



## A new landmark for superior semicircular canal: Spine of Henle

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### ABSTRACT

**Objectives:** In this study, we aimed to investigate whether the spine of Henle could a new landmark for the localization of the superior semicircular canal (SCC).

**Patients and Methods:** Between March 2014 and March 2015, a total of 30 adult cadaveric temporal bones were used in this study. All temporal bones were positioned and, then, canal-wall up mastoidectomy and facial recess approach were performed. The landmarks such as sigmoid sinus (SS), middle cranial fossa dura (MCFD), posterior cranial fossa dura (PCFD), SCCs, short process of the incus, facial nerve (FN), and chorda tympani nerve were identified. The shortest distances between the spine of Henle and the following structures were measured: (i) superior SCC; (ii) lateral SCC; (iii) posterior SCC; (iv) MCFD; (v) PCFD; (vi) SS; and (vii) FN. All measurements were performed using a digital caliper.

**Results:** After excluding three temporal bones with absent spine of Henle, 27 temporal bones were studied. The mean distances between the spine of Henle and the superior, lateral and posterior SCCs, MCFD, PCFD, SS, and FN were 20.3±2.4, 15.9±2.1, 17.8±2.0, 13.7±2.9, 19.0±2.7, 14.9±3.6, and 15.8±1.7 mm, respectively. The distances between the spine of Henle and superior SCC were higher in the temporal bones, while the distances between the spine of Henle and MCFD were higher than the mean values. Similar differences were found for the distances between the spine of Henle and the lateral and posterior SCCs and PCFD.

**Conclusion:** Based on our study results, the spine of Henle can be used as a landmark for the localization of the superior SCC during mastoidectomy and superior SCC surgeries.

**Keywords:** Mastoid, mastoidectomy, semicircular canals, spine, temporal bone.

Mastoidectomy is performed frequently in the treatment of ear diseases, as well as chronic ear infections.<sup>[1]</sup> As in many surgeries to stay safe, the most critical step in mastoidectomy is to identify the landmarks and proceed with them. Initially, the landmarks on the lateral surface of the mastoid bone is identified in mastoidectomy and subsequently, surgery proceeds with determining the landmarks in deeper location.<sup>[1]</sup>

One of the important landmarks on the lateral surface of the mastoid bone is the spine of Henle. Recognition of the distances between the spine of Henle and the deeper landmarks can guide the surgeon. Previous studies have shown that the spine of Henle can be used as a reliable landmark to the deeper structures in the temporal bone.<sup>[1,2]</sup>

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The distance between the spine of Henle and deeper structures has been known for many years and used during surgeries of different diseases. However, as new diseases emerge over time, new distances are required for the different surgical techniques. One of these diseases is superior semicircular canal (SCC) dehiscence syndrome which was first defined by Lloyd Minor in 2000.<sup>[3]</sup> It is characterized by audiological and vestibular symptoms such as vertigo evoked by intense sounds or pressure, autophony, pulsatile tinnitus, and aural fullness. The treatment options of this syndrome includes middle fossa craniotomy and repair of fistula, transmastoid superior canal occlusion, and transcanal oval and round window reinforcement.<sup>[3-6]</sup> While performing the transmastoid superior canal occlusion, the identification of the superior SCC is one of the major steps of this surgery. The superior SCC is not routinely identified during mastoidectomies and this procedure can be difficult. If the mastoid bone is sclerotic, the identification of the superior SCC can be more difficult and any landmark to localize the superior SCC becomes more important.

