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Calvarial Thickness of Nepalese skulls-Computerised Tomographic (CT) study

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Abstract

Introduction: Computerized tomographic scan (CT scan) has been much useful mean for the study of calvarial thickness on living subjects. one of important advantage of using CT for the study of calvarial thickness on living subjects is one can assess, if any, gender and racial variation. CT has been much useful mean for the study of calvarial thickness on living subjects. one of important advantage of using CT for the study of calvarial thickness on living subjects is one can assess, if any, gender and racial variation.

Methods: It was a cross-sectional study. Multistage random sampling method was adopted for selection of samples. One hundred adult people, over 20 year,s age were studied. Out of them 56 were male and 44 were female. Those people who were referred in radiology department for CT Scan of head were studied. However those who had trauma to skulls, bony pathology of skull bones were excluded in the study. Thickness of frontal and occipital bone at various points in lower, middle and upper thirds and parietal bone in anterior, middle and posterior thirds were measured with the help of CT scan.

Results: The mean and standard deviation of thickness of Frontal bone was calculated as 5.8 ± 2.1 mm, Parietal bone as 5.4 ± 2.2 mm and Occipital bone as 8.6 ± 2.9 mm. In all cases there was no significant difference between right and left side points ($p>0.05$) showing that there was no bilateral variation in calvarial thickness in Nepalese. The present study observed, in all cases, no significant difference between male and female ($p>0.05$) proving that Nepalese calvaria showed no sexual dimorphism.

Keywords: CT scan; Calvarial thickness; Gender variation

Introduction

Computed tomography (CT) scan has revolutionized the imaging study of living human body as it can show the images in cross-sectional form. Now a days CT has been much useful mean for the study of calvarial thickness on living subjects. One of important advantage of using CT for the study of calvarial thickness on living subjects is one can assess, if any, gender and racial variation as well as other influencing factors like nutritional, occupational, geographical etc. whereas the limitation being difficulty in precise location of various specific points on calvarium for measuring thickness.

The calvarial thickness study in human population is carried out for recording database which is useful for researchers, anatomists, anthropologists, surgeons and manufacturers of surgical screws. As there is no recorded database for calvarial thickness of Nepalese skulls, the present study was undertaken.

Methods

It was a cross-sectional study. Multistage random sampling method was adopted for selection of samples. One hundred adult people, over 20 year's age were studied. Out of them 56 were male and 44 were female. Those people who were referred in radiology department for CT Scan of head were studied. However those who had trauma to skulls, bony pathology of skull bones were excluded in the study. Thickness of calvarial bones at various points were measured with the help of CT Scan.

The frontal bone was divided into three regions for the study i.e. lower third around frontal sinus; middle third at level of frontal tuberosity and upper third above tuberosity and towards junction with parietal bone. Thickness of frontal bone at various points in lower, middle and upper thirds were measured with the help of CT scan.

The parietal bone was divided into three regions for the study between the coronal and lamdoid suture i.e. anterior third towards coronal suture; middle third midway between the coronal and lamdoid suture; and posterior third towards lamdoid suture. Thickness of parietal bone at various points in lower, middle and upper thirds were measured with the help of CT Scan.

The occipital bone was divided into three regions for the study i.e. lower third towards occipital protuberance; middle third midway between lamda and occipital protuberance and upper third towards lamda. Thickness of occipital bone at various points in lower, middle and upper thirds were measured with the help of CT scan.

Statistical analysis

All data were entered into computer using Microsoft Windows' Access software and after purification of data, analysis was done using SPSS (Statistical Package for Social Sciences) version 11:00 software. Mean value of thickness at various regions was calculated and right and left side thickness was compared for bilateral points. Student's

unpaired "t" test was used to test the significance for any bilateral and gender variation in thickness. One way ANOVA test was applied to test the significance difference among various regions on each bone and among the mean thickness of Frontal, Parietal and Occipital bone.

Results

100 people, 56 male and 44 female were studied. Thickness of frontal and occipital bone at various points in lower, middle and upper thirds and parietal bone in anterior, middle and posterior thirds were measured and tabulated below.

