Original Research Article

Determination of Craniofacial Relation in Human Dry Skulls: An Anthropometric Study

Raghavendra AY[1*], Santosh Manohar Bhosale[2], Shishir Kumar C Naik[3], Moin Ali Afzal Janvekar[4]

[1]Professor, Department of Anatomy, S S Institute of Medical Sciences, Davangere,Karnataka,India
[2]Associate Professor, Department of Anatomy, S S Institute of Medical Sciences, Davangere, Karnataka,India
[3]Associate Professor, JNUIMSRC, Jaipur, Rajasthan, India
[4]Second MBBS Student, SS Institute of Medical Sciences, Davangere, Karnataka,India

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Abstract

Introduction: The size, form and position of the skull and its parts are influenced by various factors. The aging process of the bone, also known as bone remodelling, occurs throughout the lifetime of every human being which confers great variability in interpersonal and with the age. Human facial contour has always been an interesting subject for anatomists, anthropologists, plastic surgeons, and artists and also the identification of an individual's race is an essential component in forensic identification and reconstructive surgery. Facial asymmetry is common in humans. The study is conducted with an aim to collect the anthropometrical data in dry skulls of south Indian origin and compare it with some of the previous studies conducted in same and different race. The mean, standard deviation and range will be calculated for the data.**Methodology**: The sample for the present study consists of 50 dry skulls irrespective of sex. Various anthropometric measurements were recorded. Based on the obtained results the length-width-height index of the face and cranium was estimated. **Results**: The mean width and length of the cranium are 13 cm and 17cm respectively. The average cranial index is about 76.8. With reference to the classification of cranium according to cephalic system by Farkas and Sicher H et al, in the present study, 20.4% belong to Brachycephalic and 13.26% belonged to Mesocephalic groups. The study shows that there is a significant positive correlation between width of face and Cranial index. **Conclusion**: Various studies are being done on anthropometric evaluation of face and cranium in different conditions like dry bone, live individuals and cadavers of different region, population, ethnicity and race. In this study, the anthropometrical data in dry skulls of south Indian origin have been collected and compare it with some of the previous studies conducted in same and different region and population. The mean, standard deviation and range are calculated for the data will be useful for the future studies and clinical application.

Keywords: Vernier Calipers, cranial index, facial index.

Introduction

Anthropometry constitutes the technique of expressing quantitatively the form of the body. The terminology used to describe the craniofacial complex stemmed from classical anthropometry, which employs measurements taken in living individuals and human skulls as well as indices that represent facial proportions[1,2].The size, form and position of the skull and its parts are influenced by various factors[3].The aging process of the bone, also known as bone remodelling, occurs throughout the lifetime of every human being which confers great variability in interpersonal and with the age[4,5]. Human facial contour has always been an interesting subject for anatomists, anthropologists, plastic surgeons, and artists and also the identification of an individual's race is an essential component in forensic identification and reconstructive surgery[6].Facial asymmetry is common in humans. Significant facial asymmetry causes both functional as well as aesthetic problems. The aetiology includes congenital disorders, acquired diseases, and traumatic and developmental deformities. The causes of many cases of developmental facial asymmetry are indistinct. fWHR (bizygomatic width divided by upper-face height) has been shown to predict aggression, deception, and untrustworthiness but also more positive behaviours such as achievement striving and self-sacrifice towards the in-group[7].

The study is conducted with an aim to collect the anthropometrical data in dry skulls of south Indian origin and compare it with some of the previous studies conducted in same and different race. The mean, standard deviation and range will be calculated for the data.

This study was done to determine the facial proportions and craniometry in dry skulls of South Indian origin and to compare the facial proportion and craniometric data for cranio-facial symmetry.

Methodology

The sample for the present study consists of 50 dry skulls irrespective of sex was collected from the Department of Anatomy. Inclusion criterion was to obtain complete skulls with mandible irrespective of sex of South Indian origin. Partial, damaged or mutilated and altered skulls and below 18 year skulls were excluded. Skulls with cranial abnormalities were not included.

