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Original Research Article

Computed tomographic scanning measurement of skull bone thickness: a single center study

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ABSTRACT

Background: Computerized tomography scan (CT scan) can be useful for the measuring the calvarial thickness in human beings. This could help in identifying the racial and the gender variations in calvarial thickness in a population. The data obtained about calvarial thickness study in human population may be useful for researchers, anatomists, anthropologists, surgeons and manufacturers of surgical screws.
Methods: This was an observational study carried out on 104 subjects, with a normal computerized tomography CT scan of the head. Any subject with a skull fractures or an underlying intracranial lesion were excluded from study. A total of 52 males and 52 females who presented in the radiology department for CT head were studied in a consecutive manner. The thickness of skull bone was measured on console (Somatom, Siemens 16 slice).
Results: Our study population consisted of 52 male and 52 female subjects. The mean age for males was 48.03 (Range 18-70) years and while as the mean age of females was 47.37 (Range 18-73) years. We did not find any difference in the thickness of the frontal bone at upper third, middle third and lower third between the two sexes. However, the posterior third parietal bone, the anterior and middle third occipital bone was significantly thicker in females when compared to males.
Conclusions: Our study suggests that the anterior third of the parietal bone has a more calvarial thickness on the right side than on the left side in both males and females. However, the female calvarium has a significantly thicker calvarium at the posterior third parietal; anterior and middle third occipital bones when compared to male counterparts showing a sexual dimorphism in our study population.

Keywords: Computerised tomography, Craniometric measurements, Skull bone thickness

INTRODUCTION

Computed tomography (CT) scan has revolutionized the imaging and diagnosis of calvarium in the last few decades. Computerized tomography scan (CT scan) can be useful for the measuring the calvarial thickness in human beings. This could help in identifying the racial and the gender variations in calvarial thickness in a population. The data obtained about calvarial thickness study in human population may be useful for researchers, anatomists, anthropologists, surgeons and manufacturers of surgical screws.[1-4] It may be also helpful in reconstructive plastic surgeries as skull is a frequently used site of bone graft harvest. Previous studies from Chinese, and Japanese population have tried to measure the cranial thickness with conflicting results about the

relationship between cranial vault thickness with age, sex and general body build.[2-4] As we do not have any available data on the calvarial skull thickness from the Indian population, we undertook this study to measure the calvarial thickness in Kashmiri population from the Indian subcontinent.

METHODS

This was an observational study carried out on 104 subjects, with a normal computerized tomography CT scan of the head. Any subject with a skull fractures or an underlying intracranial lesion were excluded from study. A total of 52 males and 52 females who presented in the radiology department for CT head were studied in a consecutive manner. The thickness of skull bone was measured on console (Somatom, Siemens 16 slice).

The three parts of skull frontal, parietal and occipital were further divided for into 3 parts each for the sake of uniformity of measurement. Parietal region was measured on both right and left sides and the two sides were compared with each other. The frontal bone was divided into three regions for the study; lower third around frontal sinus; middle third at level of frontal tuberosity and upper third above tuberosity and towards junction with parietal bone. The parietal bone was divided into three regions for the study between the coronal and lamdoid suture (anterior third towards coronal suture; middle third midway between the coronal and lamdoid suture; and posterior third towards lamdoid suture. The occipital bone was similarly divided into three regions for the study (lower third towards occipital protuberance; middle third midway between lamda and occipital protuberance and upper third towards lamda). The measurements thus obtained were analysed using SPSS version 20. The difference between male and female sex in each parameter was compared using Mann-Whitney U test. Similarly difference between right and left parietal bone and different levels were analysed.

RESULTS

Our study population consisted of 52 male and 52 female subjects. The mean age for males was 48.03 (Range 18-70) years and while as the mean age of females was 47.37 (range 18-73) years. The different dimensions are tabulated in Table 1.

Table 1: Comparison of thickness of skull at various points.

