequential to blood flow through the dural venous sinus.

The results of our study showed patients that underwent an RS approach were significantly younger than patients that had a TL approach ($p = 0.022$). This is likely due to an attempt to preserve hearing in younger patients. Patients that underwent an RS approach also had a significantly lower BMI ($p = 0.046$). The reason for this is unclear, but may be related to the patients overall younger age and potentially better baseline health status with fewer comorbidities.

Limitations of this study include the inherent variability in imaging techniques mentioned above. There were four individuals that performed the measurements which may have led to some inter-reviewer variability. Intraoperative damage to the sigmoid sinus is a potential risk factor for postoperative sigmoid sinus stenosis, but this is not always well documented for a retrospective review and was not included in our analysis.

Multiple studies have evaluated postoperative headaches in patients that have underwent AN resection and found that up to 83% of patients experience severe headaches following resection. Long lasting severe postoperative headaches are more commonly reported following RS or suboccipital approaches.[13–15] Our study was in agreement with prior studies that all patients experiencing new postoperative headaches had undergone an RS approach.

Conclusion

Decompression of the ipsilateral sigmoid sinus during a TL approach for AN resection has no apparent long-term effect on the patency of the sigmoid sinus. Careful decompression can safely be performed to obtain adequate exposure when needed without concern for increased risk of dural venous stenosis or thrombosis.

Note
The research in this manuscript will be presented at the NASBS Annual Meeting in February 2019.

Conflict of Interest
None declared.

References

1 Semaan MT, Wick CC, Kinder KJ, Stuyt JG, Chota RL, Megerian CA. Retrosigmoid versus translabyrinthine approach to acoustic neuroma resection: a comparative cost-effectiveness analysis. Laryngoscope 2016;126(05, Suppl 3):S5–S12
2 Cole T, Veeravagu A, Zhang M, et al. Retrosigmoid versus translabyrinthine approach for acoustic neuroma resection: an assessment of complications and payments in a longitudinal administrative database. Cureus 2015;7(10):e369
3 Gharabaghi A, Samii A, Koerbel A, Rosahl SK, Tatagiba M, Samii M. Preservation of function in vestibular schwannoma surgery. Neurosurgery 2007;60(02, Suppl 1):ONS124–ONS127, discussion ONS127–ONS128
4 Day JD, Chen DA, Arriaga M. Translabyrinthine approach for acoustic neuroma. Neurosurgery 2004;54(02):391–395, discussion 395–396
5 Keiper GL Jr, Sherman JD, Tomsick TA, Tew JM Jr. Dural sinus thrombosis and pseudotumor cerebri: unexpected complications of suboccipital craniotomy and translabyrinthine craniectomy. J Neurosurg 1999;91(02):192–197
6 Abou-Al-Shaar H, Gozal YM, Alzhrani G, Karsy M, Shelton C, Couldwell WT. Cerebral venous sinus thrombosis after vestibular schwannoma surgery: a call for evidence-based management guidelines. Neurosurg Focus 2018;45(01):E4
7 Schwartz MS, Lekovic GP, Miller ME, Slattery WH, Wilkinson EP. Translabyrinthine microsurgical resection of small vestibular schwannomas. J Neurosurg 2018;129(01):128–136

8 Apra C, Kotbi O, Turc G, et al. Presentation and management of lateral sinus thrombosis following posterior fossa surgery. J Neurosurg 2017;126(01):8–16
9 Moore J, Thomas P, Cousins V, Rosenfeld JV. Diagnosis and management of dural sinus thrombosis following resection of cerebellopontine angle tumors. J Neurol Surg B Skull Base 2014; 75(06):402–408
10 Crocker M, Nesbitt A, Rich P, Bell B. Symptomatic venous sinus thrombosis following bone wax application to emissary veins. Br J Neurosurg 2008;22(06):798–800
11 Sari S, Verim S, Hamcan S, et al. MRI diagnosis of dural sinus—cortical venous thrombosis: immediate post-contrast 3D GRE T1-weighted imaging versus unenhanced MR venography and conventional MR sequences. Clin Neurol Neurosurg 2015; 134:44–54
12 Higgins JN, Pickard JD. Intractable headache after excision of an acoustic neuroma treated by stent revascularisation of the sigmoid sinus. Br J Neurosurg 2013;27(06):819–821
13 Ansari SF, Terry C, Cohen-Gadol AA. Surgery for vestibular schwannomas: a systematic review of complications by approach. Neurosurg Focus 2012;33(03):E14
14 Sabab A, Sandhu J, Bacchi S, Jukes A, Zacest A. Postoperative headache following treatment of vestibular schwannoma: a literature review. J Clin Neurosci 2018;52:26–31
15 Mosek AC, Dodick DW, Ebersold MJ, Swanson JW. Headache after resection of acoustic neuroma. Headache 1999;39(02):89–94