A New Landmark for Finding the Sigmoid Sinus in Suboccipital Craniotomies

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BACKGROUND: The suboccipital craniotomy is one of the most commonly performed neurosurgical approaches.

OBJECTIVE: To define a new cranial landmark, the digastric point, located at the top of the mastoid notch in the mastoid portion of the temporal bone that may assist surgeons performing this craniotomy and to study the relationships between this point and other surface landmarks.

METHODS: Craniometric measures were taken from 127 dry human adult skulls (90 male and 37 female). The measures were taken in millimeters by a digital caliper. Trans-illumination of the skull with laser or light-emitting diode was used to assess the correspondence of the digastric point in the inner surface of the skull.

RESULTS: The mean distance between the digastric point and the sigmoid sulcus in 254 measures was 3.10 mm (SD, 3.11 mm). The digastric point was over the sulcus of the sigmoid sinus in 49.6% of the cases on the right side and in 29.9% of the cases on the left side. The distance between the jugular point and the stylomastoid foramen was smaller on the right side (mean, 8.89 mm; SD, 2.61 mm; $P = .041$). Comparing genders regardless of side, the distances between the digastric and jugular points and from the jugular point to the stylomastoid foramen were smaller in female skulls ($P = .000$ and .006, respectively).

CONCLUSION: The digastric point may be a useful landmark to expose the sigmoid sinus during suboccipital approaches.

KEY WORDS: Anatomy, Cephalometry, Sigmoid sinus, Skull base, Suboccipital craniotomy, Surgical procedures

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The suboccipital craniotomy is one of the most common approaches in neurosurgery to deal with lesions in cerebellopontine angle. Extensions of the suboccipital craniotomy include the presigmoid approach anteriorly and the transcondylar approach inferiorly. Superficial landmarks on the occipital and temporal bones help the surgeon perform these craniotomies, minimizing the risks directly associated with the approach.

Cranial sutures are natural landmarks, but they are not always easily identifiable because they are covered by periosteum or because they may be less evident. The definition of landmarks on the cranial surface and the study of the anatomic relationships of these points with internal structures are useful to plan and perform craniotomies safely.

In this study, we define a new landmark, the digastric point (DP), located at the top of the mastoid notch in the mastoid portion of the temporal bone. This point is easily identified, and its anatomic relationships may provide a new reference point when the suboccipital approach and its extensions are performed.

ABBREVIATIONS: DP, digastric point; **JF,** jugular foramen; **JP,** jugular point; **OMS,** occipitomastoid suture; **SF,** stylomastoid foramen; **SS,** sigmoid sulcus

OBJECTIVES

The objectives of this study were (1) to validate the DP as a reference for the suboccipital approach and its extensions measuring the distances between this point and the asterion, occipitomastoid suture (OMS), jugular point (JP), stylomastoid foramen (SF), jugular foramen (JF), and sigmoid sulcus (SS) and (2) to evaluate the difference in these measures as far as gender and skull side are concerned.

METHODS

From 400 skulls of the Afonso Bovero Anatomy Museum of the São Paulo University cataloged by gender and age, we studied 127 (90 males and 37 females). We excluded skulls without proper identification and those that were not cross-sectioned, which hindered access to the SS in the posterior fossa.

In the external surface of each skull, we identified the DP, asterion, OMS, JP, SF, and JF. In the inner surface of each skull, we identified the sigmoid sinus sulcus. On both sides, we took 3 measures of the following distances: between the DP and the asterion, between the DP and the OMS, between the DP and the JP, between the JP and the SF, between the SF and JF, and between the correspondence of the DP in the inner surface of the skull and the SS. The average of the 3 measurements was used to define the descriptive measures: mean, median, SD, maximum, and minimum values. We used a digital caliper (Mitutoyo, São Paulo, Brazil) for the measures because of its precision and the ease with which each measure can be read.

To access the correspondence of the DP in the inner surface of the skull, we used transillumination of the skull with laser (99 skulls) or a light-emitting diode (LED; 10 skulls). We used a laser pointer with laser and LED as a light source for transillumination. The laser pointer was put in contact with the external surface of the skull at the DP, and by transillumination, the correspondence of the DP in the inner surface of the skull was marked with a pencil (Figure 1). Then, the distance of this point to the border of the SS was measured.

