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Surface anatomy of the posterolateral cranium regarding the localization of the initial burr-hole for a retrosigmoid approach

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Abstract Knowing the location of the venous sinuses is essential for the localization of the initial burr-hole for a retrosigmoid approach, in order to avoid inadvertent entry into the venous sinuses and limitation of the size of the bony opening. In this anatomic study, external landmarks of the posterolateral cranium have been studied, in order to reveal the relationship with the venous sinuses. Eighty-four dried adult human skulls were studied and study of both sides yielded 168 sides. Morphometric measurements of the posterolateral cranium have been performed and relations of the external landmarks with the venous sinuses have been studied. The anatomic position of the asterion was variable. The superior nuchal line was roughly parallel and below the lower margin of the sulcus of transverse sinus in all specimens. The sigmoid sinus, between the superior and inferior bends, seemed to descend along an axis defined by the junction of the squamosal–parietomastoid suture and the mastoid tip, in a slightly oblique fashion. In conclusion, a burr-hole placed just below the superior nuchal line and posterior to the axis defined by the mastoid tip and the squamosal-parietomastoid suture junction is appropriate for both avoiding inadvertent entry into the sinus and limiting the size of the craniotomy.

Keywords Asterion · Retrosigmoid approach · Sigmoid sinus · Transverse sinus

Introduction

The retrosigmoid approach is one of the commonly performed procedures of neurosurgical practice. Knowing the location of the venous sinuses is essential for the localization of the initial burr-hole, in order to avoid inadvertent entry into the venous sinuses and limitation of the size of the bony opening, especially in key-hole approaches for microvascular decompression. In this anatomic study, external landmarks of the posterolateral cranium have been studied, in order to reveal the relationship with the venous sinuses. As a result, a proper location for the initial burr-hole for a retrosigmoid approach has been proposed.

Materials and methods

Eighty-four dried adult human skulls were studied. The skulls were cut into two in the mid-sagittal plane, to provide an inside view. Study of both sides yielded 168 sides. The following structures were identified on each side: the lambdoid suture, parietomastoid suture, squamosal suture, asterion, inion, posterior zygoma root, external auditory meatus, suprameatal spine, mastoid process, and sulci for transverse and sigmoid sinuses on the inner surface (Fig. 1).

After identification of the key structures, the following distances were measured: posterior zygoma root to asterion, mastoid tip to asterion, suprameatal spine to asterion, posterior zygoma root to suprameatal spine, and mastoid tip to suprameatal spine.

Following these measurements, using a 2-mm drill, the asterion was drilled perpendicular to the skull surface, and the position of the hole was noted on the inner surface.

Then, the superior nuchal line (SNL), extending from the posterior zygoma root to the inion, was drawn on the skull. Using a 2-mm drill, tiny holes were opened perpendicular to the skull surface, 1 cm apart, along the SNL. Following

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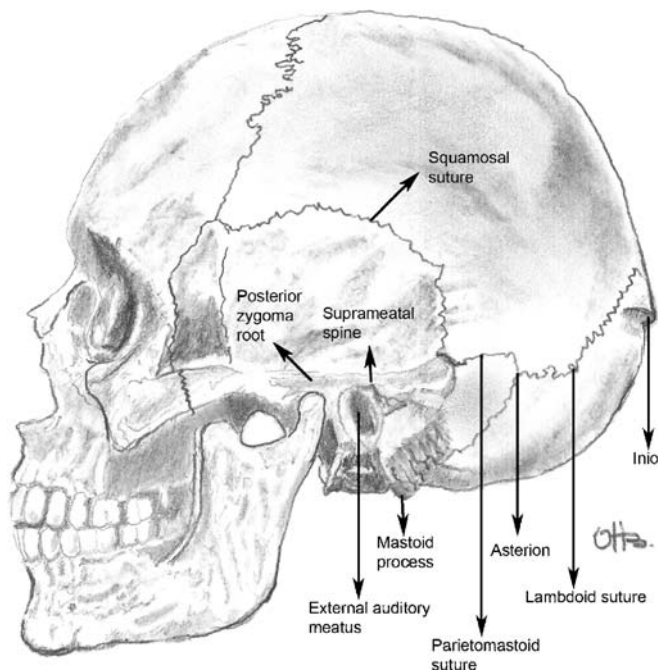


Fig. 1 Surface landmarks of the posterolateral cranium

this, using the tiny holes, the SNL was drawn on the inner surface of the skull and its relation and distance to the sulcus of the transverse sinus was studied.

