
Human Cranial Vault Thickness in Relation to Age, Sex and General Body Build in a South Indian Population

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Abstract

Background & Objectives: During legal investigations, the forensic pathologist is often required to give an opinion regarding personal identification of the deceased. The bone that is among the most helpful for these investigations is the skull. As to my knowledge, this is the first study of its kind in this part of the world where an attempt is made to find any correlation between cranial vault thickness, age sex and general body build in a population group.

Methods: The study was commenced after obtaining Institutional Ethics Committee clearance certificate (AJEC/REV/95/2016). Materials for the present study consists of eighty-two South Indian origin victims autopsied at the mortuary of A. J. Institute of Medical Sciences, Mangaluru, Karnataka between November 2016 and October 2018. The victims comprised of both the genders in the age group of 18-80 years belonging to various parts of South India (Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Telangana & Union territories of Lakshadweep & Pondicherry).

Results: The victims in the age group of 18-80 years belonging to various parts of South India The average stature among males was 168.69 ± 10.98 and ranged from 148cm and 192cm. There was found to be a significant correlation between the occipital thickness and the sexes. There was found to be no significant correlation between different areas of cranial vault thickness with respect to each other and also between cranial vault thickness with height, weight or general body build.

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Interpretation & Conclusion: The present study emphasizes the utility of cranial vault thickness in identifying individuals. It also provides useful insights in the fields of calvarial bone grafting and neurosurgery.

Keywords: Autopsy; Cranial Vault Thickness; Fragmentary remains; General body build;

Introduction

Identity is the aggregate of characteristics by which an individual is recognized by himself and others. Identification is an easy process in the living, but when it comes to unknown, mutilated, decomposed or skeletonized bodies, it becomes difficult. In medico-legal practice, the establishment of the identity of an individual is of paramount importance in civil as well as criminal disputes.¹

This study is an attempt to identify the existence of any relation between cranial vault thickness and whether any points regarding the age, sex or body build of a person can be deduced from cranial vault thickness alone.

Another application for knowing the cranial vault thickness is in neurosurgery, especially while drilling burr holes for decompression surgeries. Knowing the depth up to which the hole should be drilled will help in better planning of the surgical team and will help in being better equipped during emergency procedures.

Aims & Objectives of the study:

The aims of this study is to report the variation in cranial vault thickness in a contemporary South Indian population and to provide insight into the relation between cranial vault thickness and body mass index, stature, age, and sex.

Three measurements are taken at each location and the average of the three values is taken to minimize the observer error and bias.

Association between the cranial thickness measurements and the categorical variables (sex) was evaluated with and were compared between the sexes, for different age groups, different heights, weights and body mass index by means of an independent samples t test. All statistical analyses were performed with IBM SPSS Statistics 21.

Sample and sampling technique:

Materials for the present study consists of 82 South Indian (Karnataka, Kerala, Tamil Nadu,

Andhra Pradesh, Telengana & Union territories of Lakshadweep & Pondicherry) origin victims aged between 18 years and 80 years autopsied at the mortuary of A. J. Institute of Medical Sciences, Mangaluru, Karnataka between November 2016 and October 2018.

Inclusion criteria:

Materials for the present study consists of 82 South Indian (Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Telengana & Union territories of Lakshadweep & Pondicherry) origin victims autopsied at the mortuary of A. J. Institute of Medical Sciences, Mangaluru, Karnataka between November 2016 and October 2018.

All victims were between the ages of 18 years and 80 years provided there are no exclusion factors.

Exclusion criteria:

- Victims who originate from parts of India other than Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Telangana and Union Territories of Lakshadweep and Pondicherry are excluded as the area where the hospital serves has a diverse south Indian population from 3 states and 1 union territory
- Victims, who were either below the age of 18 years or above the age of 80 years, are excluded, as there will be increased bone resorption with age and this will result in a false thinner average²
- Those who had a known history of Alcohol abuse or were on chronic psychiatric medication are excluded. It has also been documented and studied that chronic alcoholics and those on chronic psychiatric medications will have increased skull thickness. If included this would result in an increased false average thickness³
- Any pathological conditions and head trauma that hampered correct measurements or cases with missing data or obviously flawed measurements (e.g., body weight in a severely burnt individual) are excluded from the study.