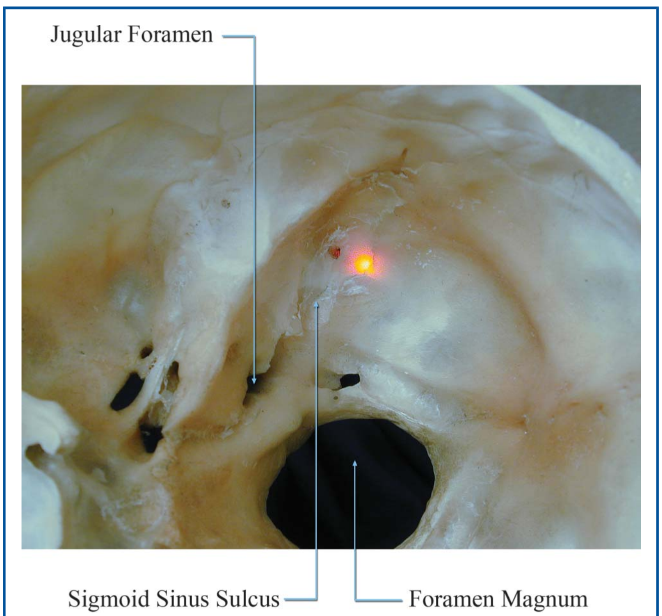

FIGURE 1. *Transillumination of the skull with a laser pointer to find the correspondence of the digastric point in the inner surface of the skull.*

When transillumination was not possible with laser because of skull thickness, we used the LED source of the same laser pointer. However, transillumination failed in 18 skulls. In these cases, the correspondence of the DP in the inner surface of the skulls was accessed with a caliper, with the tips forming a 90° angle. Again, a pencil was used to mark the skull at the DP in the inner surface, and the distance between this point and the border of the sigmoid sinus was measured. When the DP correspondence in the inner surface was over the sigmoid sinus sulcus, the distance was deemed to be zero.

Statistical Analysis

We analyzed the sample of 127 adult dry human skulls and then separated them by gender. For the quantitative variables, we used descriptive measures (mean, SD, median, minimum, and maximum values). For the qualitative variables, we used the frequency distribution.

The statistical analysis defined general reference values and values for gender and skull side for the following distances (Figure 2): asterion-DP, DP-OMS, DP-JP, JP-SF, SF-JF, and correspondence of the DP on the inner surface of the skull (DP-SS). We evaluated the difference in these measures between individuals of both genders and between skull sides. We used the intraclass ratio to evaluate the intraobserver reliability.

We tested the normal distribution of the measures to decide which statistical test would be used. We found normal distribution for all

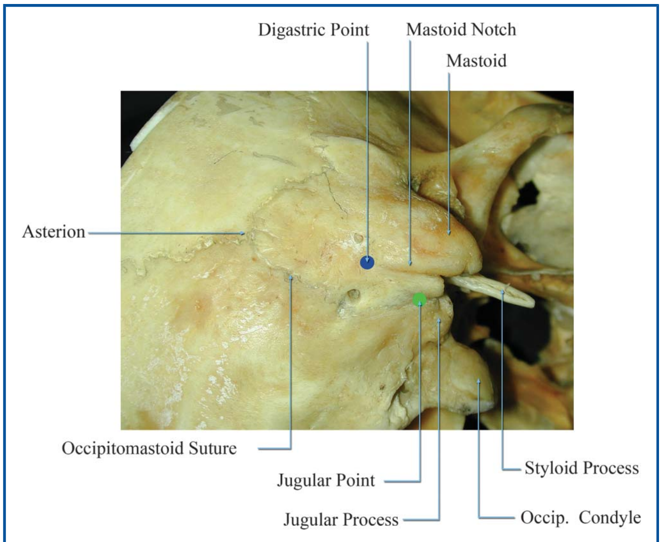

FIGURE 2. *Posterolateral surface of the skull on the right side. The digastric point is located at the top of the digastric groove. The asterion is the point of junction of the parietomastoid, lambdoid, and occipitomastoid sutures. The digastric point is defined as the point at the top of the digastric groove (blue circle). This point is easily identifiable in dry skulls and during surgical procedures because the digastric groove is covered by the posterior belly of the digastric muscle. The jugular point is a point over the occipitomastoid suture at the level of the posterior border of the jugular process of the occipital bone (green circle). The jugular process of the occipital bone is a bulged bone at each side of the occipital bone, located between the occipital (Occip.) condyle medially and the mastoid process laterally. The occipitomastoid suture is the junction of the occipital bone with the mastoid portion of the temporal bone. It begins at the asterion and descends, surrounding the jugular process of the occipital bone and ending at the jugular foramen.*