Finally, the relation between the sulcus of the sigmoid sinus and the external landmarks was studied.

Results

The mean distance between the posterior zygoma root and asterion was 55 mm on the right, and 55.9 mm on the left. The mean distance between the mastoid tip and asterion was 49.9 mm on the right, and 50.1 mm on the left. The mean distance between the suprameatal spine and asterion was 43.5 mm on the right, and 43.4 mm on the left. The mean distance between the posterior zygoma root and suprameatal spine was 14.8 mm on both sides. The mean distance between the mastoid tip and suprameatal spine was 28.5 mm on the right and 28.8 mm on the left (Table 1).

The asterion, in the anterior–posterior plane, was on the level of the transverse–sigmoid sinus junction in 31 specimens (36.9%) on the right, and 34 specimens (40.5%) on the left. It was on the level of the distal transverse sinus in 53

specimens (63.1%) on the right, and 50 specimens (59.5%) on the left. In the cranial–caudal plane, the hole opened at the asterion was in the sulcus of the transverse sinus in 47 specimens (56%) on the right, and in 50 specimens (59.5%) on the left. The asterion was over the sinus level in 11 specimens (13.1%) on the right, and in 13 specimens (15.5%) on the left. It was below the sinus level in 26 specimens (31%) on the right, and in 21 specimens (25%) on the left.

The SNL was roughly parallel and below the lower margin of the sulcus of transverse sinus in all specimens. The distance between the SNL and the lower margin of the sulcus of transverse sinus ranged from 1.8 to 12.3 mm with a mean of 7.8 mm on the right, and ranged from 2.1 to 13.6 mm with a mean of 8.1 mm on the left.

When the sulcus of the sigmoid sinus was studied in relation to external landmarks, it was noted that the sigmoid sinus, between the superior and inferior bends, seemed to descend along an axis defined by the junction of the squamosal–parietomastoid suture and the mastoid tip, in a slightly oblique fashion.

Discussion

The retrosigmoid approach is one of the commonly performed procedures of neurosurgical practice. It is the oldest approach to acoustic neuromas, first developed by Cushing and then refined by Dandy in the pre-microsurgical era [12]. It is also used for microvascular decompression, posterior inferior cerebellar artery (PICA) aneurysms, and access to the anterolateral brainstem, as well as other cerebellopontine angle (CPA) tumors [8].

Although a relatively straightforward procedure, the technique slightly varies from surgeon to surgeon, especially regarding the localization of the first burr–hole. Yasargil et al. [14] originally described three burr–holes for craniotomy: (1) three finger breadths lateral to the external occipital protuberance and just over the SNL; (2) over the mastoid; (3) 3 cm medial to the second one. In *Microneurosurgery*, Yasargil [13] presents the single burr–hole technique, and the burr–hole is located approximately 2 cm above the SNL, superior to the level of the transverse sinus. Al–Mefty [1] places the burr–hole on the asterion, below the transverse–sigmoid sinus junction. Ojemann [10] also uses a single burr–hole, and after exposing the bone over the lateral two-thirds of the cerebellar hemisphere, he opens the burr–hole just in the center. Lang and Samii [7] stated that the burr–hole should be placed 45 mm behind the supra-