The anthropometric measurements will be performed using the instruments obtained from the laboratory. Following instruments will be used[8,9].

1. Digital VernierCalipers
2. Spreading Caliper
3. Sliding Caliper
4. Dividing Caliper
5. Measuring scale

The following craniometric points, or landmarks, were used for the purpose of measurement (figure.1and 2):

- Gnathion (gn): midpoint of the lower border of mandible.

**Correspondence*
Dr. Raghavendra AY
Professor, Department of Anatomy,S S Institute of Medical Sciences, Davangere,Karnataka,India
E-mail: raghav4n72@gmail.com

- Nasion (na): is the meeting point of the fronto-nasal and inter-nasal sutures.
- Prosthion (pt): point on the alveolar arch midway between median upper incisor teath.
- Zygion (zy) : the most lateral point of the zygomatic arch.
- Ans (Anterior Nasal Spine): most prominent part of anterior nasal spine
- Euryon(eu): the most lateral point on the skull
- Gonion (gon) : the lowest posterior and lateral point of the angle of mandible.
- OFD (occipito-frontal diameter) : linear distance between the most protuberant points of frontal and occipital bones at mid sagittal plane
- Frontotemporal Points (ft): meeting point of coronal suture and squamous part of temporal bone.

On the basis of these points 10 distances were measured and variables were obtained[10].

- UFH: Upper anterior face height – na to ans.
- LFH: Lower anterior face height – ans to gn.
- MFH: middle anterior face height –ans to pro
- TFH: total facial height – na to gn
- WF: width of face – zn to zn
- WFO: ft to ft
- WM : gon to gon

The height of the face (TFH) was taken as the distance between the intersection of the median plane, i.e. internasal and nasofrontal suture (na), and the lowest point of the mental process (gnathion).

The width of the face (Wf) was determined on the basis of the interzygomatic space, i.e. linear distance between the most protuberant points of the left and right zygomatic arch (zygion). Width of forehead (Wfo) was defined as the distance between the frontotemporal points (ft).

The following were determined by craniometry: height, width and indexes of the skull and face.

8. WC: width of Cranium– eu to eu

9. LC: Length of Cranium: ofd (occipito-frontal diameter): linear distance between the most protuberant points of frontal and occipital bones at mid sagittal plane

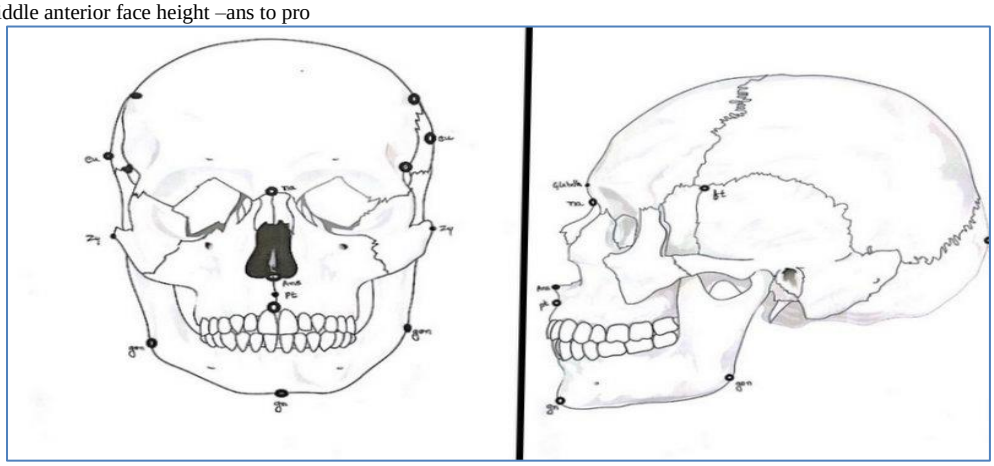

Fig 1:Norma Frontalis **Fig 2:Norma Lateralis**

Based on the obtained results the length-width-height index of the face and cranium was estimated.