Thickness	Frontal bone	Parietal bone	Occipital bone	P value
Mean thickness (mm) ± SD	5.8 ± 2.1 mm	5.4 ± 2.2 mm	8.6 ± 2.9 mm	0.047
There was significant difference among mean thickness of frontal, parietal and occipital bones (p<0.05).				

Table 1: Comparison of mean thickness of frontal, parietal and occipital bones in overall population (n=100).

Mean thickness (mm) ± SD	Frontal bone	Parietal bone	Occipital bone
Male (n=56)	5.7 ± 2.3 mm	5.5 ± 2.4 mm	8.3 ± 2.7 mm
Female (n=44)	5.5 ± 2.3 mm	5.2 ± 2.5 mm	8.2 ± 2.8 mm
P value	0.076	0.080	0.074
There was no significant difference between male and female (p>0.05)			

Table 2: Comparison of mean thickness of frontal, parietal and occipital bones sex wise

Mean thickness (mm) ±SD	Frontal bone	Parietal bone	Occipital bone
Right side (n=100)	5.7 ± 2.2 mm	5.2 ± 2.5 mm	8.5 ± 2.8 mm
Left side (n=100)	5.6 ± 2.4 mm	5.1 ± 2.3 mm	8.4 ± 2.5 mm
P value	0.078	0.081	0.083
There was no significant difference between right and left side points (p>0.05).			

Table 3: Comparison of mean thickness of frontal, parietal and occipital bones side wise.

Discussion

One hundred people, 56 male and 44 female were studied. Thickness of frontal and occipital bone at various points in lower, middle and upper thirds and parietal bone in anterior, middle and posterior thirds were measured with the help of CT scan. The mean and standard deviation of thickness of Frontal bone was calculated as 5.8 ± 2.1 mm, Parietal bone as 5.4 ± 2.2 mm and Occipital bone as 8.6 ± 2.9 mm (Table 1).

Tellioglu et al. [1] assessed the reliability of Computed Tomography (CT) to determine cranial bone thickness. Sixty-four cadaver parietal bones, the preferred site for bone-graft harvesting, were used in this study. In the first stage, posterior parietal bone thickness, which is accepted as the thickest part of cranium, was measured at specially determined points using a micrometer and the results were recorded. Bone thickness was then measured again in the same points with CT. The two methods were compared statistically. The measurements were not found to be statistically different. The similar values obtained with CT and micrometers suggest that CT can accurately and reliably determine cranial thickness. Preoperative CT can be a significant guide for the harvest of cranial bone grafts without any intracranial complications in aesthetic surgery [1].

Mean thickness (mm) ± SD	Frontal bone	Occipital bone
Upper third	6.3 ± 1.4 mm	8.4 ± 1.3 mm
Middle third	5.4 ± 1.1 mm	8.7 ± 1.5 mm
Lower third	5.8 ± 1.2 mm	10.8 ± 1.8 mm
P value	0.067	0.049
There was significant difference in thickness of occipital bone at various region (p<0.05).Lower third of occipital bone i.e. towards occipital protuberance was significantly thicker (p<0.05) than upper and middle third. However there was no significant difference (p>0.05) among various regional thirds in frontal bone.		

Table 4: CT measurement of frontal and occipital bone thickness at various regions (n=100).

Mean thickness (mm) ± SD	parietal bone
Anterior third	4.4 ± 1.4 mm
Middle third	3.7 ± 1.1 mm
posterior third	6.6 ± 1.2 mm
P value	0.047
There was significant difference in thickness of parietal bone at various region (p<0.05).Posterior third of parietal bone i.e. towards lamda and lamdoid suture was significantly thicker (p<0.05) than anterior and middle third.	

