

# The Relationships between Asterion, the Transverse-Sigmoid Junction, the Superior Nuchal Line and the Transverse Sinus in Thai Cadavers: Surgical Relevance

Pichayen Duangthongpon MD\*,  
Chaiwit Thanapaisai MD\*, Amnat Kitkhuandee MD\*,  
Kowit Chaiciwamongkol MD\*\*, Vilaiwan Morthong MD\*\*

\* Division of Neurosurgery, Department of Surgery, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand

\*\* Department of Anatomy, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand

---

**Background:** Anatomical localization of the venous sinuses in the posterior cranial fossa is important to preventing inadvertent venous sinus injury during surgical approaches to the area. Identification of surface landmarks related to these structures is useful in planning such approaches.

**Objective:** To identify the positions of the asterion and the superior nuchal line for localization of the venous sinus in the posterior fossa.

**Material and Method:** Twenty fresh cadaveric heads, yielding 40 sides, were used. The vessels were injected with colored silicone. The soft tissues were removed to expose the posterior cranium, frominion to the foramen magnum and laterally to the mastoid process. Using digital calipers, the relationship of asterion to the transverse-sigmoid sinus junction was determined and the distance from the highest superior nuchal line to the nearest transverse sinus was measured.

**Results:** Asterion was located in 82.5% of the cadavers on the right side and 85.0% on the left side. The most common asterion position was at the junction of the transverse and sigmoid sinuses (67.5%), of which 5.0% were superior to the transverse-sigmoid junction, 2.5% inferior to the transverse-sigmoid junction and 7.5% medial to the transverse-sigmoid junction, at the transverse sinus. The superior nuchal line was identified in all cadavers. The most common position was inferior to the transverse sinus (60.0%) at an average distance of 8.55 mm 35.0% were at the same level as the transverse sinus and 5.0% were superior to the transverse sinus at an average distance of 2.14 mm.

**Conclusion:** A burr hole inferior-medial to asterion can expose the posterior fossa dura with the least risk. The superior nuchal line is always identifiable and relatively close to the transverse sinus. A burr hole more than 3 mm inferior to the superior nuchal line can expose the posterior fossa dura with the least risk.

**Keywords:** Posterior cranial fossa, Retrosigmoid approach, Venous injury, Surgical safety

**J Med Assoc Thai 2016; 99 (Suppl. 5): S127-S131**

**Full text. e-Journal:** <http://www.jmatonline.com>

---

Localization of internal cranial anatomy based on external landmarks is paramount in identifying and avoiding important structures during retrosigmoid surgery of the posterior cranial fossa in order to reduce surgical morbidities. External landmarks indicative of the location of intracranial venous sinuses is important to neurosurgeons in avoiding venous sinus injury and resultant blood loss, or sinus occlusions with a consequent risk of venous infarction. In posterior fossa

surgery, it needs to expose the venous sinus to improve visibility and to reduce brain retraction. Asterion has previously been cited and used as a superficial landmark in locating the transverse-sigmoid junction<sup>(1,2)</sup>. However, the landmark for this venous junction site is easily seen in only dry cadavers because fibrous tissues have been removed during preparation of the specimens and not easily locatable intra-operatively.

The superior nuchal line is the highest attachment of the occipitalis muscle, the splenius capitis muscle, the trapezius muscle and the sternocleidomastoid muscle. It is a visible intra-operative landmark when the posterior fossa is exposed. The superior nuchal line has been reported

---

**Correspondence to:**

Thanapaisai C, Department of Surgery, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand.

Phone & Fax: +66-43-363123

E-mail: [Chaiwit@kku.ac.th](mailto:Chaiwit@kku.ac.th)

as being in a variable position in relation to the transverse sinus<sup>(4-8)</sup>. Both asterion and the superior nuchal line have never been studied in Thai cadavers.