The facial skeletal index (FSI) was calculated by the following formula:

FSI= [(Upper facial height (UF) + middle facial height (MFH)] / WF

Cranial Index (CI) was calculated by the following formula :

CI= width of Cranium (WC)/ Length of Cranium (LC)x 100

Statistical Methods

Appropriate statistical analysis of the data will be done. The data were analyzed statistically using IBM SPSS Statistics for Windows, Version 22.0 (Armonk, NY: IBM Corp. Released 2013). Method of statistical analysis: Pearson's Correlation, Independent sample t-Test, Mean and Standard Deviation.

Person correlation is used to correlate the two continuous variables which are normally distributed. Correlation coefficient (r) , is classified as excellent if >0.8, good if 0.6-0.8, fair if 0.4-0.6 and poor if <0.4. The significant correlation indicates that there is linear relationship between variables. R2 is square if r, coefficient of determination, indicates the % variability in the variable due to other variable. The sign of r value, indicates the direction of correlation, when positive, as one variable increases, other variable also increases linearly and when it is negative, as one variable increases, other decreases and vice versa.

Observations and Results

This anthropometric study provides the facial and cranial dimensions of the dry skulls obtained in the Department of anatomy. These skulls are of cadavers of voluntary body donors who are from the local places in and around Karnataka. Total number of skulls studied is 50 (N=50).

Table 1: Mean, standard deviation and range of anthropometry of facial skeleton and cranium

Parameters	Mean (in cm)	Standard Deviation	Minimum (in cm)	Maximum (in cm)
Facial anthropometry				
UFH	4.62	.30	3.90	5.30
MFH	1.81	.44	1.10	2.90
UFH+MFH	6.44	.52	5.30	8.00
WF	12.22	.71	10.40	13.60
WFO	11.42	.64	10.10	12.80

WF/UFH	2.65	.21	2.00	3.18
UFH/WF	.38	.03	.31	.50
FSI=(UFH+MFH)/WFx100	53	05	4.6	66
Cranial anthropometry				
WC	13.04	.69	10.60	14.40
LC	17.04	.78	15.50	18.90
CI=WC/ LC x 100	76.81	4.72	67.58	88.05

The study shows that the anthropometric parameters of face vary proportionately and the Pearson's correlation shows the variables are positively correlated to each other except MFH and WFo. So it can be implied that the Facial index and Facial skeletal Index remains within a close range among skulls obtained from a specific region or race. The mean FSI (facial skeletal index) is 53. The mean, standard deviation and range of facial anthropometric parameters are mentioned in the table.1.The mean width and length of the cranium are 13 cm and 17cm respectively. The average cranial index is about 76.8.

Table 2: Correlations of among facial anthropometric parameters

		UFH	MFH	WF	WFo
UFH	Pearson Correlation	1	-.037	.131	.221
	Sig. (2-tailed)		.801	.365	.123
MFH	Pearson Correlation	-.037	1	.138	-.020
	Sig. (2-tailed)	.801		.341	.892
WF	Pearson Correlation	.131	.138	1	.512**
	Sig. (2-tailed)	.365	.341		.000
WFO	Pearson Correlation	.221	-.020	.512**	1
	Sig. (2-tailed)	.123	.892	.000	
**. Correlation is significant at the 0.01 level (2-tailed).					