measures except for those between the DP and the OMS. Parametric tests were used when the distribution was normal. We used a nonparametric test for the measures between the DP and the OMS.

An independent group *t* test was used to evaluate the difference between the mean values of the measures associated with gender. In this test, the null hypothesis was that the mean values of the variables were the same between groups (males and females) and the alternative hypothesis was that the mean values were different.

We used the Mann-Whitney test when the distribution was not normal. In this test, the null hypothesis is that the medians were the same between the groups (males and females). The alternative hypothesis was that the medians were different.

To access the difference between the mean values of the distances between the right and left sides of the skulls, we used the paired *t* test. Both sides of the same skull were evaluated. When the distribution was not normal, the Wilcoxon test was used.[1,2]

We defined the level of significance of all tests to be 5%. Statistically significant associations were those in which the $P < .05$. All statistical analyses were carried out with SPSS version 13.0 software (SPSS Inc, Chicago, Illinois).

RESULTS

To test the reliability of the 3 measurements for each distance, we used the intraclass ratio. The ratios were close to one, showing measurement reliability. The mean values of the 3 measures were used for the following comparisons.

The mean age of the skulls was 34.93 years (SD, 13.16 years). For male skulls, the mean age was 33.62 years (SD, 12.35 years); for female skulls, it was 38.46 years (SD, 14.41 years).

The distribution was found to be normal for all parameters except for the measure between the DP and the OMS (DP-OMS). We used a parametric test to compare the mean values between genders for those measures showing normal distribution.

The mean DP-JP distances were different between genders, being smaller in female skulls on both sides ($P = .006$ on the right and $P = .007$ on the left). The mean DP-SS and JP-SF distances were smaller in female skulls only on the left side.

For the parameters in which there was a statistically significant difference between genders (DP-JP and DP-SS), we carried out a separate analysis with paired *t* test to compare skull sides.

For the JP-SF, SF-JF, and DP-SS distances, there were statistically significant differences between the sides but only in male skulls: The JP-SF distance was smaller on the right side (mean, 8.89 mm; SD, 2.61 mm; $P = .041$), the SF-JF distance was smaller on the right side (mean, 5.49 mm; SD, 1.73; $P = .000$), and the DP-SS distance was smaller on the right side in both genders, but this difference was statistically significant only in male skulls (mean, 2.78 mm; SD, 3.01 mm; $P = .000$).

The DP was over the SS (distance equals zero) in 49.6% of the skulls (n = 63) on the right side and in 29.9% of the skulls (n = 38) on the left side. The DP-SS distance range was 0 to 12.38 mm. The mean DP-SS distance regardless of side was 3.10 mm in the 254 measures taken (Table).

When we compared the DP-SS distance between genders, regardless of skull, the results were smaller in females, with statistical significance ($P = .004$). A comparison of the measures of the DP-JP, JP-SF, and DP-SS distances between genders, regardless of side, showed that the DP-JP and JP-SF distances were smaller in female skulls ($P = .000$ and $P = .006$, respectively).

The DP-OMS distance did not show normal distribution. Therefore, a nonparametric test was used to compare the medians. We used the Mann-Whitney test for independent parameters. There was no statistically significant difference between genders and skull sides.

TABLE. Mean Values of the Digastric Point on the Inner Surface of the Skull–Sigmoid Sulcus Distance in Both Sexes Regardless of Skull Side

	n	Mean, mm	SD, mm
Mean	254	3.10	3.11
Male	180	3.45	3.01
Female	74	2.23	3.20

DISCUSSION

One of the most important concerns when performing lateral suboccipital approaches is the exposure of the sigmoid sinus. Surface landmarks on the skull help the surgeon choose where to place burr holes, taking into account vascular and neural structures underneath these areas.

