Anatomical Study of Relationship between Zygoma-inion Line and Transverse Sinus in Dried Thai Human Skulls

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Background: *The zygoma-inion line (ZI line) is an important surface landmark of transverse sinus in suboccipital craniotomy; however, previous anatomical studies showed variation in relationship between the ZI line and transverse sinus.*
Objective: *To study anatomical relationship between the ZI line and transverse sinus.*
Material and Method: *The ZI line was projected to the inner surface of the skull by using transillumination technique. Anatomical relationship between the projected ZI line and groove of the transverse sinus was investigated in 60 dried Thai human skulls (120 sides).*
Results: *The projected ZI line was located exactly on the transverse sinus in 6 of 120 sides (5 %). In 114 of 120 sides (95%), the projected ZI line was positioned below the inferior margin of the transverse sinus. The distance between the projected ZI line and inferior margin of the transverse sinus gradually increased as it moved outward from the midline.*
Conclusion: *The ZI line is a reliable external landmark for localization of the transverse sinus. Most of the ZI line was located inferior to the transverse sinus about 4 mm with trend to be lower as transverse sinus moved away from the midline.*

Keywords: *Relationship, Zygoma-inion line, Transverse sinus, Suboccipital craniotomy, Posterior cranial fossa*

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In the management of posterior cranial fossa lesions, suboccipital craniotomy is one of the most common neurosurgical approaches. The boundaries of this approach are defined by the transverse and sigmoid sinuses. Knowing the exact location of the venous sinus is essential to avoiding inadvertent entry into the venous sinus or determining the size of craniotomy[1-8]. Surface landmarks are important when mapping for skin incision. The zygoma-inion line (ZI line) is commonly used as a surface landmark of the transverse sinus[2-4,8,9]. However, previous anatomical studies have described significant variation in the relationship between the ZI line and transverse sinus[2,4,8]. Race-based genetic differences in size, shape, and structures of the cranium are known to exist[10]. Race is a factor influencing size of craniotomy and length of surgical approach; optimal parameters in one race cannot be applied for the others[11]. Therefore, the objective of this study was to demonstrate the relationship between the ZI line and groove of the transverse sinus in Thai using dried human skull.

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Material and Method

Sixty dried Thai adult human skulls were evaluated in this study. Study of both sides of the skull yielded 120 sides. At the outer surface of the skull, both zygomatic roots and inion were identified. At the inner surface of the skull, the grooves for both the transverse sinuses and sigmoid sinuses, and the depression for confluence of sinuses were identified. After identification of these key structures, the ZI line was drawn at on the outer surface of the skull (Fig. 1). The ZI line was then projected to the inner surface of the skull and traced via transillumination of the skull using a laser pointer (Fig. 2) positioned perpendicular to the skull surface. The transverse sinus was marked at 25%, 50%, and 75% along its length, from the midline. The projected ZI line was evaluated according to whether it was positioned exactly on the transverse sinus or not (Fig. 3). If not, the distance from sinus margin to the projected ZI line was measured at each of the 3 points.

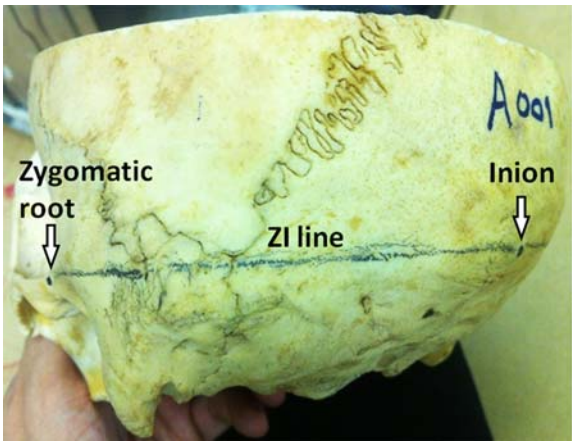

Fig. 1 ZI line on the external surface of the skull.

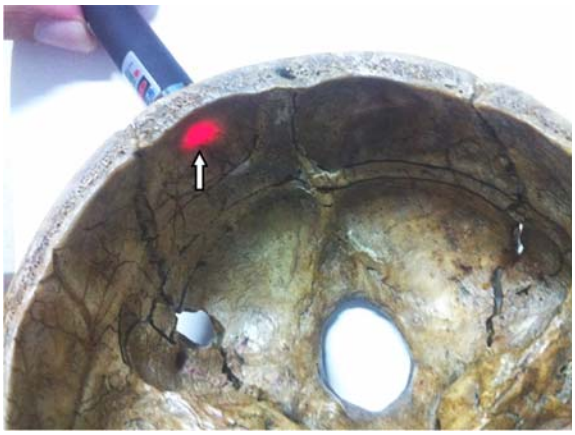

Fig. 2 Transillumination technique for delineating projected ZI line.