Table 5: CT measurement of parietal bone thickness at various regions (n=100)

Jung et al. [2] studied on regional thickness of parietal bone in Korean adults. To clarify the clinical utility of the parietal bone graft in maxillofacial reconstruction, they performed an anatomical study by measuring the regional thickness of the parietal bone in 47 Korean adult dry skulls. Before sectioning of the calvaria, the appropriate anatomical landmarks were marked on each specimen. They measured the total thickness of the parietal bone, and the thickness of the outer and inner cortical plates at various points in each section of parietal bones using a digital caliper under the stereomicroscope. The total thickness of the parietal bone ranged from 5.04 mm to 7.17 mm, and there was no statistical difference in the total thickness of the parietal bone on the same points bilaterally. The parietal bone tended to be thicker toward the lambda point than at the coronal suture area. On the other hand, the outer plate of parietal bone was thickest at the point nearest to the coronal suture, and the inner plate proved thickest at the posteromedial area. In conclusion, this study showed that the

better donor site of the parietal bone for maxillofacial reconstruction is located at its more posterior and medial area [2].

The present study also showed the posterior part of parietal bones were significantly thicker than anterior and middle part ($p<0.05$).

Choompoopongkasem et al. [3] carried out study on calvarial thickness and its correlation to three dimensional CT Scan. It was a descriptive study that measured the thickness of parietal bone in Thai adult cadavers and found out its correlation to three-dimensional CT scan. A total of 65 (male 34 and female 31) cadaveric skulls were used in this study. The calvarial thickness was measured in 9 points on each parietal area of skull by Depth micrometer series 128-101 (Mitutoyo Corporation, Kanagawa, Japan). The three-dimensional CT scans were made on a GE light speed VCT 64 scanner (General Electrics Medical System, Milwaukee, Wisconsin). Mean thickness of all parietal bones was 6.68 ± 1.94 mm (0.84-15.59 mm). At point 5, mean thickness measured by micrometer was 7.13 ± 2.28 mm and 7.00 ± 2.22 mm with three-dimensional CT scan, respectively. Mean difference was 0.13 mm that statistically significant (p-value < 0.01) but the upper limit of 95% confidence interval of all difference was only 0.28 mm that not clinically significant. The relationship between the two measurement modalities could had equation of relationship as micrometer = 0.025 + 1.025 (3D-CT). The study concluded that agreement between the micrometer and three-dimensional CT measurements was acceptable [3].

In the present study the parietal bone was divided into three regions for the study between the coronal and lamdoid suture i.e. anterior third towards coronal suture; middle third midway between the coronal and lamdoid suture; and posterior third towards lamdoid suture. Thickness of parietal bone at various points in lower,middle and upper thirds were measured with the help of CT Scan. There was significant difference in thickness of parietal bone at various region ($p<0.05$). Posterior third of parietal bone i.e., towards lamda and lamdoid suture (mean ± SD=6.6 ± 1.2) was significantly thicker ($p<0.05$) than anterior (mean ± SD=4.4 ± 1.4) and middle third (mean ± SD=3.7 ± 1.1).The mean and standard deviation of thickness of Parietal bone was calculated as 5.4 ± 2.2 mm.

Weber et al. [4] carried out thickness mapping of the Occipital bone on CT-data and opined that information about the thickness of cranial bones are not only of great medical interest, particularly for pre-operative surgical planning, but can be useful for investigations of fossil hominid material [4]. Smith et al. [5] Identified of human skeletal remains by comparison of bony details of the cranium using computerized tomographic (CT) scans. A case was described where a cranium from an unknown individual was identified by comparison of antemortem and postmortem computerized tomographic (CT) images of the bony structure of the skull. Bony details of the frontal and sphenoid sinuses, ethmoid and mastoid air cells, sagittal cranial suture, and the internal occipital protuberance were exactly the same on both CT scans, confirming them as the same person [5].

Ross et al. [6] investigated skull thickness of Black and White races and found that White women have the thickest and White men the thinnest skulls. The skulls of women were statistically significant thicker than those of men in both ethnic groups [6]. Ross et al. [7] had done research on cranial thickness in American females and males with an objective to examine sex and age variation in cranial thickness in a White sample. An increase in cranial thickness with age was observed and there was no statistical difference in calvarial thickness between male and female [7]. Contrary to the Ross et al. [7] and similar to Ross et al. [6] finding, Hatipoglu et al. [8] found sexual dimorphism in all craniometric data observed positive correlation between body mass index and diploeic thickness [8].