Upper Limit of the Sigmoid Sinus

There are few anatomic studies of points in the skull that can be used as landmarks to find the sigmoid sinus during craniotomies. Ribas[3] studied different points of the cranial sutures in relation to the topography of the transverse and sigmoid sinuses and in relation to their related surgical approaches. A hole burred at the retrosigmoid point, located immediately below the asterion, exposes the lateral portion of the posterior fossa in an angle formed by the transition of the lateral and sigmoid sinuses.

In 2 other articles, Ribas et al[4,5] studied the correspondence of burred holes in the posterior fossa with the venous sinuses in 50 human adult skulls; they knew gender, age, and race for 25 of them. The authors described the asterion and the middle point of the inio-asterion line in relation to the inferior half of the lateral sinus; the superior point of the transition lateral/sigmoid sinuses was above the posterior portion of the parietomastoid suture; the inferior point of the transition lateral/sigmoid sinuses was below the posterior portion of the parietomastoid suture; the crossing point of the squamous and parietomastoid sutures was related to the posterior portion of the middle fossa; the OMS, at the level of the digastric groove, was related to the posterior wall of the sigmoid sinus; this point marked the intersection of an imaginary line between the inion to the mastoid tip with the OMS. The authors placed the initial burr hole at this point. They found no differences between genders and skull sides. The OMS is not always identifiable in heads and was located about 7 mm posterior to the DP.[6]

Day et al[7] studied 15 human heads to identify reference points in the surface of the skull to help the surgeon safely find the lateral and sigmoid sinuses. In their study, the mean distance between the asterion and the mastoid tip was 49.2 ± 4.4 mm. There was considerable variation in the distance between the asterion and the superior border of the lateral sinus (mean, 2 mm; ± 8 mm). The border of the lateral sinus was found above and below the asterion. In all specimens, the lateral sinus was below the axis of a line between the root of the zygoma and the inion. The junction of the parietomastoid and squamous sutures marked the anterior border of the superior curve of the sigmoid sinus.

In another article, Day and Tschabitscher[8] studied 100 dry skulls drilling holes over the asterion in both sides of the skulls. The asterion was above the dura mater of the posterior fossa in 32% of the skulls on the right side and in 25% on the left. The asterion was related to the transition of the lateral and sigmoid sinuses in 61% of the cases on the right side and in 66% on the left. The asterion was above the transition of the sinuses in 7% of the cases on the right side and in 9% on the left. With this study, they showed the variability of the asterion and its relationship with the dura mater of the posterior fossa and the transition of the lateral and sigmoid sinuses, and they did not consider the asterion a reliable landmark.

Avci et al[6] studied the relationship between the venous sinuses of the posterior fossa with superficial landmarks in 12 heads injected with silicone and in 10 dry skulls. Although the asterion is easily identified in dry skulls, it was identified in only 60% of the regular heads. The digastric groove was over the sigmoid sinus in 85% of the specimens. When performing the suboccipital craniotomy, the authors recommended drilling a hole 1 cm medially to the top of the mastoid groove to avoid the sigmoid sinus. The authors also did not consider the asterion useful as a reference point because of its anatomic variability and because its identification was not always easy.

In a morphometric study of 84 dry adult skulls, Bozbuga et al[9] measured the distance between the mastoid tip and the asterion. This measure was 49.9 mm (mean) on the right side and 50.1 mm on the left. The authors also reported differences in both sides for the correspondence of the asterion in an anterior-posterior plane with the junction of the sigmoid and transverse sinuses. The asterion was over the junction in 36.9% on the right side and 40.5% on the left. The asterion was over the distal portion of the transverse sinus in 63.1% of the cases on the right side and in 59.5% on the left. The axis of the sigmoid sinus projected over an oblique line between the junction of the squamous and parietomastoid sutures and the mastoid tip.

Lower Limit of the Sigmoid Sinus

There are few studies about reference points for the lower limit of suboccipital craniotomy and the relationship with the lower portion of the sigmoid sinus. In our anatomic dissections, to illustrate the petrosal approach with partial labyrinthectomy (Sekhar et al),[10] we observed that the sigmoid sinus makes an anterior curve toward the jugular bulb. This curve was located near the top of the mastoid notch. Inspired by the work of Ribas[3] and Ribas et al[4,5] and our own dissections, we created a reference point located immediately above the mastoid notch. We called it the DP and started to use it as a reference point to drill the skull when performing the lateral suboccipital approach (Figure 3).