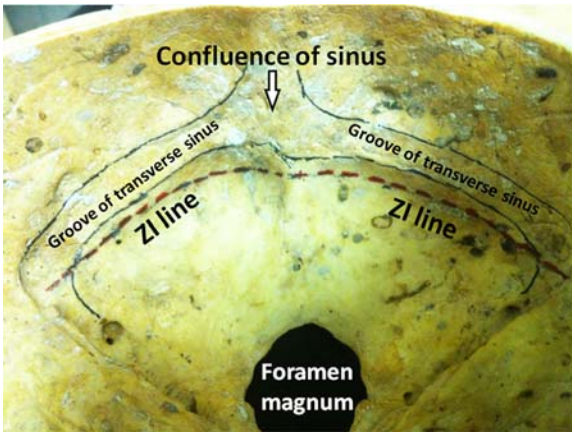

Fig. 3 Relationship between ZI line (dotted line) and transverse sinus.

Descriptive statistics included mean and standard deviation. Difference between mean value of the distance from the sinus margin to the projected ZI line between the right and left side was analyzed by paired-samples t-test using SPSS v. 11.5. A *p*-value of less than 0.05 was considered statistically significant. This study was approved by the Siriraj Institutional Review Board (SIRB).

Results

The projected ZI line was located exactly on the transverse sinus in 6 of 120 sides (5%), with 2 presenting on the right side and 4 presenting on the left.

In the remaining 114 sides (95%), the projected ZI line was positioned below the inferior margin of the transverse sinus. The distance between the projected ZI line and inferior margin of the transverse sinus gradually increased as it moved outward from the midline. The distance between the projected ZI line and lower margin of the transverse sinus is described in Table 1.

Discussion

Suboccipital craniotomy is one of the most common craniotomies for the management of posterior fossa lesions. Two factors must be considered regarding bony exposure in this area, to include avoidance of inadvertent entry into the regional venous sinus and limitation of bony opening. Given that the boundaries of this approach are defined by the transverse and sigmoid sinuses, knowing the precise location of the venous sinus is essential[1-8].

There are several landmarks on the skin or skull that can be used for locating the venous sinus. Surface landmarks are preferable for skin incision, given that bony landmarks are non-visible. As compared to accurate and reliable advanced technological navigation systems, these surgical landmarks are crude and variable[6,7]. However, this novel navigation alternative is often not suitable for emergency situations and may not be available. As such, this specialized anatomical knowledge is essential for neurosurgeons.

The ZI line is commonly used as a surface landmark for locating the course of transverse sinus[2-4,8,9]. Previous anatomical studies reported varying results. Day et al reported that the superior nuchal line (SNL), a line starting from the zygomatic root and ending at the inion (same as the ZI line), was reliable for locating the transverse sinus[2]. According to their findings, the transverse sinus was found to lay

Table 1. Distance from lower margin of transverse sinus to projected ZI line

Distance (mm)	Right Mean ± SD	Left Mean ± SD	*p*-value	Average of both sides Mean ± SD
At 25% from midline	4.25±2.47	3.89±2.09	0.23	4.08±2.20
At 50% from midline	4.37±2.26	4.51±1.89	0.82	4.45±2.07
At 75% from midline	4.53±2.06	4.57±2.02	0.91	4.55±2.02

along the axis of the SNL in all cases. Bozbuga et al studied dried human skulls[4]. They found the SNL roughly parallel and below the lower margin of the transverse sinus in all specimens. From their study, the mean distance between the SNL and lower margin of the transverse sinus was 7.9 mm on the right and 8.1 mm on the left. Ugur et al, using dried human skulls and transillumination method, also found the midpoint of the ZI line inferior to the groove of the transverse sinus in all specimens. The mean distance in their study was 12.6 mm on the right side and 13.1 mm on the left[8].

A radiological study of cranial surface landmarks and the venous sinus was conducted by Sheng et al[9]. They used CT angiography and found that 70% of the ZI lines projected onto the transverse sinus at the proximal end, but gradually moved below the transverse sinus at the distal end. They concluded that the ZI line was not an accurate landmark for locating the transverse sinus. In our opinion, the use of 2-dimensional radiological images of the ZI line for purposes of locating the transverse sinus is less accurate than 3-dimensional anatomical study.

Moreover, there are race-related differences in size, shape, and structure of the cranium[10]. Accordingly, external landmarks which may be suitable for use in one race may be unreliable for another. Low et al found that Europeans have a greater petrous angle than Chinese and recommended a larger-sized craniotomy in Europeans[11].

In this study, the ZI line was positioned mostly below the inferior margin of the transverse sinus. Only 5% of the ZI lines projected exactly on the transverse sinus and none were located above the transverse sinus. The ZI line had trend to be lower as the transverse sinus moved away from the midline. The mean distances from the lower margin of the transverse sinus were 4.08 mm, 4.45 mm, and 4.55 mm at 25%, 50%, and 75% distance from the midline, respectively. There was no statistical difference between right and left side. The results imply that performing suboccipital craniotomy using the ZI line as a surgical landmark is associated with low risk of exposure or injury to the transverse sinus.

