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What is This?
Detection of the Petrosquamosal Sinus in Chronic Otitis Media Using High-Resolution CT

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

Abstract
Objective. To evaluate the prevalence of the persistent petrosquamosal venous sinus in patients with chronic otitis media using a high-resolution CT scan.

Study Design. Retrospective chart review.

Setting. Tertiary referral center.

Subjects and Methods. Eighty-four patients older than 6 years of age underwent surgery (in a total of 92 ears) for chronic otitis media at Kyoto University Hospital, Department of Otolaryngology-Head and Neck Surgery. We used high-resolution CT scans to evaluate the prevalence and size of persistent petrosquamosal sinuses, as well as their relative position to the middle fossa.

Results. A petrosquamosal sinus was detected in 42 (45.7%), a higher frequency than in ears without chronic otitis media (10.3%). The diameter of the sinuses was <1.0 mm in 20 ears, 1.0 mm to 2.0 mm in 17 ears, and ≥2.0 mm in 5 ears. The petrosquamosal sinus was positioned inferior to the lowest part of the middle fossa in 10 ears.

Conclusion. The petrosquamosal sinus was detected frequently in high-resolution CT scans in patients with chronic otitis media. In approximately half of the patients, the sinus was larger than 1 mm in diameter and may be encountered during mastoidectomy.

Keywords
petrosquamosal sinus, chronic otitis media, high-resolution CT scan

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Introduction
The petrosquamosal sinus (PSS) is an emissary vein seen in the fetus and in infants. This vein branches from the sigmoid or transverse sinus, travels anteriorly in the lateral part of the temporal bone, and drains into the external jugular vein. Although a persistent PSS is found in a considerable proportion of normal adults (37.5%1 and 19.2%2), otologists have paid little attention to the vein. The PSS either courses along the middle fossa dura or passes through a bony canal below the middle fossa dura. In the latter case, the PSS can be encountered during middle ear surgery and may cause bleeding or obstruct the surgical approach.

High-resolution CT scans have been shown to be useful in assessing small emissary veins.3 However, the incidence of the PSS detected by CT scans is much lower than that seen in cadaver studies in a normal population.4 CT scans are able to detect a PSS only when it is circumferentially surrounded by bony structures. In normal temporal bones, the mastoid is well pneumatized, and only a thin layer of bone remains. This may explain the limited ability of CT scans to detect PSSs. In particular, the PSS is clinically important in patients with chronic otitis media (OMC), and these patients typically have a sclerotic mastoid.

In the present study, we hypothesized that the PSS is frequently detected by high-resolution CT scans in patients with OMC. To support this hypothesis, we determined the prevalence of the PSS in patients with OMC using high-resolution CT scans and compared it with that in patients without OMC. In addition, we evaluated the size and position of the PSS to assess the risk of problematic bleeding during the ear surgery.
Materials and Methods

This study was approved by the Ethic Committee, Graduate School and Faculty of Medicine, Kyoto University (E1682).

Between January 2011 and April 2012, surgery for OMC was performed on 98 ears at Kyoto University Hospital. Patients younger than 6 years were excluded from the study because the mastoid air cells grow rapidly before that age. Another patient was excluded because he had a temporal bone anomaly. In total, 92 ears (84 patients) were included in the analysis (male: 44, female: 48). The age at the time of surgery ranged from 11 to 79 years (average 54.2 years). All patients underwent a helical 0.5-mm CT scan before the operation. The prevalence, size, and position of the persistent PSS were evaluated using GE Centricity Version 3.2 (GE Healthcare, Madison, Wisconsin). With this system, we are able to follow a small channel with correlated axial and coronal images. In the present study, a bony canal was diagnosed as a PSS when it branched at the junction of sigmoid and transverse sinuses, coursed anteriorly at the union of petrous and squamous portions of the temporal bone, and entered into the middle fossa or the glenoid fossa. The diameter of the PSS was measured and classified into 3 groups (<1.0 mm, 1.0 mm–2.0 mm, and >2.0 mm) (Figure 1). The relationship between the PSS and middle fossa was evaluated using a coronal section of the CT scan at the midportion of the lateral semicircular canal. The PSS was classified as superiorly positioned when the inferior border of the PSS was above the lowest portion of the middle fossa (Figure 2) or when the PSS was within the middle fossa. In patients with an inferiorly positioned PSS, the distance between the inferior border of the PSS and the bottom of the middle fossa was measured. All the analyses were conducted by a neuroradiologist (AY) who was blinded for the clinical and surgical findings.

During the same time period, 39 patients with Bell’s Palsy or Ramsay-Hunt syndrome (non-OMC patients) underwent high-resolution CT scanning (male: 19, female: 20). These patients were used as controls; the frequency, size, and position of the PSSs were examined in the 78 ears of these patients.

Results

Of the 92 ears with OMC, PSSs were detected in 42 (45.7%). The incidence was similar between the right and left ears (right ear: 22/52, left ear: 20/40) and between the 2
genders (male: 18/44, female: 24/48). In non-OMC patients, PSSs were found in 8 of 78 ears (10.3%). The PSS was more frequently observed in patients with OMC than in non-OMC patients ($P < .01$, chi-square test).

In patients with OMC, the diameter of the persistent PSS was $<1.0$ mm in 20 ears, 1.0 mm to 2.0 mm in 17 ears, and $>2.0$ mm in 5 ears. In non-OMC patients, the diameter of the PSS was $<1.0$ mm in 4 ears and 1.0 mm to 2.0 mm in 4 ears. None of the patients had a PSS larger than 2.0 mm. There was no statistically significant difference in the size of the PSSs between the OMC patients and the non-OMC patients ($P = .68$, Mann-Whitney test).