The DP is easy to find, both in dry skulls and during surgical approaches. In dry skulls, its location corresponds to the top of the mastoid notch. The posterior belly of the digastric muscle completely fills the mastoid notch. Therefore, in surgical procedures, we define the DP as the point immediately above the posterior belly of the digastric muscle.

In our study, the DP projected over the SS in the inner surface of the skull in 49.6% of cases on the right side and in 29.9% of cases on the left.

Inferior Extension and the Facial Nerve

For downward extensions of the lateral suboccipital approaches, the measures found in this study may be useful for the surgeon. The JP is over the OMS at the level of the posterior border of the jugular process of the occipital bone. The DP-OMs distance measured in our study did not show normal distribution. The median of this measure was between 6 and 7 mm, with no significant difference between the sides of the skulls or between genders. The DP-JP measures showed normal distribution, and the mean distance was 21.13 mm (SD, 4.32 mm).

The facial nerve exits the skull through the stylomastoid foramen. It is very easy to locate the SF in dry skulls. It is located immediately posterior to the styloid process and anterior to the mastoid notch.

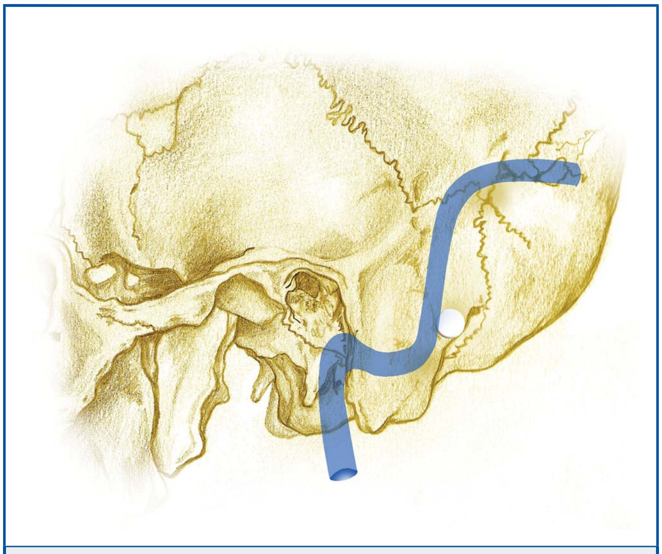

FIGURE 3. *Illustration of the left lateral view of the skull. Blue indicates the sigmoid sinus; the white circle, a burr hole over the digastrics point.*

However, these spaces are occupied by muscles, blood vessels, periosteum, connective tissue, and fat, which makes it difficult to locate the facial nerve in the foramen during surgical procedures.

The craniometric measures from the DP and JP performed in this study may assist the surgeon in locating the facial nerve. The mean distance between the DP and JP in the 254 sides studied was 21.13 mm (range, 10.53-32.22 mm) with an SD of 4.32 mm. From the JP to the SF, the mean distance was 8.86 mm (range, 2.41 to 18.03 mm), with an SD of 2.63 mm.

Asymmetry Between Sides and Gender Differences

In their study of 263 cerebral angiograms with digital subtraction technique, Shima et al[11] found symmetry of the sigmoid sinus in 49% of cases. In about 36% of cases, the right sigmoid sinus was dominant or exclusive. It was expected that anatomic studies showed statistically significant differences in measures of the sigmoid sinus. However, in the studies by Ribas et al,[4,5] there was no difference between skull-side measures. Avci et al[6] also did not compare the sides in their craniometric measures.

In an evaluation of the measures performed by Tedeschi and Rhoton[12] between the tip of the mastoid and the lateral margin of the JF and between the lateral margin of the SF and the lateral margin of the occipital condyle, there was no difference between the sides in 25 skulls studied. When the number of skulls studied is larger, one usually can find differences between the sides. Day and Tschabitscher[8] studied 100 skulls and Bozbuga et al[9] studied 84 skulls and found a difference between the right and left sides in the asterion and transverse sinus sites.