### Material and Method

Twenty fresh cadaveric heads, with the vessels injected with colored silicone, were studied on both sides, yielding 40 sides. The soft tissues were removed in order to expose the posterior cranium, frominion to the foramen magnum and laterally to the mastoid process on both sides. The following sutures were identified in each specimen: lambdoid, occipitomastoid, parietomastoid and squamosal sutures. Asterion, which is located at the junction of the lambdoid, occipitomastoid, and parietomastoid sutures, was marked. Asterion and the superior nuchal line are shown in Fig. 1-3. Asterion was drilled with a small drill (1.5 mm diameter) and the dura was painted with methylene blue. The superior nuchal line was cut with a high-speed craniotome and the dural surface was painted with methylene blue. The posterior cranial bone was then cut to expose the dural sinus.

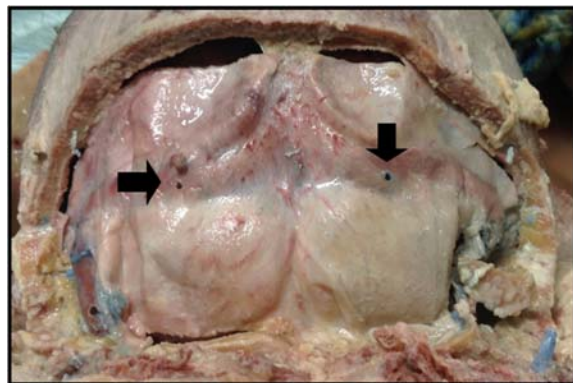
Measurements were taken between bony surface landmarks using digital calipers. The distance from asterion to the nearest margin of the transverse-sigmoid sinus was measured. The relationship of the asterion to the transverse-sigmoid sinus junction was also determined. The distance was measured from the highest margin of the superior nuchal line to the lower border of the nearest transverse sinus.

This research was approved by the Khon

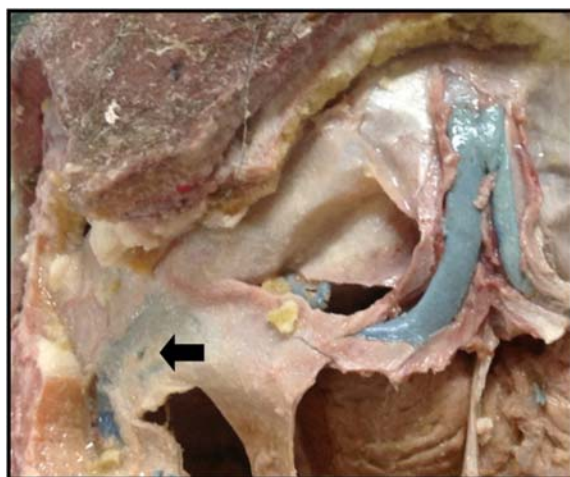
Kaen University Ethics Committee in Human Research.

### Results

The 20 cadavers in our samples consisted of nine females and 11 males. Asterion was found on 33 of 40 sides. The main reason of unsuccessful locating the asterion was having adhesive fibrous tissue in the fresh cadavers. The most common location of asterion was at the transverse-sigmoid junction (27/40, 67.5%). Two (5.0%) were located superiorly to the transverse-sigmoid junction, one (2.5%) was inferior to the transverse-sigmoid junction and three (7.5%) were medial to the transverse-sigmoid junction, at the transverse sinus. In the two cases that the asterion located superiorly to the transverse-sigmoid junction, the distances above the junction were 17.36 mm and 7.88 mm (Mean = 12.62 mm). In one case with asterion located inferiorly to the transverse-sigmoid junction, the distance between



**Fig. 2** The highest point of superior nuchal line (arrows) with burr holes.



**Fig. 1** The burr hole at asterion (arrow) and the opened skull with exposed transverse-sigmoid junction (veins injected with colored silicone).



**Fig. 3** The opened durawhich allows measurements of the distance from the superior nuchal line to the lower border of the transverse sinus.

the landmark and the venous junction was 2.9 mm (Table 1).

The superior nuchal line was identified in all fresh skull cadavers. The most common position was below the transverse sinus (60%) with a wide range of distance between the line and the sinus from 1.68 to 19.00 mm. For the most remaining cases (35.0%), the superior nuchal line was the same level with the transverse sinus. In remaining two cases, the superior nuchal line was found on the left side and superior to the transverse sinus and the distance of the line above the transverse sinus was 1.79 and 2.50 mm (Table 2).