Thickness	Male	Female	P value
Upper 3rd frontal (mm)	6.14 ±1.13	6.31 ±.0.93	NS
Middle 3rd frontal (mm)	6.35 ±1.43	6.35 ±1.05	NS
Lower 3rd frontal (mm)	6.44 ±1.35	6.97 ±1.42	NS
Anterior 3rd parietal (mm)	4.46 ±0.78	4.68 ±0.8	NS
Middle 3rd parietal (mm)	4.33 ±0.74	4.57 ±0.67	NS
Posterior 3rd parietal (mm)	4.65 ±0.9	5.55 ±1.62	S
Anterior 3rd occipital (mm)	8.01 ±1.04	7.43 ±1.17	S
Middle 3rd occipital (mm)	8.29 ±1.32	7.31 ±1.6	S
Posterior 3rd occipital (mm)	9.97 ±2.62	9.68 ±1.85	NS

Table 2: Comparison of right and left side parietal bone.

Thickness	Right side	Left side	P value
Anterior 3rd parietal (mm)	4.7 +0.81	4.43 +0.95	S
Middle 3rd parietal (mm)	4.46 +0.71	4.45 +0.71	NS
Posterior 3rd parietal (mm)	5.11 +1.22	5.08 +1.12	NS

We did not find any difference in the thickness of the frontal bone at upper third, middle third and lower third between the two sexes. However the posterior third parietal bone,the anterior and middle third occipital bone was significantly thicker in females when compared to males. (Table 1) Similarly it was observed that in both males and females the right side of the parietal bone was significantly thicker (p value <0.05) than the left side Table 2.

DISCUSSION

Skull bone consists of the inner table, outer table and the middle layer or diploe of cancellous bone.[1] 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, any gender and racial variation. In addition to effect of nutritional, occupational and geographical factors on calvarial development and thickness can be studied.[2]

The measurement of the human skull based on CT images results are of great practical value in the fields of anatomy, clinical medicine, biomechanics study and head injury analysis.[3] The total skull bone thickness is the total thickness of diploe and the external and internal tables. Numerous studies have used different radiological tests for assessment of cranial thickness like A-mode ultrasound, CT and MRI. The thickness and the breadth of the human skull are variable and in general females tend to have thicker skulls than their male counterparts.[4]

Several authors have recorded a slight increase in cranial thickness with age and have related the frontal bone thickness increase to hyperostosis of frontalis interna.[5-7] However other authors found that age-related increase in thickness, may be a result of inconsistencies in the radiologic examination.[8,9] It is assumed that hyperostosis frontalis interna is caused by a prolonged oestrogen production in females.[10] Ross et al found a 10% frequency of hyperostosis frontalis in females.[7] Ishida and Lynnerup found that there was no significant relationship between age and diploeic thickness.[11,12] However in our study we did not find any dimorphism in the frontal bones between the two sexes. This may be a result of racial and ethnic differences between our study and the studies conducted by Ross.[7]

Many investigators carried out computed tomographic study of calvarial bones in different perspectives. Gerhard et al 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.[13]

Ross MD et al 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.[10] Ross AH et.al 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 finding, Hatipoglu HG et al found sexual dimorphism in all craniometric data observed positive correlation between body mass index and diploeic thickness.[14] Hwang K et al 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.[15] Daniel Novakovie et al 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; mean patient age was 60.9 years, of whom 54.4% were males and 45.6% were females. Mean calvarial thickness was greatest at +1 cm above external auditory canal level i.e.6.3mm Such data can be useful for surgeons for planning different burr holes at different positions and for cranioplasties.[16] In contrast to these studies the craniometric measurements from our study showed that posterior parietal, anterior occipital and middle occipital bone thickness is more in females than in the male population. Hence there is a selective craniometric increase in thickness in posterior parietal and occipital bones when compared to other populations. Similarly, the anterior third of right parietal bone was significantly thicker when compared to the left parietal bone.

CONCLUSION

Our study suggests that the anterior third of the parietal bone has a more calvarial thickness on the right side than on the left side in both males and females. However, the female calvarium has a significantly thicker calvarium at the posterior third parietal; anterior and middle third occipital bones when compared to male counterparts showing a sexual dimorphism in our study population. More studies enrolling other centre's need to be carried out, to confirm these findings.

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