Our results also showed differences in craniometric measures between the sides of the skulls. We studied 127 skulls, 254 sides. The DP was projected over the SS in 49.6% of cases on the right and in 29.9% on the left. When the DP did not project over the SS, the mean distance between this point and the SS was 3.10 mm (SD, 3.11 mm). This distance was smaller in females (mean, 2.23 mm; SD, 3.20 mm), reaching statistical significance when the measures of both sides were considered. We can conclude that the sigmoid sinus is wider on the right side.

The mean distances between the JP and the SF and between the SF and JF were significantly smaller on the right, but only in males. These results also indicate that there is an asymmetry between the 2 sides of the skull.

Craniometric studies for surgical application usually do not compare the findings in terms of gender. Ribas et al[5] studied craniometric points in 25 skulls classified by age and gender. They found no significant differences between genders.

Our results showed that the mean distances between the DP and JP were smaller in females. The mean distances between the DP and SS and between the JP and SF were also smaller in females, but only on the left side of the skull.

Exposure of the Sigmoid Sinus

Al-Mefty et al,[13] describing the petrosal approach, made 4 trepanations: 2 above and 2 below the lateral sinus; the first was just below the asterion. Rhoton[14] preferred to make their initial trephination 2 cm below the asterion, two-thirds anteriorly and one-third posteriorly to the OMS. Yasargil[15] did not use the asterion as a reference point for the suboccipital craniotomy. Yasargil described 3 trepanations: the first 1 to 2 cm above the superior nuchal line, the second in the superior nuchal line behind the mastoid process, and the third 3 cm medial to the second.

This variation in preference for the location of the drill holes on this short anatomic area takes into account 2 aspects: the potential risk of injury to the venous sinuses and bone opening limitations.

We prefer to expose the border of the sigmoid sinus during the suboccipital approach. We use the asterion as the upper landmark and the DP as the lower. By drilling bone between these 2 landmarks, one can expose the entire lateral border of the sigmoid sinus. The potential risk of damage to the sinus wall is counterbalanced by better exposure of the lateral limit of the approach, reducing the need to retract the cerebellum.

CONCLUSION

The craniometric measures and statistical analyses of this study showed that the distance between the DP and the SS was smaller on the right side; the measures between the DP and JP, JP and SF, and DP and sigmoid sinus sulcus were smaller in females; the relationship between the DP and JP and the JP and SF may assist in finding the location of the facial nerve at its exit from the skull base; and the relationship of the DP with the sigmoid sinus can be used as lateral limit on the suboccipital access.

Disclosure

The authors have no personal financial or institutional interest in any drugs, materials, or devices described in this article.

REFERENCES

1. Hollander M, Wolfe DA. *Nonparametric Statistical Methods*. 2nd ed. New York, NY: John Wiley & Sons; 1999:27-33, 68-75.
2. Triola MF. *Introdução à Estatística*. 7th ed. Rio de Janeiro, Brazil: LTC Editora; 1998.
3. Ribas GC. Estudo das relações topográficas das suturas lambdóide, occipitomastóidea e parietomastóidea com os seios transverso e sigmóide e de trepanações da região. São Paulo: Tese (Doutorado); Faculdade de Medicina da Universidade de São Paulo; 1991.
4. Ribas GC, Rhoton AL Jr, Cruz OR, Peace D. Temporo-parieto-occipital burr hole sites study and systematized approaches proposal. In: Samii M, ed. *Skull Base Surgery: First International Skull Base Congress*. Basel, Switzerland: Karger; 1992:723-730.
5. Ribas CG, Rhoton AL Jr, Cruz OR, Peace D. Suboccipital burr holes and craniectomies. *Neurosurg Focus*. 2005;19(2):E1.
6. Avci E, Kocaogullar Y, Fosset D, Caputy A. Lateral posterior fossa venous sinus relationships to surface landmarks. *Surg Neurol*. 2003;59(5):392-397.
7. Day JD, Kellogg JX, Tschabitscher M, Fukushima T. Surface and superficial surgical anatomy of the posterolateral cranial base: significance for surgical planning and approach. *Neurosurgery*. 1996;38(6):1079-1084.
8. Day JD, Tschabitscher M. Anatomic position of the asterion. *Neurosurgery*. 1998;42(1):198-199.
9. Bozbuga M, Boran BO, Sahinoglu K. Surface anatomy of the posterolateral cranium regarding the localization of the initial burr-hole for a retrosigmoid approach. *Neurosurg Rev*. 2006;29(1):61-63.

