Title

Novel grading system of sigmoid sinus dehiscence for radiologic evaluation of pulsatile tinnitus

Authors

Willis, Shelby
Duong, Courtney
Yang, Isaac
et al.

Publication Date

2021-05-01

DOI

10.1016/j.jocn.2021.02.022

Peer reviewed

Journal of Clinical Neuroscience 87 (2021) 147–149

Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: www.elsevier.com/locate/jocn

Neuroanatomical study

Novel grading system of sigmoid sinus dehiscence for radiologic evaluation of pulsatile tinnitus

Shelby Willis [a], Courtney Duong [b], Isaac Yang [a,b,c,d,e,f], Quinton Gopen [a,*]

[a] Department of Head & Neck Surgery, Los Angeles Biomedical Research Institute at Harbor-UCLA Medical Center, Torrance, CA, United States
[b] Department of Neurosurgery, Los Angeles Biomedical Research Institute at Harbor-UCLA Medical Center, Torrance, CA, United States
[c] Department of Radiation Oncology, Los Angeles Biomedical Research Institute at Harbor-UCLA Medical Center, Torrance, CA, United States
[d] Jonsson Comprehensive Cancer Center, University of California Los Angeles, Los Angeles Biomedical Research Institute at Harbor-UCLA Medical Center, Torrance, CA, United States
[e] Department of Neurosurgery, Los Angeles Biomedical Research Institute at Harbor-UCLA Medical Center, Torrance, CA, United States
[f] Los Angeles Biomedical Research Institute at Harbor-UCLA Medical Center, Torrance, CA, United States

ARTICLE INFO

Article history:
Received 15 December 2020
Accepted 18 February 2021

Keywords:
Sigmoid sinus dehiscence
Tinnitus

ABSTRACT

Background: Sigmoid sinus dehiscence (SSD) is an important etiology of pulsatile tinnitus (PT) though there is currently no consensus on the prevalence of SSD in non-PT populations. This study establishes a grading system of SSD and analyzes a non-PT cohort for prevalence of SSD.
Methods: In this retrospective study temporal bone CT scans of 91 patients without PT were analyzed for SSD. The dehiscence was divided into three grades: Grade 1 indicating a micro dehiscence of <3.5 mm with an opening to the mastoid air cells, Grade 2 indicating a major dehiscence of >3.5 mm with an opening to the mastoid air cells, and Grade 3 indicating a sigmoid sinus wall dehiscence opening directly to the underlying tissue.
Results: In patients without PT, SSD occurred in 34% of the cohort. Of these, 75% were Grade 1 and 25% were Grade 2. The range of dehiscence measurements for Grade 1 dehiscences was 0.9–3.4 mm. The range of dehiscence measurements for Grade 2 was 4–7.5 mm. There were no cases of Grade 3 dehiscence among this cohort.
Conclusions: SSD occurred in over a third of our non-symptomatic cohort. While all grades of SSD may currently be treated surgically, a large portion of non-PT patients may have these sigmoid sinus anomalies asymptomatically. This grading system allows for the standardization of SSD definition and severity in future studies. Grade 3 dehiscences were completely absent in this cohort of non-PT patients.

1. Introduction

Tinnitus is a common symptom that 25.3% of the US population has experienced at some point in their life with 8% experiencing frequent tinnitus in the past year [1]. A population study in the UK similarly demonstrated that 10% of the population have experienced tinnitus with 4% of those affected experiencing a subset of tinnitus called pulsatile tinnitus [2]. PT is distinguished from other types of tinnitus by the noticeable pulsing or beating in addition to perception of noise [3,4]. There are a variety of vascular and nonvascular etiologies associated with PT ranging from solid tumors like a glomus tumor to atherosclerosis, one of the most common causes of PT [3]. Among these etiologies SSD has been recently characterized as a cause of PT for which a resurfacing surgery is available [5–7]. Given the novelty of this diagnosis, there is no consensus in the literature of which types of SSD are more likely to produce symptoms or may be more responsive to surgical therapy, leaving this radiologic finding open to wide interpretation. In one of the early case reports of surgical intervention for PT due to SSD, the dehiscence was caused by a large aneurysm and had created an opening through the bone to the underlying tissue [8]. In further studies there has been surgical intervention in cases with a temporal bone dehiscence to the mastoid air cells [9]. This placement differs significantly in how the sound from the sigmoid sinus may be transmitted as there will still be an additional boney covering over the mastoid air cells in dehiscences that open to the air cells instead of directly to the underlying tissue. Given this variety in types of dehiscence addressed through surgery, a grading system for dehiscence should be implemented to guide clinical decision making based on imaging results.

