

Surface Anatomy of the Transverse Sinus for the Midline Infratentorial Supracerebellar Approach

Orta Hat Inferior Supraserebellar Yaklaşım için Transvers Sinüsün Yüzey Anatomisi

ABSTRACT

AIM: Knowing the location of the transverse sinus in the midline supracerebellar infratentorial approach is important to prevent its inadvertent injury. The external landmarks of the occipital bone have been studied in this anatomic study in order to reveal their relationship with the transverse sinus.

MATERIAL and METHODS: Fifty-two dried skulls were used to study the relationship of the transverse sinus with various surface bone structures. The key bone surface structures identified in each specimen were the superior nuchal line, the inferior nuchal line, the inion, internal occipital protuberance, and the transverse sulcus.

RESULTS: The distance from the inion to the inferior nuchal line in specimens ranged from 12.7 mm to 37.7 mm. The distance from the inferior nuchal line to the midline foramen magnum in the specimens ranged from 19 mm to 34.75 mm. The width of the proximal transverse sulcus ranged from 2.6 mm to 10.16 mm with an average of 6.43 mm on the right side and 3.4 mm to 10.6 mm with an average of 6.15 mm on the left.

CONCLUSION: The first and most superior burr hole for midline supracerebellar infratentorial approach can be safely placed approximately 1 cm below the inferior nuchal line. A burr hole in this localization will avoid the transverse sinus.

KEYWORDS: Supracerebellar infratentorial approach, Pineal tumor, Inferior nuchal line, Transverse sinus, Transvere sulcus

ÖZ

AMAÇ: Ortahat supraserebellar inferior tentorial yaklaşımında transvers sinüsün lokalizasyonunu bilmek, istenmeyen hasarını önlemekte önemlidir. Oksipital kemigin eksternal landmarkları, bu anatomiç çalışmadada transvers sinüsle ilişkilerini ortaya çıkarmak için çalışıldı.

YÖNTEM ve GEREÇ: 52 kuru kafada transvers sinüsle çeşitli yüzey kemik yapılarının ilişkisi çalışıldı. Her bir örnekte ortaya konan kemik yüzey markerlar superior nukhal line, inferior nukhal line, inion, internal oksipital protuberens ve transvers sulkus idi.

BULGULAR: Örneklerde inion ile inferior nukhal line arası mesafe 12.7 ila 37.7 mm arasında ölçüldü. Inferior nukhal line ile orta hatta foramen magnum arasındaki mesafe 19 ila 34.75 mm arasında ölçüldü. Proksimal transvers sulkusun genişliği sağda ortalama 6.43 mm, solda ortalama 6.15 mm olarak ölçüldü.

SONUÇ: Orta hat superior cerebellar yaklaşımında ilk ve en superior burr hole güvenle inferior nukhal linedan yaklaşık 1 cm aşağı yerleştirilebilir. Bu lokalizasyondaki burr hole ile transvers sinüsten sakınılır.

ANAHTAR SÖZCÜKLER: Supraserebellar infratentorial yaklaşım, Pineal tümör, Inferior nukhal line, Transvers sinüs, Transvers sulkus

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INTRODUCTION

With the increasing use of the keyhole concept in neurosurgery, appropriate placement of burr holes for cranial approaches is of paramount importance to allow proper positioning for optimal visualization of the anatomic and pathological structures. Isolating superficial landmarks to pinpoint the location of deeper structures is of immense importance in planning surgical approaches to the pineal region.

Posterior approaches to the pineal region are difficult to execute, given the complexity and importance of the vital neurovascular structures. The midline infratentorial-supracerebellar approach (ITSCA) is usually preferred for tumors located below the deep venous complex in the pineal region (1,15). The placement of the initial burr hole is often the most crucial part of the approach phase of the procedure in standard midline ITSCA for pineal lesions (2). Injury to the underlying transverse sinus leads to intraoperative complications as well as significant postoperative neurological morbidity or mortality (2). Our study investigates the relationship of the transverse sinus to various occipital bone surface landmarks. The utility of these surface landmarks for surgical planning is discussed.

MATERIALS and METHODS

Fifty-two dried skulls were studied. The key bone surface structures identified in each specimen were the superior nuchal line (SNL), the inferior nuchal line (INL), the inion, the foramen magnum, the internal occipital protuberance (IOP), and the transverse sulcus (TS). After identification of the key structures, the following distances were measured utilizing the Marathon 8 inch/200 mm Electronic Digital Caliper for all measurements (Table I).

Table I: Morphometric measurements of the occipital bone.

Distance (mm)	Minimum	Maximum	Mean
INL to midline foramen magnum	19	34.75	24.18
INL to inion	12.7	37.7	21.30
Vertical diameter of right proximal TS	2.6	10.16	6.43
Vertical diameter of left proximal TS	3.4	10.6	6.15
The center of the torcular herophili	10.2	21.3	13.2

Following these measurements, the inion, INL, and SNL were drilled perpendicular to the skull surface using a 1-mm drill, and the position of the hole was noted on the inner surface. We studied the relationship of the lower margin of the INL to the upper margin of the TS. We also analyzed the distance to the superior and inferior margins of the proximal TS (the segment of TS just after the torcular herophili).