In patients with OMC, the PSS was inferiorly positioned in 10 ears. The distance between the PSS and the middle fossa was $<1.0$ mm in 1 ear, 1.0 mm to 2.0 mm in 8 ears, and $>2.0$ mm in 1 ear. Among the inferiorly positioned PSSs, the size of the venous sinuses were $<1.0$ mm in 1 ear, 1.0 mm to 2.0 mm in 7 ears, and $>2.0$ mm in 2 ears. In the other 32 ears, the PSS was superiorly positioned. In all non-OMC patients, the PSS was superiorly positioned.

Of the 10 ears with an inferiorly positioned PSS, complete mastoidectomy was conducted in 6. In conducting mastoidectomy, we start drilling with a cutting bur 6 mm in the diameter. First we open the antrum and widen the mastoidectomy until we can access whole the pathology. Bleeding from the PSS was encountered in 3 ears. In 1 case, we immediately observed PSS injury, and the bleeding was controlled with Surgicel (Ethicon, Somerville, New Jersey). In the other 2 ears, we initially thought the bleeding originated from the middle fossa dura. However, we determined—in one ear by a postoperative CT scan, in the other via careful dissection—that the bleeding in these cases came from the PSS. In 1 ear, the bleeding was controlled with Surgicel. In the other, the vein was dissected and closed using bipolar coagulation to provide access to the petrous apex (Figure 3). In 2 of the 3 cases, we skeletonized the middle fossa dura, the sigmoid sinus, and the posterior fossa dura in order to obtain full access to the pathology.

**Discussion**

The present study showed that the PSS was more frequently detected in patients with OMC than in non-OMC patients (45.7% and 10.3%, respectively) using high-resolution CT scanning. Because the fate of the PSS is determined during fetal and early postnatal life, it is unlikely that the presence of OMC affects the true prevalence of the persistent PSS. The prevalence of the PSS in normal human adults was reported in 2 cadaver studies. Knott found 7 bilateral and 19 unilateral PSSs in 44 adult cadavers (37.5%). San Millán Ruiz et al found 5 PSSs in 26 human temporal bones (19.2%). The incidence of the PSS in our OMC patients was almost the same as that reported by Knott. It has been suggested that although the PSS was more frequently detected in CT scans in OMC patients, the true prevalence is not different from that in non-OMC patients. The PSS is covered in whole or in part by a thin sheet of cartilage in the infant. The CT scan is able to detect the PSS only when this covering is completely ossified after maturation. Pneumatization of the mastoid develops until puberty. In patients with OMC, mastoid pneumatization is usually limited and thick bone persists. This may have made it easier to identify the PSS with CT.

Despite its high incidence, the clinical importance of the PSS has long been ignored. Recently, high-resolution CT scans have been shown to be useful in detecting the PSS, and the clinical significance of this vein has been increasingly appreciated. In cochlear implant candidates with complete aplasia of the semicircular canals, the PSS was found in 65% of the ears with a median diameter of 4.4 mm. Persistent PSSs were also found in patients with tinnitus. An et al reported 2 cases of large PSSs encountered during or before middle ear surgery. In 1 case, unintentional bleeding from the PSS occurred and required hemostasis with Surgicel. In our series, most of the PSSs were found superior to the bottom of the middle fossa. In such cases, the risk of damage to the PSS during the surgery is low. Cases with inferiorly positioned PSSs accounted for 10.9% of all cases with OMC. In these cases, the PSS is more frequently encountered during total mastoidectomy, especially in cases requiring the skeletonization of the middle fossa dura and the sigmoid sinus. We found only 5 ears with the PSSs larger than 2 mm in the diameter. The largest size of the PSS was 2.4 mm. A mastoid emissary vein is considered to be large when the diameter exceeds 3.5 mm. According to this criterion, all the PSSs in our series were not large. Therefore, if the correct diagnosis is made before surgery, the PSSs are controllable with ordinary procedures.

During middle ear operations, we have occasionally encountered an unexpected inferiorly positioned middle fossa dura. Because a partially skeletonized PSS can mimic the middle fossa dura, it is possible that a considerable proportion of this is caused by a persistent PSS.
Koesling et al reported the detectability of the PSS via CT scan in various diseases. In their study, the PSS was identified in only 6 of 440 temporal bones. This frequency is lower than that among non-OMC patients in our study. This may be due to the technological and ethnic differences in the studies. Koesling et al performed CT scans with slice thicknesses of 1 mm and used only the axial images. By contrast, we used high-resolution CT scans (0.5 mm slice thickness) and both axial and coronal images in all cases. Moreover, it has been reported that the frequency of cranial traits varies among different ethnic groups. In our study, all the patients were Japanese.

The factors described previously may have contributed to the high rate of PSS detection in our study.

Conclusion

A persistent PSS was frequently detected using high-resolution CT scanning in patients with OMC. Damaging this vein causes massive bleeding. Therefore, when reviewing a CT scan before temporal surgery, we should look carefully for a persistent PSS.

Author Contributions

Harukazu Hiraumi, study design, surgery, data analysis, writing; Akira Yamamoto, data analysis, revising the article, final approval; Norio Yamamoto, data collection, analysis, surgery, revising the article, final approval; Tatsunori Sakamoto, data collection, analysis, surgery, revising the article, final approval; Juichi Ito, data interpretation, revising the article, final approval.

Disclosures

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