## Discussion

During posterior cranial fossa surgery, it is always necessary to identify the position of the venous sinus in order to avoid injury and exposure of the vessels, especially in the retrosigmoid approach to craniotomy. Injury of the venous sinus can lead to intra-operative complications as well as significant neurological morbidity or mortality. Previously, the axis of the line connecting the root of sigma and inions was used as an external landmark to identify the position of the transverse sinus.

In a dry skull study, a study of Day et al<sup>(3)</sup> reported that the transverse sinus was found lying along the axis of a line connecting the root of the sigma with the external occipital protuberance in all specimens, and that this line corresponds to the superior nuchal line. In dry skulls, this line can be identified easily, but

in fresh cadavers or in operative surgical practice it is not always palpable because of overlying soft tissue and the patient's position.

In performing surgical approaches to the lateral posterior cranial fossa (the retrosigmoid approach), the zygoma root and inion are not always visible within the surgical field. An external landmark can help with optimizing location of the incision and internal landmark is helpful with identifying the position of the venous sinus. The superior nuchal line and asterion are internal landmarks allowing identification of the position of the transverse sinus and the transverse-sigmoid junction.

In the present study, the superior nuchal line was identified in all fresh cadaveric skulls, with the most common positions of the transverse sinus being above or level with the line. In only two cases, both on the left side, the transverse sinus was inferior to the line, and the distance between the line and the sinus was 1.8-2.5 mm. This finding suggests that a burr hole more than 3 mm below the superior nuchal line can safely expose the posterior fossa dura.

Asterion may be identified in all dry skulls<sup>(6)</sup> but Avci et al<sup>(8)</sup> reported that this osteological landmark could not be clearly identified in 60% of the cadaver specimens. Lang et al<sup>(5)</sup> reported that asterion is often difficult to palpate through the skin and can be difficult to see, especially in older adults. In our study, asterion was identified in only 80% of the samples. Meticulous dissection and curettage can remove fibrous tissue and

**Table 1.** Position and distance between asterion and the transverse-sigmoid junction

| Asterion position   | Number<br>(total = 33) | Mean distance from transverse-sigmoid junction (mm) |
|---|------------------------|---|
| Superior to transverse-sigmoid junction                     | 2 (5.0%)               | 12.62   |
| At transverse-sigmoid junction                              | 27 (67.5%)             | 0.00  |
| Inferior to transverse-sigmoid junction                     | 1 (2.5%)               | 2.90  |
| Medial to transverse-sigmoid junction (at transverse sinus) | 3 (7.5%)               | 12.06   |

**Table 2.** Position and distance between superior nuchal line and transverse sinus

| Superior nuchal line position         | Number<br>(total = 40) | Mean distance from<br>superior nuchal line to<br>transverse sinus (mm) | Right side | Left side |
|---------------------------------------|------------------------|--|------------|-----------|
| Superior to transverse sinus          | 2 (5.0%)               | 2.14 (range 2.50-1.79)   | 0          | 2         |
| At the same level as transverse sinus | 14 (35.0%)             | 0  | 9          | 5         |
| Inferior to transverse sinus          | 24 (60.0%)             | 8.55 (range 1.68-19.00)  | 10         | 14        |

better identify this bony landmark. Avci et al also reported that asterion was likely to overlie a portion of the lateral transverse sinus and was found to lie at least 1.0 cm medially to the transverse-sigmoid junction. Thus, it is not a useful landmark to identify the transverse-sigmoid junction<sup>(8)</sup>.

