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

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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, from inion 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

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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 morbidity. 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 sinuses 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\(^1\)(2). 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
as being in a variable position in relation to the transverse sinus\(^{4-8}\). 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, from inion 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

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

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

**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(3) 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(6) but Avcı et al(7) reported that this osteological landmark could not be clearly identified in 60% of the cadaver specimens. Lang et al(5) 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

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

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

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

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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(8).

Day et al(3) 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(6) 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%(6) Martinez et al(7) 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(7).

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 a75% 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.

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.

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Potential conflicts of interest

None.

References

6. Ucerler H, Govsa F. Asterion as a surgical landmark...
การศึกษาความสัมพันธ์ของปุ่มกระดูก Asterion รองฐานโรคศีรษะ Superior nuchal line และตำแหน่งของโพรงหลอดน้ำดีบริเวณ posterior cranial fossa in Thais

พิษณุนาท ดวงทอง, ไชยวัฒน์ อนันตพล, อานนท์ กิจวงศ์, โอวิท โอศิริมณกุล, วิไลวรรณ หนุนทอง

วัตถุประสงค์: เพื่อทำการศึกษาประโยชน์ของจุดกล้ามเนื้อโรคศีรษะ asterion และ superior nuchal line ว่าสามารถสังเกตได้ง่ายและมี ความสำคัญในการเตรียมตั้งค่าบริเวณ posterior fossa อย่างไร

วัตถุประสงค์: การศึกษาเป็นแบบ descript study โดยเก็บข้อมูลอยู่ที่ศรีนครินทร์มหาวิทยาลัย 18 ปี จำนวน 20 คน (40 ขวบ) ซึ่งได้จากการรักษาผู้ป่วยทางศัลยศาสตร์นอกระบบ ผ่านการทดสอบและคอนเฟิร์มเรื่องโปรดที่ศีรษะและวัดระยะทาง posterior cranial fossa.

ผลการศึกษา: พบว่า asterion สามารถพบได้ 82.5% และพบว่า 67.5% ตั้งนกอุ้มตรงกับ transverse-sigmoid junction 2.5% ตั้งใจ 5% สุทธิกับ transverse-sigmoid junction และ 7.5% อยู่บน transverse sinus บน superior nuchal line พบว่ามีการพบมากที่สุด (100%) และพบว่า 60% ของ superior nuchal line อยู่ด้านกว้าง transverse sinus โดยมีระยะเฉลี่ย 8.55 มิลลิเมตร และ 35% of superior nuchal line อยู่ในระดับเดียวกับ transverse sinus มีเพียง 5% ที่ superior nuchal line อยู่ด้านกว้าง transverse sinus โดยมีระยะเฉลี่ย 2.14 มิลลิเมตร transverse sinus

สรุป: asterion นั้นสามารถสังเกตเห็นได้ชัดเจนทั้งในผู้ป่วยและสามารถจะเป็นประโยชน์ในการตั้งค่าใน case superior nuchal line ซึ่งสามารถสังเกตและจะได้ความสัมพันธ์กับ transverse sinus โดยการจะเป็นประโยชน์ต่อ superior nuchal line นอกจากนี้ 3 มิลลิเมตรจะเป็นเกณฑ์ของโพรงหลอดน้ำดี transverse sinus เสมอ

8. Avci E, Kocagullar Y, Fossett D, Caputy A. Lateral posterior fossa venous sinus relationships to