Occipital bone thickness: Implications on screw placement. A study done in dry skulls

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ABSTRACT

AIM: The aim of this study is to evaluate the thickness of occipital bones in dry skulls.

INTRODUCTION: The occipito-cervical junction is the most cephal portion of the axial skeleton, connecting the cranium and the spine. It is a functional unit including the occiput, atlas and axis. The osseous complex allows significant mobility while maintaining biomechanical stability. Due to the anatomic complexity of this area a thorough understanding of the bony elements and about the involved soft-tissue elements is essential.

MATERIALS AND METHODS: This study was carried out using skull bones from the Anatomy department, Saveetha dental college. Sample size of the study was 30 dry skulls, which was used to analyse the thickness of occipital bone. The thickness of the occipital bone was measured with a digital vernier calliper with an accuracy of ±0,002 mm.

RESULT: The maximum thickness of the occipital bone can be measured at the external occipital protuberance- mean value of 12.2mm. Male skulls had higher bone thickness around this point. Female had a mean value of 9.3mm thickness at the external occipital protuberance and male had a mean value of 14.6mm around the area. The thickness below the superior nuchal line ranged between 1.4 and 7.3 mm respectively. The thickness above the superior nuchal line ranged between 2.3 and 8.5 respectively.

CONCLUSION: The maximum thickness was high among males than in females. The maximum thickness of screw fixation in case of surgeries was found to be an average of 8mm.

KEYWORDS: external occipital protuberance, occipito- cervical junction, screw fixation, superior nuchal line, Trauma.

INTRODUCTION

The occipital condyles are undersurface protuberances of the occipital bone in vertebrates, which function in articulation with the superior facets of the atlas vertebra. (1) Occipital region has always been an area of interest for neuroanatomist. Occipital emissary vein are important source of bleeding during surgeries. (2)

The occipital-cervical (OC) junction is the junction of the cranium and vertebral column, which spans from the occiput to C2. (3) Protecting the lower brain stem, upper spinal cord, and lower cranial nerves, the biomechanical stability of this osseous complex is vital important.

The most important region of the axial skeleton, connecting the cranium and the spine is the occipito-cervical junction.[4,20)] It is a functional unit including the occiput, atlas and axis. The osseous complex allows considerable mobility while also maintaining the biomechanical stability.[3,19]

Trauma, infection, tumour, some congenital disorders, and in other disorders are well-known risk factors for occipitocervical instability. Some surgical procedures in this region have also been described as a risk factor.[5] As in all other conditions that lead to spinal instability, occipitocervical instability finally leads to neural compression . Hence, occipitocervical fixation and fusion are indicated to treat the instability.[6,19]

To rectify instability of the occipito-cervical junction and to provide biomechanical stability after decompressive surgery, Occipital-cervical fusion (OCF) is used as a tool for treatment.[7] The specific areas that require complete morphologic knowledge to prevent technical failures are the thickness of the occipital bone and diameter of the C2 pedicle, as the occipital midline bone and the C2 pedicle have structurally the strongest bone to provide the biomechanical stability for cranio-cervical instrumentation.[8]

Many studies highlighted the high rates of instrumentation failure occurring in OCF. Given these rates of failure, it is critical that sufficient attention is paid to minimise technical failures irrespective of the method chosen for OCF.[9]

Misplacement or choose of the wrong occipital region can potentially lead to complications which include venous sinus injury, dura penetration with cerebrospinal fluid leak, and death secondary to acute epidural hematoma.
So one of the key area to perform a screw fixation and to prevent any technical failures is the thickness of the occipital bone which require thorough morphological, anatomical knowledge. This permit the selection of the most optimal hook or screw.[10]
Although a few previous anatomic or CT studies have looked at occipital bone thickness, there have been no studies in Indian populations at our knowledge.

In the present study, we aim on measuring the thickness of the occipital bone in places compatible with screw location. The results of this study can therefore be taken as a reference to a safety OCF.

MATERIALS AND METHODS

This study was carried out using skull bones from the Anatomy department, Saveetha dental college. Sample size of the study was 30 dry skulls, which was used to analyse the thickness of occipital bone.
To follow a uniform and coordinate system for each head we define three benchmarks, which can be reliably determined: the right and left processus mastoideus and the external occipital protuberance.
From the external occipital protuberance both axis were scaled every 5 mm. Starting at every of these points we reconstructed to the perpendicular axis points every 5 mm. Following this procedure a coordinate systems results with defined points every 5 mm

The thickness of the occipital bone was measured with a digital vernier calliper with an accuracy of ±0,002 mm. Due to the round surface of the occipital bone minor errors of this technique appear to be possible. However, previous investigations have demonstrated the accuracy of this technique.

Fig:1- occipital bone

RESULT
The maximum thickness of the occipital bone can be measured at the external occipital protuberance- mean value of 12.2mm. Male individuals had higher bone thickness around this point. Further lateral evaluation showed a steady decrease of the bone. Gender

differences were also observed. Female had a mean value of 9.3mm thickness at the external occipital protuberance and male had a mean value of 14.6mm around the area. The thickness below the superior nuchal line ranged between 7.3 and 1.4 mm. In cranial direction the occipital thickness increased gradually to higher values at the superior nuchal line with a maximum at the protuberance externe. In a further cephalic direction thickness gradually diminished. However, values above the superior nuchal line were with a range of 8,5 to 2,3 mm on average thicker than below.