Depending upon cranial index the types of head shapes were classified as given by Williams et al, 1995

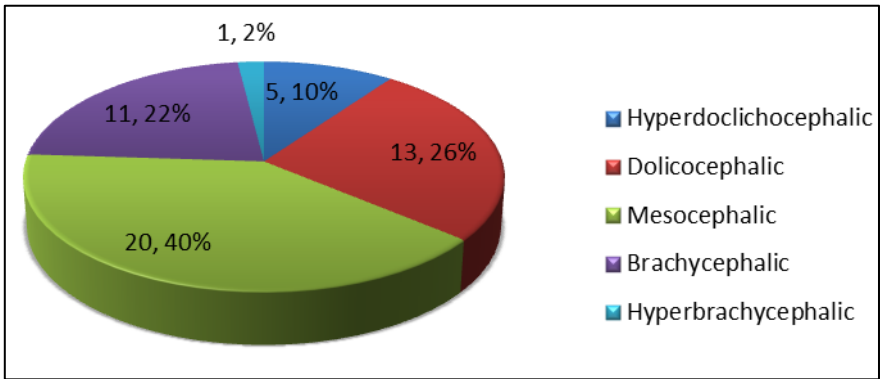

Fig 3: Classification of cranium according to Cranial Index

With reference to the classification of cranium according to cephalic system by Farkas and Sicher H et al[11,12], in the present study, 20.4% belong to Brachycephalic and 13.26% belonged to Mesocephalic groups.

Table 3:Correlation between Cranial Index and Facial anthropometry

		CI	UFH	MFH	WF	WFO
CI	Pearson Correlation	1	.087	.206	.298*	.170
	Sig. (2-tailed)		.547	.151	.036	.238
UFH	Pearson Correlation	.087	1	-.037	.131	.221
	Sig. (2-tailed)	.547		.801	.365	.123
MFH	Pearson Correlation	.206	-.037	1	.138	-.020
	Sig. (2-tailed)	.151	.801		.341	.892
WF	Pearson Correlation	.298*	.131	.138	1	.512**
	Sig. (2-tailed)	.036	.365	.341		.000
WFO	Pearson Correlation	.170	.221	-.020	.512**	1
	Sig. (2-tailed)	.238	.123	.892	.000	
*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).						

The study shows that there is a significant positive correlation between width of face and Cranial index. Other parameters are not significantly correlating with each other. They are variable independently.

Table 4:Correlation between Cranial Index and Facial anthropometry

		(UFH+MFH)/WC	CI
FSI= (UFH+MFH)/WC	Pearson Correlation	1	-.265
	Sig. (2-tailed)		.063
CI = WC/LC	Pearson Correlation	-.265	1
	Sig. (2-tailed)	.063	
		WC	**UFH+MFH**
WC	Pearson Correlation	1	.328*
	Sig. (2-tailed)		.020
UFH+MFH	Pearson Correlation	.328*	1
	Sig. (2-tailed)	.020	
* Correlation is significant at the 0.05 level (2-tailed).			

From the table 4, it is observed that the FSI (Facial Skeletal Index) is inversely proportional to CI (Cranial Index). Width of the cranium is directly proportional to the sum of upper and middle facial heights.

Discussion

Most of the earlier researchers have suggested developing a cranial and facial indices for our population, in order to obtain local data about classification ranges. There are many dissimilarities in cephalic and facial indices among the race , ethnicity and population groups. Such dissimilarities are also known to occur between various geographical and ethnic groups. This is because the growth of the human skeleton is under the influence of several factors; among them are hormones, nutritional status, cultural differences and environmental factors[13-17].To assess both the head and the face, measurements can be conducted that yield cranial and facial classification, using indices associated with growth patterns, which make orthopedic and/or orthodontic diagnosis and treatment planning easier.In this present study the skulls were obtained without the information of gender. The anthropometric study did not imply any influence on determination of sex. The study by Anil Kumar (2013) showed that the absolute sex differences seldom exist, there are some distinct differences observed in the cranial features of the male and female crania for given a population.In the present study the mean cranial length is 17cm, mean width of the cranium is 13.4 cm. The mean cranial index is 76.8. Study by Anil Kumar showed that, in Males' cranial length ranged from 16.2 cm to 19.7 cm with mean of 17.76±0.78 and cranial breadth from 12.1 cm to 13.9 cm with mean of 13.08±0.40. In female's cranial length ranged from 15.7cm to 18.3 cm with mean of 16.91±0.74 and cranial breadth ranged from 11.7 cm to 14.3 cm with a mean of 12.69 ±0.60. The mean cephalic index was higher in females compared to males in the present study. Among the male skulls, the mean cephalic index recorded to be 73.75±3.56 whereas in females it was 75.22 ± 5.15[14].Depending upon cranial index the types of head shapes were classified as given by Williams et al, 1995[12].The cranial index [dolichocephalic (index ≤ 75.9%), mesocephalic (between 76% - 81%), and brachycephalic (≥81.1%)] were determined.