However the present study observed, in all cases, no significant difference between male and female ($p>0.05$) proved that Nepalese calvaria showed no sexual dimorphism.

Hwang et al. [9] carried out thickness mapping of the parietal bone in Korean adults and concluded that the parietal bone tended to be thicker towards the Lamda point than at the coronal suture area [9].

The present study also showed that parietal bone was thicker towards lamda or posterior third (6.6 ± 1.2mm) than bregma or anterior third (4.4 ± 1.4mm).

Novakovie et al. [10] carried out computed tomographic analysis of outer calvarial thickness for osseointegrated bone-anchored hearing system insertion. A total of 195 temporal bones were examined in 100 patients. It was observed that mean calvarial thickness was greater at 1 cm above external auditory canal level i.e. 6.3 cm. [10].

The present study also carried out computed tomographic analysis of calvarial thickness in 100 patients. It was observed that mean calvarial thickness was greater towards external occipital protuberance (10.8 ± 1.8mm).

Conclusion

One hundred people, 56 male and 44 female were studied. Thickness of frontal and occipital bone at various points in lower, middle and upper thirds and parietal bone in anterior, middle and posterior thirds were measured with the help of CT scan. The mean and standard deviation of thickness of Frontal bone was calculated as 5.8 ± 2.1 mm, Parietal bone as 5.4 ± 2.2 mm and Occipital bone as 8.6 ± 2.9 mm.

In all cases there was no significant difference between right and left side points ($p>0.05$) showing that there was no bilateral variation in calvarial thickness in Nepalese.

The present study observed, in all cases, no significant difference between male and female ($p>0.05$) proving that Nepalese calvaria showed no sexual dimorphism. Thus the study needed to be conducted with more sample size. However these data could be used by surgeons as reference during craniotomy. The research found that Nepalese skull thickness is not fully same as that of black and whites at some points they are similar only.

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References

1. Tellioglu AT, Yilmaz S, Baydar S, Tekdemir I, Elhan AH (2001) Computed tomographic evaluation before cranial bone harvesting to avoid unexpected hazards during aesthetic procedures. Aesthetic Plast Surg 25: 198-201.
2. Jung YS, Kim HJ, Choi SW, Kang JW, Cha IH (2003) Regional thickness of parietal bone in Korean adults. Int J Oral Maxillofac Surg 32: 638-641.
3. Chompoopongkasem K, Chandraphak S, Chiewvit P, Aojanepong C (2008) Calvarial thickness and its correlation to three dimensional CT(3D-CT). Scan.Medical Journal 27: 1171-1183.

4. Weber GW, Johann K, Arnold N, , Magori CC, Saanane CB, et al. (2000) Thickness mapping of the occipital bone on CT-data. Acta Anthropologica Sinica Supplement 19: 37-46.
5. Smith DR, Limbird KG, Hoffman JM (2002) Identification of human skeletal remains by comparison of bony details of the cranium using computerized tomographic (CT) scans. J Forensic Sci 47: 937-939.
6. Ross MD, Lee KA, Castle WM (1976) Skull thickness of Black and White races. S Afr Med J 50: 635-638.
7. Ross AH, Jantz RL, McCormick WF (1998) Cranial thickness in American females and males. J Forensic Sci 43: 267-272.
8. Hatipoglu HG, Ozcan HN, Hatipoglu US, Yuksel E (2008) Age, sex and body mass index in relation to calvarial diploe thickness and craniometric data on MRI. Forensic Sci Int 182: 46-51.
9. Hwang K, Kim JH, Baik SH (1997) Thickness map of parietal bone in Korean adults. J Craniofac Surg 8: 208-212.
10. Novakovic D, Meller CJ, Makeham JM, Brazier DH, Forer M, et al. (2011) Computed tomographic analysis of outer calvarial thickness for osseointegrated bone-anchored hearing system insertion. Otol Neurotol 32: 448-452.