Results

Among the 82 cases, 61 (74.4%) were males and 21 (25.6%) were females as shown below in Table no.1 and Fig.12. The male female ratio was 2.9:1.

Most of the cases (31.7%) of our study were in the age group of 30 to 45 years. This was followed by the age group between 45 to 60 years which accounted for 26.8% of the total cases. The youngest victim was 18 years old and the oldest was 80 years old.

Majority of the study population (54.9%) had body weight ranging from 40-60 kg followed by body weight ranging from 60-80 kg. Only 4 of the victims had body weight exceeding 80kg.

The largest group comprising of 42.7% of the study population belong to the stature ranging from 170-180cm followed by 29.3% having stature ranging from 160-170cm.

Majority of the victims (59.8%) had ideal body mass index whereas 17 victims (20.7%) were overweight.

The mean frontal thickness in males is 6.45±1.52mm and the mean frontal thickness in females is 7.62±2.50mm. The difference in mean was not found to be statistically significant with independent T test as the P value is 0.054.

The mean euryon thickness in males is 6.98±1.60mm and the mean euryon thickness in females is 6.90±1.54mm. The difference in mean was not found to be statistically significant with independent T test as the P value is 0.829.

The mean occipital thickness in males is 8.67±1.75mm and the mean occipital thickness in females is 7.61±1.76mm. The difference in mean was found to be statistically significant with independent T test as the P value is 0.019.

Males and females did not differ significantly in cranial thickness except for the occipital region where there was statistically significant difference with males having thickest measures.

There is no statistically significant correlation between the thicknesses of the cranial vault sites in relation to each other as the P values are all greater than 0.05.

There was no statistically significant correlation between cranial thickness and age for frontal thickness, euryon thickness and occipital thickness as shown in table 1.

Table No 1: Pearson correlation matrix for cranial thickness for age and sex

		Age	
		Correlation coefficient	P value
Frontal	Male	-0.071	0.585
	Female	-0.169	0.463
Euryon	Male	0.009	0.943
	Female	-0.217	0.344
Occipital	Male	-0.202	0.118
	Female	0.377	0.092

There was no statistically significant correlation between cranial thickness and weight for frontal thickness, euryon thickness and occipital thickness as shown in Table 2.

Table No 2: Pearson correlation matrix for cranial thickness for weight and sex

		Weight	
		Correlation coefficient	P value
Frontal	Male	0.066	0.616
	Female	0.133	0.567
Euryon	Male	0.098	0.450
	Female	0.327	0.148
occipital	Male	-0.123	0.345
	Female	0.088	0.703

There was no statistically significant correlation between cranial thickness and height for frontal thickness, euryon thickness and occipital thickness as shown in Table 3.

Table No 3: Pearson correlation matrix for cranial thickness for height and sex

		Height	
		Correlation coefficient	P value
Frontal	Male	0.191	0.141

	Female	0.273	0.232
Euryon	Male	-0.137	0.291
	Female	0.291	0.201
Occipital	Male	0.074	0.571
	Female	0.203	0.378