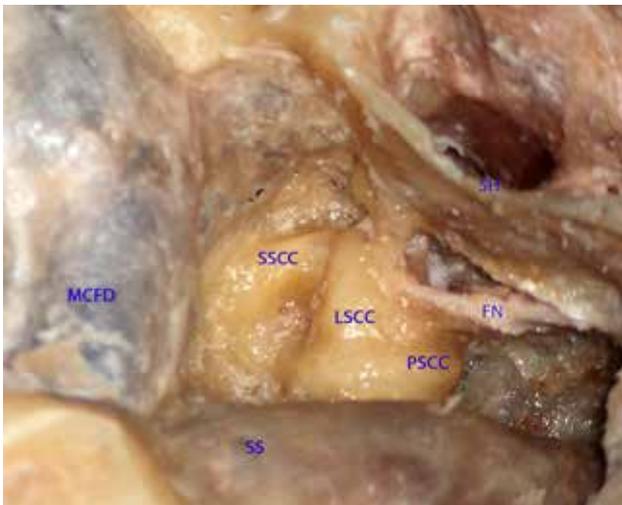
In the present study, we aimed to investigate whether the spine of Henle could a landmark to localize the superior SCC and to evaluate the

relationship of the spine of Henle with deeper structures in terms of better localization of the superior SCC.

## PATIENTS AND METHODS

Between March 2014 and March 2015, a total of 30 adult dry temporal bones were used in the study. No data including age and gender of the cadavers were able to be obtained. *Exclusion criteria were as follows:* the absence or significant damage of the spine of Henle, facial nerve, SCCs, sigmoid sinus (SS), and middle (MCFD) and posterior cranial fossa dura (PCFD). As the study was conducted on cadaveric temporal bones, no ethical approval was required.

All temporal bones were positioned in the temporal bone laboratory. Canal-wall up mastoidectomy and facial recess approach were performed with an operating microscope (Leica M500N, Wetzlar, Germany) and a high-speed drill. The landmarks such as SS, MCFD, PCFD, SCCs, short process of the incus, facial nerve (FN), and chorda tympani nerve were identified (Figure 1). The shortest distances between the spine of Henle and the following structures were measured: (i) superior SCC; (ii) lateral SCC; (iii) posterior SCC; (iv) MCFD; (v) PCFD; (vi) SS; and (vii) FN. The closest point of the dome of the SCCs were used to measure the distance between the spine of Henle and the SCCs. All measurements were performed using a digital



**Figure 1.** Identification of the landmarks during a canal-wall up mastoidectomy in a right temporal bone.

SH: Spine of Henle; SSCC: Superior semicircular canal; LSCC: Lateral semicircular canal; PSCC: Posterior semicircular canal; FN: Facial nerve; MCFD: Middle cranial fossa dura; SS: Sigmoid sinus.



**Figure 2.** The measurement of distance between spine of Henle and sigmoid sinus using a digital caliper in right temporal bone.

SH: Spine of Henle; SS: Sigmoid sinus.

**Table 1.** Distance measurements between spine of Henle and anatomical structures in temporal bone

	n	Mean±SD (mm)	Min-Max (mm)
SH-SSCC	27	20.3±2.4	15.41-27.05
SH-LSCC	27	15.9±2.1	11.74-21.54
SH-PSCC	27	17.8±2.0	14.76-22.97
SH-MCFD	27	13.7±2.9	8.26-19.59
SH-PCFD	27	19.0±2.7	13.66-24.32
SH-SS	27	14.9±3.6	7.11-21.71
SH-FN	27	15.8±1.7	12.50-19.06

SD: Standard deviation; Min: Minimum; Max: Maximum; SH: Spine of Henle; SSCC: Superior semicircular canal; LSCC: Lateral semicircular canal; PSCC: Posterior semicircular canal; MCFD: Middle cranial fossa dura; PCFD: Posterior cranial fossa dura; SS: Sigmoid sinus; FN: Facial nerve.

caliper (Mitutoyo Digimatic Caliper, Coolant Proof, measuring range: 0-150 mm, Takatsu-ku, Kawasaki, Japan) which is accurate to 0.025 mm. All measurements were performed by a single surgeon. The measurement of the distance between the spine of Henle and the sigmoid sinus is shown in Figure 2.

### Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 10.0 software (SPSS Inc., Chicago, IL, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max), or number and frequency for continuous measurements. Two-independent t-test was used to compare the distances with respect to laterality and the distances between the spine of Henle and superior SCC of the temporal bones, when other measurements were above and below the mean values. A *p* value of <0.05 was considered statistically significant.