Conclusion

The ZI line is a reliable external landmark for identifying the location of the transverse sinus. Most of the ZI lines were located approximately 4 mm inferior to the transverse sinus and it had trend to be lower as the transverse sinus moved away from the midline.

What is already known from this topic?

The ZI line is an imaginary line commonly used as a surgical landmark of the transverse sinus in surgery of the posterior cranial fossa. Varied anatomical relationships between a line connecting the zygomatic root with the inion, and the transverse sinus were found in previous studies.

What this study adds?

Almost all of the ZI lines located inferior to the transverse sinus indicates that the ZI line is a reliable surgical landmark of posterior cranial fossa surgery for avoiding accidental injury of the sinus. The distance between the ZI line and transverse sinus tends to increase when the transverse sinus moves laterally. These results can be applied for Thai people.

Potential conflicts of interest

None.

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การศึกษาทางกายวิภาคศาสตร์เพื่อหาความสัมพันธ์ระหว่างเส้นสมมติจากกระดูกโหนกแก้มไปยังปุ่มกระดูกกลางกะโหลกศีรษะด้านหลังกับโพรงหลอดเลือดดำแนวขวางในกะโหลกศีรษะแห้งของคนไทย

โชติวัฒน์ ตันศิริสิทธิกุล, บรรพต สิทธินามสุวรรณ, ประจักษ์ ศรีรพีพัฒน์, ปฤณัต อิทธิเมธินทร์, ธีรพล วิทธิเวช, เอกวุฒิ จันแก้ว

ภูมิหลัง: เส้นสมมติจากกระดูกโหนกแก้มไปยังปุ่มกระดูกกลางกะโหลกศีรษะด้านหลังเป็นจุดสังเกตภายนอกที่สำคัญสำหรับบ่งชี้ตำแหน่งของโพรงหลอดเลือดดำแนวขวางในการผ่าตัดเปิดกะโหลกศีรษะทางด้านหลัง อย่างไรก็ตามการศึกษาทางกายวิภาคศาสตร์ก่อนหน้านี้พบว่า มีความแตกต่างของความสัมพันธ์ระหว่างเส้นสมมติดังกล่าวกับโพรงหลอดเลือดดำแนวขวาง

วัตถุประสงค์: เพื่อศึกษาความสัมพันธ์ทางกายวิภาคศาสตร์ระหว่างเส้นสมมติจากกระดูกโหนกแก้มไปยังปุ่มกระดูกกลางกะโหลกศีรษะด้านหลังกับโพรงหลอดเลือดดำแนวขวาง

วัสดุและวิธีการ: คณะผู้นิพนธ์ทำแนวเส้นสมมติจากกระดูกโหนกแก้มไปยังปุ่มกระดูกกลางกะโหลกศีรษะด้านหลังโดยอาศัยปากกาเลเซอร์ส่องผ่านกะโหลกศีรษะ จากนั้นจึงศึกษาความสัมพันธ์ระหว่างเส้นสมมติดังกล่าวกับร่องของโพรงหลอดเลือดดำแนวขวางในกะโหลกศีรษะแห้งของคนไทย 60 กะโหลก (120 ข้าง)

ผลการศึกษา: พบว่าแนวเส้นสมมติจากกระดูกโหนกแก้มไปยังปุ่มกระดูกกลางกะโหลกศีรษะด้านหลังซ้อนทับกับโพรงหลอดเลือดดำแนวขวางเพียง 6 จาก 120 ข้าง (ร้อยละ 5) และใน 114 ข้างที่เหลือ (ร้อยละ 95) พบว่าแนวเส้นสมมติจากกระดูกโหนกแก้มไปยังปุ่มกระดูกกลางกะโหลกศีรษะด้านหลังอยู่ต่ำกว่าขอบล่างของโพรงหลอดเลือดดำแนวขวางระยะห่างระหว่างแนวของเส้นสมมติดังกล่าวกับโพรงหลอดเลือดดำแนวขวางค่อย ๆ เพิ่มขึ้นเมื่อเคลื่อนออกไปทางด้านข้างของกะโหลกศีรษะ

สรุป: เส้นสมมติจากกระดูกโหนกแก้มไปยังปุ่มกระดูกกลางกะโหลกศีรษะด้านหลังเป็นจุดสังเกตภายนอกที่เชื่อถือได้ในการระบุตำแหน่งโพรงหลอดเลือดดำแนวขวาง เส้นสมมติดังกล่าวส่วนใหญ่อยู่ต่ำกว่าโพรงหลอดเลือดดำแนวขวางประมาณ 4 มิลลิเมตร และมีแนวโน้มจะอยู่ต่ำลงเมื่อเคลื่อนออกไปทางด้านข้างของกะโหลกศีรษะ