Discussion

Cranial thickness has been studied by several authors and attempts have been made to correlate thickness with other parameters such as sex, age, height and weight. This study did not show any statistically significant sexual dimorphism in cranial thickness. Although the calculated means did indicate that except for the occipital region where there was statistically significant difference with males having thickest measures. Research conducted by Ross et al. and Lynnerup, showed female skulls were thicker than male skulls at euryon.^{4,5} Roche found that "the average cranial thickness of the males exceeds that of the females at all points where measurements were made except at euryon".⁶ Ross MD investigated skull thickness of Black and White races and found that White women have the thickest and White men the thinnest skulls⁴. The skulls of women were statistically significant thicker than those of men in both ethnic groups Ross AH 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.⁴ An increase in cranial thickness with age was observed and there was no statistical difference in calvarial thickness between male and female.⁴ Females having thicker skulls than males (and for both whites and South African blacks), and also reported by Ishida and Dodo for a Japanese sample⁷(statistically significant for two measures), and by Smith et al.⁸ for Near Eastern populations (a trend, not statistically significant), while Getz reported no sexual dimorphism⁹. The latter studies do not mention examination for hyperostosis frontalis or data on possible bone-related diseases, aside from Ross et al., who mention a frequency of 10% among the females investigated¹⁰. In a recent study, Ross et al. did not find an overall sexual dimorphic difference until onset of hypostasis frontalis interna, the condition being prevalent among older females⁴. In older individuals (i.e. 55 years and older), Ross et al. found that thickness above a certain measure indicated a female⁴

Roche found no differences in cranial thickness on right and left sides, which is in agreement with the present study⁶. Right and left sides were highly and statistically significantly correlated. This is the reason for opting for measurement from either right or left side.

In this study there was no statistically significant correlation between age and cranial thickness, thus, reflecting results of Schmitt and Saternus, Ishida and Dodo and Ross et al. Todd found a slight increase in one of his measures (vertex) up to 60 years of age, but it is not possible to adequately test this result statistically^{11,12,4}

Summary

The present study group comprised of 82 cases of autopsies conducted at the mortuary of A. J. Institute of Medical Sciences & Research Centre. The cranial vault thickness (CVT) measurements were correlated with age, sex and general body build.

- Majority of the study population belongs to male gender (74%). The male female ratio was 2.9:1.
- Significant proportion of the study population (31.7%) was in the age group of 30 to 45 years, followed by the age group between 45 to 60 years which accounted for 26.8% of the total cases. The youngest victim was 18 years old and the oldest was 80 years old.
- Majority of the study population (54.9%) had body weight ranging from 40-60 kg followed by body weight ranging from 60-80 kg.
- The largest group comprising of 42.7% of the study population belong to the stature ranging from 170-180cm followed by 29.3% having stature ranging from 160-170cm.
- Majority of the victims (59.8%) had ideal body mass index whereas 17 victims (20.7%) were overweight.
- The mean frontal thickness in males is 6.45±1.52mm and the mean frontal thickness in females is 7.62±2.50mm. The difference in mean was not found to be statistically significant with independent T test as the P value is 0.054.
- The mean euryon thickness in males is 6.98±1.60mm and the mean euryon thickness

in females is 6.90 ± 1.54 mm. The difference in mean was not found to be statistically significant with independent T test as the P value is 0.829.

- The mean occipital thickness in males is 8.67 ± 1.75 mm and the mean occipital thickness in females is 7.61 ± 1.76 mm. The difference in mean was found to be statistically significant with independent T test as the P value is 0.019.
- Males and females did not differ significantly in cranial thickness except for the occipital region where there was statistically significant difference with males having thickest measures.
- There is no statistically significant correlation between the thicknesses of the cranial vault sites in relation to each other as the P values are all greater than 0.05.
- Strong points- Possibly this could be the only research undertaken in this part of the world correlating Cranial Vault Thickness (CVT) to age, sex, and general body build. The results of which could be of great clinical significance wherein they could be used for estimating the depth of burr holes, in neurosurgical interventions, or in estimating the thickness of bone to be grafted in case of loss of significant thickness of bone, or planning and executing craniotomy and cranioplasties in addition to determining the identity forensically.
- **Limitations:** this study can be further valuated by increasing the sample size and by coupling autopsy measurements of calvarial vault thickness with that of measurements obtained from imaging technologies. More impetus to the results can be done by incorporating pre-existing pathological conditions or addictive states which could be having a role in increasing or decreasing the dimensions of cranial vault thickness.

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Ethical Clearance : The study was commenced after obtaining Institutional Ethics Committee clearance certificate (AJEC/REV/95/2016).

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