10. Sekhar LN, Schessel DA, Bucur SD, Raso JL, Wright DC. Partial labyrinthectomy petrous apicectomy approach to neoplastic and vascular lesions of the petroclival area. *Neurosurgery*. 1999;44(3):537-552.
11. Shima T, Okita S, Okada Y, Nishida M, Yamane K, Hatayama T. Anatomical dominance of venous sinuses and jugular vein examined by intravenous digital subtraction angiography. In: Hakuba A, ed. *Surgery of the Intracranial Venous System*. Tokyo, Japan: Springer Verlag; 1996.
12. Tedeschi H, Rhoton AL Jr. Lateral approaches to the petroclival region. *Surg Neurol*. 1994;41(3):180-216.
13. Al-Mefty O, Fox JL, Smith RR. Petrosal approach for petroclival meningiomas. *Neurosurgery*. 1988;22(3):510-517.
14. Rhoton AL Jr. Surface and superficial surgical anatomy of the posterolateral cranial base: significance for surgical planning and approach [comment]. *Neurosurgery*. 1996;38(6):1083-1084.
15. Yasargil MG. *Lateral Suboccipital Craniotomy: Microsurgical Anatomy of the Basal Cisterns and Vessels of the Brain: Diagnostic Studies, General Operative Techniques and Pathological Considerations of the Intracranial Aneurysms*. Stuttgart, Germany: Gerg Thieme Verlag; 1984;1:238-241.

COMMENT

Although the frontotemporal approaches are relatively systematized in the sense that their craniotomies are usually done from defined burr hole sites[1,2] with minor variations, the lateral suboccipital approaches are still performed mostly from various and nonstandardized initial burr hole placements, which justifies and welcomes this careful study by Raso and Gusmão. Because the transverse and sigmoid sinuses are the natural limits of these exposures, knowledge of their cranial topography constitutes the main factor for the placement of the initial burr holes for the lateral suboccipital approaches, and the digastric point proposed here can easily be exposed surgically and lies just next to the sigmoid sinus. Because the diagnostic point is described as located at the top of the mastoid notch, it seems to be similar to the point we describe as located at the superior and posterior aspect of the mastoid notch, which also corresponds to the crossing point between the occipitomastoid suture and the posterior margin of the sigmoid sinus.[3,4]

Considering the currently available cranial topography knowledge, while the upper portion of the cerebellopontine angle can be exposed from an initial burr hole over or just anterior to the asterion, [3-5] its lower portion can then be exposed from an initial burr hole located at the posterior aspect of the top of the mastoid notch.

The authors should be also congratulated for their careful and complete statistical analysis, not usual in anatomical studies.

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1. Yasargil MG. *Microneurosurgery, Volume 1*. Stuttgart, Germany: Georg Thieme; 1984a.
2. Yasargil MG, Fox JL, Ray MW. The operative approach to aneurysms of the anterior communicating artery. In: Krayenbül H, ed. *Advances and Technical Standards in Neurosurgery*. Wien, Austria: Springer-Verlag; 1975;2:114-70.
3. Ribas GC. Study of the anatomic relationships of the lambdoid, occipitomastoid and parietomastoid sutures with the transverse and sigmoid sinuses, and of regional burrholes sites [in Portuguese]. São Paulo, Brazil: Faculdade de Medicina, Universidade de São Paulo; 1991.
4. Ribas GC, Rhoton AL Jr, Cruz OR, Peace D. Suboccipital burr holes and craniectomies. *Neurosurg Focus*. 2005;19(2):E1-E12.
5. Ribas GC, Yasuda A, Peace D, Rhoton AL Jr. Microsurgical anatomy of the cerebellopontine angle and its suboccipital retromastoid approaches. In: Bambakidis NC, Megerian CA, Spetzler RF, eds. *Surgery of the Cerebellopontine Angle*. Shelton: BC Decker; 2009. Part I: Foundations for Treatment; Chap. 2:11-30.