Day et al<sup>(3)</sup> reported that asterion was located at the transverse-sigmoid junction complex in 61% on the right side and 66% on the left side, and above the transverse-sigmoid complex in 7% on the right side and 9% on the left side. The authors concluded that asterion was not a reliable landmark for locating the posterior fossa dura. Ucerler et al<sup>(6)</sup> reported the position of asterion was found to be superficial to the transverse-sigmoid sinus junction in 87% of the samples, below the transverse-sigmoid sinus junction in 11%, and above the transverse-sigmoid sinus junction in 2%<sup>(6)</sup> Martinez et al<sup>(7)</sup> found that in 87.8% of their cases, asterion was located over the transverse sinus, in which 72.2% over the sinus proper, and 27.8% over the transverse-sigmoid junction. They concluded that burr holes for post erolateral approaches to the posterior fossa must be located inferoposterior to the asterion<sup>(7)</sup>.

In our study, we used colored silicone to label the vessels on fresh cadavers and performed the surgery as if it was a real surgical operation. We were able to identify asterion in only 85% of our samples. Even though, the most common position was superficial to the transverse-sigmoid junction, it was also found, in a small number of cases, that the position was superior, inferior or medial to the junction. In our samples, a burr hole at the asterion would have had a 75% chance of exposing the transverse sinus or transverse-sigmoid junction and risking injury to the sinus. In cases where asterion can be identified, the initial burr hole for posterior fossa dura can be located most safely inferior and medial to the asterion.

## Conclusion

Asterion is a bony landmark that can assist neurosurgeons to recognize the location of the transverse-sigmoid junction but is not always seen intra-operatively. Identifying the asterion depends on the patient's age and surgical techniques. Based on our study's results of fresh cadavers, we suggest a burr hole inferior-medial to the asterion can expose the posterior fossa dura with the least risk. The superior nuchal line is always visible in the fresh cadavers and found relatively close to the transverse sinus. We suggest that a burr hole more than 3 mm inferior to the

superior nuchal line would again expose the posterior fossa dura with the least risk.

## What is already known on this topic?

The superior nuchal line and asterion are bony landmarks that are easy to be located in dry skulls but cannot always be identified intra-operatively or in fresh cadavers. The relationship between the superior nuchal line and the transverse sinus, and asterion and the transverse-sigmoid junction have previously been studied but with variable results.

## What this study adds?

This study identifies landmarks that are visible intra-operatively to indicate the safest locations to drill burr holes when locating the posterior fossa dura during the retrosigmoid approach to posterior cranial surgery.

## Acknowledgements

We would like to acknowledge Prof. Nancy Tayles for her assistance with the English language presentation of the manuscript and The Center of Cleft Lip and Palate and Craniofacial Deformities, Khon Kaen University in association with the Tawanchai Project for publication support.

## Potential conflicts of interest

None.

## References

1. Rhoton AL Jr. The cerebellopontine angle and posterior fossa cranial nerves by the retrosigmoid approach. In: Rhoton AL Jr, editor. Cranial anatomy and surgical approaches. Baltimore: Lippincott Williams & Wilkins; 2003: 525-61.
2. Yamashita T, Lee JH, Tobias S, Kim CH, Chang JH, Kwon JT. Surgical procedure "simplified retrosigmoid approach" for C-P angle lesions. J Clin Neurosci 2004; 11: 168-71.
3. 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; 38:1079-84.
4. Tubbs RS, Salter G, Oakes WJ. Superficial surgical landmarks for the transverse sinus and torcular herophili. J Neurosurg 2000; 93: 279-81.
5. Lang J Jr, Samii A. Retrosigmoidal approach to the posterior cranial fossa. An anatomical study. Acta Neurochir (Wien) 1991; 111: 147-53.
6. Ucerler H, Govsa F. Asterion as a surgical landmark



- for lateral cranial base approaches. J Cranio-maxillofac Surg 2006; 34: 415-20.
7. Martinez F, Laxague A, Vida L, Prinzo H, Sgarbi N, Soria VR, et al. Topographic anatomy of the asterion. Neurocirugia (Astur) 2005; 16: 441-6.
8. Avci E, Kocaogullar Y, Fossett D, Caputy A. Lateral posterior fossa venous sinus relationships to surface landmarks. Surg Neurol 2003; 59: 392-7.