* Corresponding author at: Department of Head and Neck Surgery, 200 UCLA Medical Plaza, Suite 550, Los Angeles, CA 90095, United States.
E-mail address: qgopen@mednet.ucla.edu (Q. Gopen).

https://doi.org/10.1016/j.jocn.2021.02.022
0967-5868/

We hypothesize that a micro dehiscence will be less likely to contribute to PT and therefore less likely to be correctable via surgical intervention than a sigmoid sinus wall dehiscence.

2. Methods

This study was approved by our institutional review board (Approval Number 17-001793). A retrospective analysis of CT scans without contrast of the temporal bones of 91 patients and 182 ears at a single academic institution was performed. Patients without PT who received CT scans in 2011–2017 were included in this study. Only patients without PT were included in this cohort. One patient was excluded after the cohort was identified due to history of craniofacial abnormalities.

Axial images of both the right and left ear were analyzed for any dehiscence in the temporal bone to the mastoid air cells or directly to the underlying tissue. Dehiscences were measured for their greatest point-to-point distances. In cases with multiple dehiscences, the section with the greatest length of bone loss was measured. Groups were split into three grades micro < 3.5 m m (1), major > 3.5 mm (2), and wall dehiscence directly to underlying tissue (3) (Figs. 1–3).

3. Results

A total of 91 cases were analyzed with a male to female ratio of 55:36 and an average age of 46.4 years (range: 9–96 years, 22). Overall 34% of the cohort had a SSD. Notably 5 cases were bilateral, yielding a total of 36 dehiscences graded. In the overall SSD cohort there were 10 females and 21 males with a median age of 39.4 years (range: 9–96 years, 22). Of 36 dehisced ears in 31 patients, 27 were Grade 1 and 9 were Grade 2. The range of dehiscence measurements for Grade 1 were 0.9–3.4 mm. The range of dehiscence measurements for Grade 2 were 4–7.5 mm. There were no cases of Grade 3 dehiscence among this cohort. Two of the bilateral cases had a bilateral Grade 2 dehiscence while the other three cases had a mixed Grade 1 and Grade 2. Results are summarized in Table 1.

Fig. 1. Non-contrast axial CT of the temporal bones with a 2.8 mm dehiscence from the sigmoid sinus into the mastoid air cells. The bony covering separating the air cells from the sinus has thinned to the point of creating this opening resulting in a direct contact between the tissue and the air. Since this dehiscence is between the sinus and the mastoid air cells and is < 3.5 mm it is counted as a Grade 1 SSD.

Fig. 2. Non-contrast axial CT of the temporal bones with a 6.7 mm dehiscence from the sigmoid sinus into the mastoid air cells. The bony covering separating the air cells from the sinus has thinned to the point of creating this opening resulting in a direct contact between the tissue and the air. Since this dehiscence is between the sinus and the mastoid air cells and is > 3.5 mm it is counted as a Grade 2 SSD.

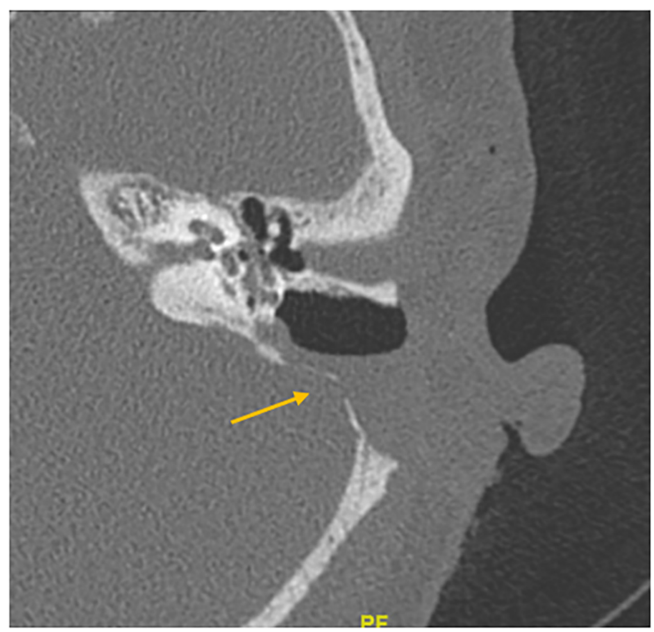

Fig. 3. Non-contrast axial CT of the temporal bones with a sigmoid sinus wall dehiscence creating a large opening between the sigmoid sinus and not only the mastoid air cells but also underlying tissue. There were no dehiscences of this nature in our cohort of non-PT patients. This image was drawn from a separate cohort of patients that do have pulsatile.