Table: 1: Result

GENDER	BELOW SUPERIOR NUCHAL LINE	ABOVE SUPERIOR NUCHAL LINE	AT EXTERNAL OCCIPITAL PROTUBERANCE
MALE- 19	7.3mm	8.5mm	12.2mm
FEMALE- 11	1.4mm	2.3mm	9.3mm

Fig: 2 Thickness of occipital bone

DISCUSSION

In the present study, it is seen that The maximum thickness of the occipital bone can be measured at the external occipital protuberance- mean value of 12.2mm. Male skulls had higher bone thickness around this point. Female had a mean value of 9.3mm thickness at the external occipital protuberance and male had a mean value of 14.6mm around the area. The thickness below the superior nuchal line ranged between 1.4 and 7.3 mm respectively. The thickness above the superior nuchal line ranged between 2.3 and 8.5 respectively. Hence skull with maximum thickness was taken as male skulls and skulls with minimum thickness was considered as female skulls.

In the study by Zarghooni, et al, The maximum thickness of the occipital bone could be measured at the external occipital protuberance located midline on the superior nuchal line with a mean value of 16.1 mm (SD 3,9). [(11)]Individually a wide range could be measured with values between 9 and 29.3 mm. Gender differences were obvious, too. In woman the mean thickness was 15.3 mm (SD2.8) with a range of 9–20.3 mm, in men 17.0 mm (SD 4.9) with a range of 9.9–29.3 mm.

In the study by Hilmani, et al, Occipital thickness in those levels ranged from 4.8 mm to 28.5 mm. They were ranged from 4.8 to 25.00 mm in males and from 5.7 mm to 28.5 mm in females. The maximum thickness of the occipital bone, was in the midline at 1 cm above EOP (17.36 mm ± 3.46 mm) followed by 2 cm below EOP (12.57 mm ± 2.43 mm). [(12)]

In the study by Morita, et al, The maximum thickness of the occipital bone was at the level of the EOP at 16.4 mm. Areas with thicknesses > 8 mm were more frequent at the EOP and up to 2 cm in all directions, as well as up to 1 cm in all directions at a height of 1 cm inferiorly, and up to 3 cm from the EOP inferiorly. [(13)]The male group tended to have a thicker occipital bone than the female group, and the differences were significant around the EOP.

In the study by Winegar, et al, Among the patients identified within the cited articles, the use of posterior screw/rod instrumentation constructs were associated with a lower rate of postoperative adverse events (33.33%) (p < 0.0001), lower rates of instrumentation failure (7.89%) (p < 0.0001), and improved neurological outcomes (81.58%) (p < 0.0001) when compared with posterior wiring/rod, screw/plate, and onlay in situ bone grafting techniques[(14).] The technique associated with the maximum number of fusion rate was posterior wiring and rods (95.9%) (p = 0.0484), which also demonstrated the shortest fusion time (p < 0.0064). Screw/rod techniques also had a high fusion rate, fusing in 93.02% of cases.

When contrast outcomes of surgical techniques depending on the disease status, inflammatory diseases had the lowest rate of instrumentation failure (0%) and the highest rate of neurological improvement (90.91%) following the use of screw/rod techniques.[15] Occipitocervical fusion performed for the treatment of tumours by using screw/rod techniques had the lowest fusion rate (57.14%) (p = 0.0089). causes such as trauma of occipitocervical instability had the highest percentage of pain improvement with the use of screw/plates (100% improvement) (p < 0.0001).[16]

In the study by K.King, et al, In this study of occipital bone thickness in a South East Asian population, they found that the thickest point was in the midline with a maximum thickness below the EOP of 16.2 mm (±3.0 mm). [17]At 2 cm below the EOP, which is relevant in the clinical context as this is a common location for screw placement, it was determined in our study that the average bone thickness was 10.8 mm (±3.3 mm). Therefore, the most common length of screw for use in our patient population would be an 8-10 mm screw for that location.[18]

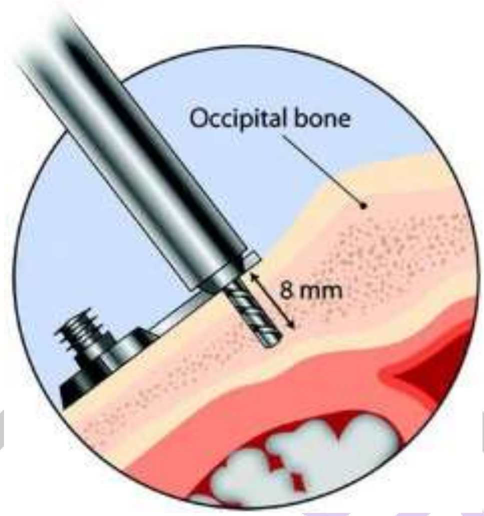

Fig: 3 Ideal measurement for screw placement

CONCLUSION

From the present study, we can conclude that the maximum thickness of the occipital bone was found to be at external occipital protuberance. The maximum thickness was high among males than in females. The maximum thickness of screw fixation in case of surgeries was found to be an average of 8mm.

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