RESULTS

All landmarks were always clearly seen in the skull preparations (Figure 1A,B,C). The morphometric relationships between surface structures are summarized in (Table I).

The distance from the inion to the INL in the specimens ranged from 12.7 mm to 37.7 mm with an average of 21.3 mm. The distance from the INL to the midline foramen magnum in the specimens ranged from 19 mm to 34.75 mm with an average of 24.18 mm. The width of the proximal TS ranged from 2.6 mm to 10.16 mm with an average of 6.43 mm on the right side and 3.4 mm to 10.6 mm with an average of 6.15 mm on the left side. The TS was symmetrical on the left and right side in 4% of the specimens. We found no specimen with a TS that could be described as S shaped (13). The center of the torcular herophili ranged from 10.2 mm to 21.3 mm with an average of 13.2 mm. There was an occipital sinus in one skull. Inion was inferior to the IOP in 98% of specimens. The inion and the IOP were on the same horizontal level in one specimen. The external landmark of the upper part of TS was the lower margin of the INL in all specimens in our study.

DISCUSSION

Krause was the first to operate on patients with lesions in the area of the pineal gland (4). After a

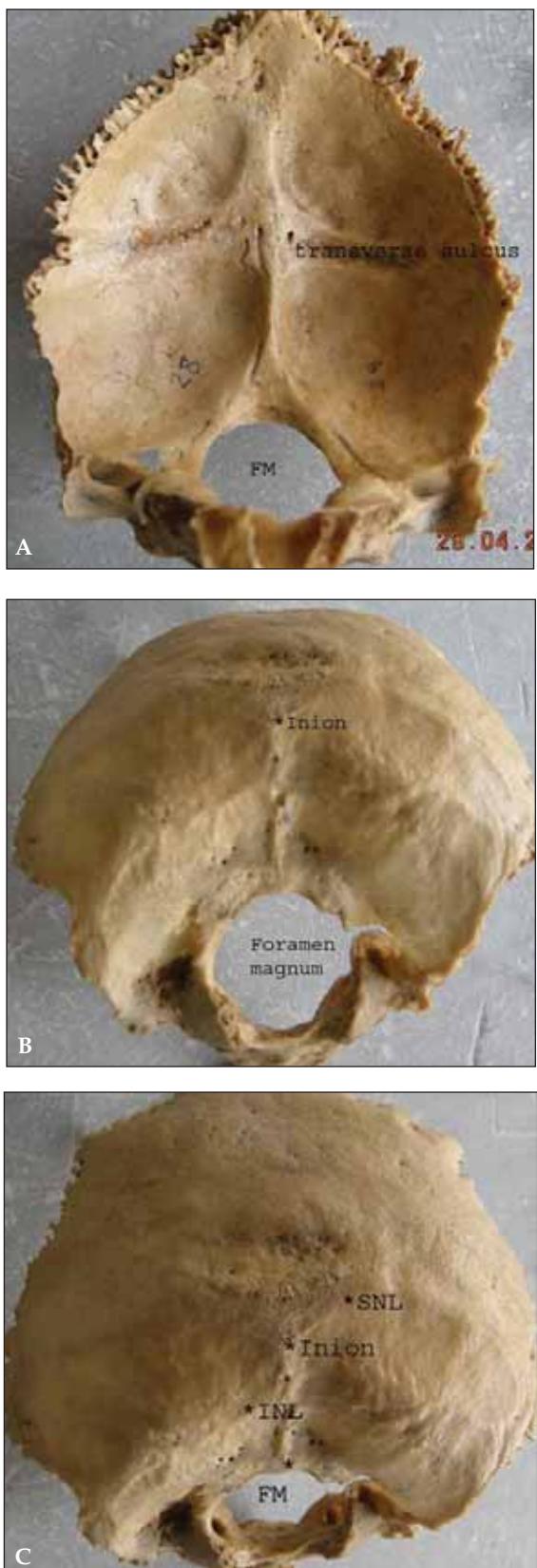


Figure 1A,B,C: Photographs shows external and internal surface of occipital bone (INL: inferior nuchal line, SNL: superior nuchal line, FM: foramen magnum).

while different approaches around the lateral ventricle and occipital lobe were defined (6,12). The increasing use of the operating microscope rekindled interest in direct surgical approaches to the pineal region (5,7,10) and most importantly, the anatomic relationships of the tumor and the surrounding structures of the pineal tumor. The best approach to use depends on the anatomic location or spread of the tumor, along with a degree of familiarity and confidence that the surgeon has with a given approach.