Table 1 Morphometric measurements of the posterolateral cranium

Distance (mm)	Right			Left		
	Min.	Max.	Mean	Min.	Max.	Mean
Posterior zygoma root to asterion	36.4	71.0	55.0	42.3	67.0	55.9
Mastoid tip to Asterion	38.0	62.5	49.9	37.0	65.5	50.1
Suprameatal spine to asterion	12.0	53.0	43.5	12.0	55.0	43.4
Posterior zygoma root to suprameatal spine	7.1	21.5	14.8	8.2	21.5	14.8
Mastoid tip to suprameatal spine	20.0	54.0	28.5	19.9	53.0	28.8

meatal spine and 7 mm below the Frankfurt horizontal plane (FHP). Day et al. [4] proposed that the burr-hole should be opened just below the SNL and posterior to the body of mastoid. Rhoton [11] stated that he prefers to open the burr-hole 2 cm below the asterion, two-thirds behind and one-third in front of the occipitomastoid suture.

This variance of localization of the burr-hole, in a relatively small anatomic area depends on two factors: avoidance of inadvertent entry into the venous sinuses and limitation of the bony opening, especially in key-hole approaches for microvascular decompression.

The asterion has long been advocated as an important landmark for the retrosigmoid approach and the burr-hole was placed in reference to it [2, 6]. But recent studies have shown that the asterion is not a reliable anatomic landmark. Day et al [4] reported that the anatomic location of the asterion, in relation to venous sinuses, is variable. In the anterior-posterior plane, it marks the transverse-sigmoid sinus junction, but varies in the cranial-caudal plane. However, Day and Tschabitscher [5], in a following study, concluded that it is also variable in anterior-posterior plane. In our study, in the anterior-posterior plane, the asterion was located on the junction in 36.9% on the right and 40.5% on the left. In the cranial-caudal plane, it was over the sinus level in 13.1% on the right and 15.5% on the left. It was below the sinus level in 31% on the right and 25% on the left. Therefore, a burr-hole opened in reference to the asterion may result in inadvertent entry into the sinus, because of its varying anatomical position.

On the other hand, vertical skin incision can be centered on the asterion for adequate exposure. The scalp over the asterion can be palpated as a slight depression [11]. Its place can also be estimated in relation to palpable anatomic landmarks. According to our findings, the mean distance between the asterion and the posterior zygoma root is 55 mm on the right and 55.9 mm on the left. The mean distance between the suprimeatal spine and the asterion is 43.5 mm on the right and 43.4 mm on the left. The distance between the mastoid process and asterion is 49.9 mm on the right and 50.1 mm on the left.

Another important point is the trajectory of the transverse sinus. Lang and Samii [7] have investigated the relationship of the transverse sinus to the FHP, which is a line starting from the inferior margin of the orbit, and passing through the upper margin of the external auditory meatus. They concluded that in 92% of the patients no sinus is opened if the burr-hole is opened 45 mm behind the suprimeatal spine and 7 mm below the FHP. But Day et al. [4] noted that the method is not reliable, because of the fact that the FHP ends over the inion in some cases and below the inion in others. Therefore, they stated that the SNL, which is a line starting from the posterior zygoma root and ending in the inion [9], is much more reliable, and according to their findings, this line overlies the transverse sinus in all cases. In a following study by Avci et al. [3], the upper margin of

the SNL was found to be 1.5–14 mm below the lower margin of the transverse sinus. In our study, the SNL was below the lower margin of the sulcus of transverse sinus in all cases, and the mean distance was 7.8 mm on the right and 8.1 mm on the left. Therefore, a burr-hole located below the SNL will avoid inadvertent entry into the sinus.

The next important point is the trajectory of the sigmoid sinus, but there is less debate about it. Day et al. [4] stated that the sigmoid sinus descends along an axis defined by the mastoid tip and the squamosal-parietomastoid suture junction. Avci et al. [3] reported that the mastoid groove was found to completely overlie the sigmoid sinus in 85% of the specimens. Our results were comparable with these findings. Therefore, a burr-hole located posterior to the body of mastoid will avoid a sinus injury.

In conclusion, localization of the burr-hole for a retrosigmoid approach is important for both avoiding inadvertent entry into the sinus and limiting the size of the craniotomy. A burr-hole placed just below the SNL and posterior to the axis defined by the mastoid tip and the squamosal-parietomastoid suture junction would serve both purposes.

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