### RESULTS

After excluding three temporal bones (10%) with absent spine of Henle, 27 temporal bones were studied. Eleven (41%) of 27 temporal bones were right-sided, and 16 (59%) were left-sided. The measurements of the distances between the spine of Henle and superior, lateral, and posterior SCCs, MCFD, PCFD, SS, and FN are shown in Table 1. The distances were compared for left versus right ears, although there was no significant difference was found among the groups.

The distances between the spine of Henle and superior SCC were higher in the temporal bones, while the distances between the spine of Henle and MCFD were higher than the mean values (*p*=0.045). Similar differences were found for the distances between the spine of Henle and lateral (*p*=0.01) and posterior (*p*=0.005) SCCs and PCFD (*p*=0.006).

### DISCUSSION

In the treatment of superior SCC dehiscence syndrome, middle cranial fossa approach was initially used and became the conventional treatment over time.<sup>[3,4,7]</sup> Later on, the transmastoid approach was developed to avoid a craniotomy and temporal bone retraction, thereby, reducing morbidity and hospital stay.<sup>[5,8,9]</sup> In 2001, Brantberg et al.<sup>[8]</sup> described the plugging of the superior SCC using a transmastoid approach. During surgery, they initially identified the lateral SCC and used it as a landmark for the exposure and blue lining of the superior SCC. They drilled four small holes approximately equidistantly apart along the superior SCC. Then, they filled the canal with small pieces of fascia from the temporal muscle. Since the transmastoid approach obviates a craniotomy and experienced otologists are familiar to this approach, many case series via transmastoid approach have been reported to date with good auditory and vestibular results.<sup>[5,9-11]</sup> As it has become more popular in recent years, the identification of the superior SCC has come to the front. However, lateral

SCC is the only landmark used for the superior SCC and, in case of sclerotic mastoid bones, it can be difficult to localize the superior SCC. Therefore, we believe that the spine of Henle can be used as an adjuvant landmark. To the best of our knowledge, the spine of Henle has not been defined as a landmark for the superior SCC, yet in the literature. We found the distance between the spine of Henle and superior SCC to be  $20.3 \pm 2.4$  mm.

In our study, we also investigated the relationship of the spine of Henle with the deeper structures such as the other SCCs, MCFD, PCFD, SS, and FN in terms of better localization of the superior SCC. Aslan et al.<sup>[1]</sup> reported the distance between the spine of Henle and the lateral SCC as 15 mm. We also found a similar result ( $15.9 \pm 2.1$  mm). However, the aforementioned authors did not measure the distance between the spine of Henle and the other SCCs. The reason for this could be that the transmastoid approach was not used frequently for the treatment of the superior SCC dehiscence syndrome in 2004.

In the present study, we found that the distances between the spine of Henle and superior SCC were higher in the temporal bones, while the distances between the spine of Henle and MCFD, PCFD, lateral, and posterior SCCs were higher than the mean values. The mean distance between the spine of Henle and lateral SCC was 15.94 mm. There were 16 temporal bones above this value and the mean distance between the spine of Henle and superior SCC in these bones was 21.03 mm. There were 11 temporal bones below the mean value and the mean distance between the spine of Henle and the superior SCC in these bones was 19.17 mm. This result can be attributed to the degree of temporal bone pneumatization: when pneumatization of the temporal bone increases, the distances increase and vice versa.

The major strength of our study is that it defines a new landmark for the superior SCC. Another strength is that all distance measurements were performed by a single surgeon. The distances between the spine of Henle and the superior SCC in 27 temporal bones had a normal distribution, confirming a

population mean. Nonetheless, one of the main limitations to our study is its small sample size. The disadvantage of the spine of Henle as a landmark is that it can be absent in some temporal bones. Aslan et al.<sup>[1]</sup> reported the absence of the spine of Henle as 20% in their study and this rate was 10% in our study.

In conclusion, the spine of Henle can be used as a landmark for the localization of the superior SCC during mastoidectomy and superior SCC surgeries. If the temporal bone has hyperpneumatization, the distance between the spine of Henle and superior SCC may be higher than the mean value.

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