The main surgical approaches to pineal region tumors are the occipital transtentorial approach (OTA) and the ITSCA. The ITSCA approach was first reported by Krause (4) and was later refined by Stein (10). It was advocated by Yasargil in 1984 and, subsequently, by others as a useful approach to the dorsal portion of the midbrain and pons (16). ITSCA is to the center of the tumor, which begins at the midline and grows eccentrically, ventral to the velum interpositum and the deep venous system, to which the tumor is often adherent. No normal tissue is violated on route to the tumor. This approach with 2 cm of cerebellar retraction allows 76% exposure of the pineal region mass (14). The main advantage of this approach is essentially extra-axial route to the IIIrd ventricle and the pineal region (15). The disadvantage of this approach is that it has a narrow operative field because of the presence of the tentorium, which produces restricted visualization at both lateral and superior corners and poor visualization of supratentorial structures. This approach should therefore not be used when the tumor is large and extends dorsally above the tentorium and/or extends laterally into the trigone of the lateral ventricle (14,15). With this approach, craniectomy should extend just over the transverse sinus and include the torcular region so that the view is not obscured by overhanging bone (1). A standard suboccipital craniectomy measuring 8x5 cm is performed by drilling the bone and skeletonizing the transverse sinus (1,8). This craniectomy region is enough to reach the pineal gland (1).

Surface anatomic structures would be helpful in accurately placing the cranial opening and minimizing complications secondary to injuring the transverse sinus during bone removal at ITSCA (2). Ziyal et al (13) reported the external landmark of the upper part of TS was the INL. Tubbs et al. (11)

remarked that *musculus semispinalis capitus* (MSC) was a safer landmark for intraoperative identification of the lower border of the medial segment of the TS. Tubbs et al. (11) have reported that staying at least 5 mm below the insertion of the MSC during surgery will prevent transverse sinus injury. The other external landmarks in occipital bone are inion and SNL. The inion is not a reliable external landmark to use when determining the internal location of the proximal TS (3,7). The SNL does not reflect the location of the TS accurately (9).

We have found that INL is reliable in specifically determining the internal location of the proximal TS for ITSCA to the pineal region. The INL was the external landmark of the superior margins of the proximal TS. While the first and most superior burr hole for midline ITSCA can be safely placed, the width of TS should be considered. Tubbs et al (11) have found that the width of the TS tends to be greater on the right side. In our study there was no clear difference between the width of right and left TS. The width of proximal TS is 6.3 mm on average. Considering these results, the first and most superior burr hole for midline ITSCA can be safely placed approximately 1 cm below the INL.

In conclusion, our results show that the INL are always visible or palpable within surgical field in midline ITSCA to the pineal region. Localization of the burr-hole for ITSCA is important both for avoiding inadvertent entry into the transverse sinus and limiting the size of the craniotomy.

REFERENCES

- Cardia A, Caroli M, Pluderi M, Arienta C, Gaini S, Lanzino G, Tschabitscher M: Endoscope-assisted infratentorial-supracerebellar approach to the third ventricle: An anatomical study. *J Neurosurg (6 Suppl Pediatrics)* 104: 409-414, 2006
- 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* 38: 1079-1084, 1996
- Fukui M, Natori Y, Matsushima T, Nishio S, Ikezaki K: Operative approaches to the pineal region tumors. *Child's Nerv Syst* 14: 49-52, 1998
- Krause F: Operative Freilegung der Vierhugel Nebst Beobachtungen über Hirndruck und Dekompression. *Zentbl Chir* 53:2812-2819, 1926
- Page LK: The infratentorial-supracerebellar exposure of tumors in the pineal region. *Neurosurgery* 1:36-40, 1977
- Poppen JL: The right occipital approach to a pineoloma. *J Neurosurg* 25:706-710, 1966
- Reid WS, Clark WK: Comparison of the infratentorial and transtentorial approaches to the pineal region. *Neurosurg* 3:1-8, 1978
- Ribas GC, Rhoton AL, Cruz OR, Peace D: Suboccipital burr holes and craniectomies. *Neurosurg Focus* 19(2):E1, 2005
- Roberts DA, Doherty BJ, Heggeness MH: Quantitative anatomy of the occiput and the biomechanics of occipital screw fixation. *Spine* 23:1100-1108, 1998
- Stein BM, Bruce JN: Surgical management of pineal region tumors. *Clin Neurosurg* 39:509-532, 1992
- Tubbs RS, Salter G, Oakes J: Superficial surgical landmarks for the transverse sinus and torcular herophili. *J Neurosurg* 93:279-281, 2000
- Von Wagenen WP: A surgical approach for the removal of certain pineal tumors: Report of a case. *Surg Gynecol Obstet* 53:216-220, 1931
- Ziyal IM, Ozgen T: Landmarks for the transverse sinus and torcular herophili. *J Neurosurg* 94:686-687, 2001
- Ziyal IM, Sekhar LN, Salas E, Olan WJ: Combined supra/infratentorial-transsinus approach to large pineal region tumors. *J Neurosurg* 88:1050-1057, 1998
- Yamamoto I: Pineal region tumor: surgical anatomy and approach. *Journal of Neuro Oncology* 54:263-275, 2001
- Yasargil MG: Microsurgery I: Microsurgical Anatomy of the Basal Cisterns and Vessels of the Brain, Diagnostic Studies, General Operative Techniques and Pathological Considerations for Intracranial Aneurysms. Stuttgart: George Thieme Verlag, 1984, 128-132