---

## การศึกษาความสัมพันธ์ของปุ่มกระดูก Asterion รอยนูนกะโหลกศีรษะ Superior nuchal line และตำแหน่งของโพรงหลอดเลือดดำบริเวณ posterior cranial fossa in Thai

พิษเชณทร์ ดวงทองพล, ไชยวิทย์ ธนไพศาล, อำนาจ กิจควรรดี, โกวิท ไชยสีวามงคล, วิไลวรรณ หมอทอง

**ภูมิหลัง:** เนื่องจากการผ่าตัดบริเวณ posterior fossa เป็นหัตถการทำบ่อยในทางประสาทศัลยศาสตร์ความผันผวนเส้นโพรงเส้นเลือดดำบริเวณ posterior fossa เช่น transverse sinus, occipital sinus, sigmoid sinus มีมากและแม้จะมีการศึกษาความสัมพันธ์โพรงเส้นเลือดดำและจุดอ้างอิงที่กะโหลกศีรษะในต่างประเทศแต่พบว่ามีความผันผวนในแต่ละงานวิจัยและจุดอ้างอิงที่สังเกตได้ง่ายกะโหลกศีรษะในอาจารย์ใหญ่ (dry skull) ไม่สามารถสังเกตได้จริงในการผ่าตัดประกอบกับยังไม่มีการศึกษาในคนไทย

**วัตถุประสงค์:** เพื่อการศึกษาประโยชน์ของจุดอ้างอิงบนกะโหลกศีรษะ asterion และ superior nuchal line ว่าสามารถสังเกตได้ง่ายจริงและมีความสัมพันธ์กับโพรงเส้นเลือดดำบริเวณ posterior fossa อย่างไร

**วัสดุและวิธีการ:** การศึกษาพรรณนา (descriptive study) โดยนำศพอาจารย์ใหญ่ที่เสียชีวิตเมื่ออายุมากกว่า 18 ปี จำนวน 20 ศพ (40 ข้าง) ซึ่งได้จากการบริจาคร่างกายให้แก่ภาควิชากายวิภาคศาสตร์ จากนั้นทำการฉีดสีน้ำเงินผสมซิลิโคนเพื่อให้เห็นโพรงเส้นเลือดดำชัดเจน และลงมือผ่าตัดเปิดกะโหลกถ่ายภาพ พร้อมสังเกตจุดอ้างอิงที่กะโหลกศีรษะและวัดระยะกับโพรงเส้นเลือดดำที่ศึกษาทางดังกล่าวด้วยเครื่องมือวัด digital caliper ใช้นหน่วยเป็นมิลลิเมตรทศนิยมสองตำแหน่งและรายงานเป็นค่าเฉลี่ย

**ผลการศึกษา:** พบว่า asterion สามารถพบได้ 82.5% และพบ 67.5% ตำแหน่งอยู่ตรงกับ transverse-sigmoid junction 2.5% ต่ำกว่า 5% สูงกว่า transverse-sigmoid junction และ 7.5% อยู่บน transverse sinus ส่วน superior nuchal line พบว่าสามารถพบได้ในทั้งหมด (100%) และพบ 60% ของ superior nuchal line อยู่ต่ำกว่า transverse sinus โดยมีระยะเฉลี่ย 8.55 มิลลิเมตร และ 35% of superior nuchal line อยู่ในระดับเดียวกับ transverse sinus มีเพียง 5% ที่ superior nuchal line อยู่สูงกว่า transverse sinus โดยมีระยะเฉลี่ย 2.14 มิลลิเมตร transverse sinus

**สรุป:** asterion ไม่สามารถสังเกตเห็นในผู้ป่วยทุกรายและการเจาะเปิดกะโหลกศีรษะในตำแหน่งที่ต่ำและด้านในกว่า asterion เป็นตำแหน่งที่ปลอดภัยต่อโพรงหลอดเลือดดำ superior nuchal line สามารถสังเกตได้เสมอและมีความสัมพันธ์กับ transverse sinus โดยการเจาะเปิดกะโหลกต่ำกว่า superior nuchal line มากกว่า 3 มิลลิเมตรจะปลอดภัยต่อโพรงหลอดเลือดดำ transverse sinus เสมอ

---