4. Discussion

The primary goal of this study was to characterize the prevalence of SSD in a non-PT population which led to a grading system of radiologic SSD findings on CT imaging studies. While few studies have considered the prevalence of SSD in non-PT populations those that have find disparate results ranging from 1% to 13% [5,10]. Our study sought to establish a grading system for SSD to clarify the prevalence of this condition among PT and non-PT cohorts.

Table 1
Patient demographics and dehiscence characteristics results based on grade. In mixed bilateral cases the patient demographics were included in the Grade 2 results, however the dehiscence measurement and ear side information was still added to the Grade 1 data for the Grade 1 dehiscences.

	Total Number of Patients	Average Length of dehiscence (mm)	Ratio of Right to Left Ears	Average Age (years)	Ratio of Males to Females
No dehiscence	60	0	0	46.4	55:36
Grade 1	27	0.19	16:11	39.6	19:8
Grade 2	9	0.54	3:6	35.8	7:2

A cohort of 91 patients without PT who received a CT of the temporal bones at single academic institution were analyzed for SSD. Dehiscences were subsequently divided into three grades based on size and location. Over a third of our cohort had a SSD despite lack of PT. This supports our theory that microdehiscences may be less likely to contribute to PT.

Grade 3 dehiscences were completely absent in this cohort of non-PT patients. This type of significant dehiscence through the temporal bone leaving the underlying tissue exposed with no bony covering over the sinus is rare and less likely to be asymptomatic.

If all grades of dehiscence are currently being treated surgically it is important to consider that 34% of non-PT patients may have these sigmoid sinus anomalies asymptomatically. Given this prevalence, further work needs to be done to elucidate which features of SSD may contribute to PT and which may be incidental findings.

Sigmoid sinus resurfacing surgery has been an important part of PT management and has clearly improved PT symptoms for many patients [7]. By establishing a grading system there can be more clarity in the reporting values of the prevalence of this condition and the therapeutic benefit of surgery in different types of dehiscence.

Limitations to our study include a relatively small cohort of 91 patients, and the retrospective nature of the data collection. Author collecting the data was not blinded to clinical findings such as the patient's PT status or the SSD findings in the previous ear while grading the second ear. Additionally selection bias is a limitation of this study as all cases were from an ENT clinic at a single tertiary care center.

5. Conclusion

SSD occurred in over a third of our non-symptomatic cohort, the largest percentage discovered to date. While all grades of SSD may currently be treated surgically, it is important to consider that a large portion of non-PT patients may have these sigmoid sinus anomalies asymptomatically. Grade 3 dehiscences were completely absent in this cohort of non-PT patients. This type of significant dehiscence through the temporal bone leaving the underlying tissue exposed with no bony covering over the sinus is rare and more likely to provoke symptoms. Larger cohort studies are necessary and should consider which grades of dehiscence are most common in patients with PT, particularly in patients undergoing sigmoid sinus wall reconstruction to clarify which grades of SSD are most responsive to surgical repair.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Shargorodsky J, Curhan GC, Farwell WR. Prevalence and characteristics of tinnitus among US adults. Am J Med 2010;123(8):711–8.
[2] McFerran DJ, Phillips, Tinnitus JS. J Laryngol Otol 2007;121(3):201–8.
[3] Madani G, Connor SEJ. Imaging in pulsatile tinnitus. Clin Radiol 2009;64:319–28.
[4] Sismanis A. Pulsatile tinnitus: contemporary assessment and management. Curr Opin Otolaryngol Head Neck Surg 2011;19:348–57.
[5] Grewal AK et al. Clinical presentation and imaging findings in patients with pulsatile tinnitus and sigmoid sinus diverticulum/dehiscence. Otol. Neurotol 2014;35:16–21.
[6] Mattox DE, Hudgins P. Algorithm for evaluation of pulsatile tinnitus. Acta Otolaryngol 2008;128:427–31.
[7] Eisenman DJ. Sinus wall reconstruction for sigmoid sinus diverticulum and dehiscence: a standardized surgical procedure for a range of radiographic findings. Otol Neurotol 2011;32:1116–9.
[8] Gologorsky Y et al. Novel surgical treatment of a transverse-sigmoid sinus aneurysm presenting as pulsatile tinnitus: technical case report. Neurosurgery 2009;64:E393–4.
[9] Raghavan P, Serulle Y, Gandhi D, Morales R, Quinn K, Angster K, et al. Postoperative imaging findings following sigmoid sinus wall reconstruction for pulse synchronous tinnitus. Am J Neuroradiol 2016;37(1):136–42.
[10] Schoeff S, Nicholas B, Mukherjee S, Kesser BW. Imaging prevalence of sigmoid sinus dehiscence among patients with and without pulsatile tinnitus. Otolaryngol Head Neck Surg 2014;150(5):841–6.