In India, according to Mahajan A the brachycephalic type prevails. The present study shows that most (40%) skulls were mesocephalic, followed by dolicicephalic (26%), and brachicephalic (22%).The study by Kiran V et al on growing children, showed that Indian population presents mesocephalic index (77.92%) in males and brachycephalic index (80.85%) in females [17], while Poland children were brachycephalic (81.45%), as Japanese population In Iran, 38.6% were eurypro scopic and 38% brachycephalic[18-20].The mean cephalic index in the present study is 76.8, comparatively these following previous studies Shah GV jadhav , mean values of cephalic index is 80.42, Mahajan et al mean is 81.34, and Anitha MR et al mean is 79.14 have more mean values than the present study. In the study by Praveen Kumar Doni.R mean Cephalic index was 76.48 and facial index mean was 90.95[23]. In the study by Singh and Purkait[24]mean is 82.5, and 85.1 in Dangi of Khurai block of MP. Shetti R mean is 87.19[25].It was observed that the maximum head length and facial index were not found to have any significant relation with the studied group. The cephalic indices of Gujarati samples were 77.207±0.177 which is greater in comparison to the average Non-Gujarati index 74.133±0.4242. It was concluded that dominant head types in Gujarati males was Mesocephalic (40.2%) followed by Dolicocephalic (39.8%). In females the dominant head types was Dolicocephalic (42.7%) followed by Mesocephalic (42.2%).The mean cephalic index of Gujarati was 77.2, whereas Dr. H.R.Jadav et al[26], who studied on cephalic index of 180 males, was 80.20. Shah GV et al[16]worked for cephalic index on 500 (302 male, 198 female) medical students of Gujarat aging 17-23 years only and concluded them to be brachycephalic with 80.81 index. Kasai et al (1993) reported that dietary habits have been also shown to influence the craniofacial form of a population. In his study dominant type was Dolicocephalic (53.33%) and Mesocephalic (42.22%), followed by 2.22% Brachicephalic and Hyper brachicephalic in male skulls whereas in female crania majority were Mesocephalic (62.85%), 31.42% of Dolicocephalic, with 2.85% each Brachicephalic and Hyperbrachicephalic[21-26].

Rathee et al (2014) reported in north Indian Haryanvi population that the most of the crania in both sexes were Mesocephalic (53.33% male and 62.85% female) followed by Brachycephalic (42.22% male and 31.42% female[27].In the study by Anil Kumar (2013) on north Indian population, the mean cephalic index in males was 73.75 and in females 75.22. The dominant head shape was Mesocephalic in female (62.85%) and Dolicocephalic in male crania (53.33%)[15]

In the present study, the mean Upper facial height(UFH) is 4.6 cm, the mean middle facial height(MFH) is 1.8 cm, the mean width of forehead(WFo) is 11.4 cm and the mean facial width(WF) is 12.2cm. The mean facial skeletal index(FSI) is 53. The study conducted on 81 Malay people by Tahamida Yesmin et al., showed the mean morphological facial height as 111.9±8.4 and morphological facial width was 127.3±8.0. The range of facial index was 67.44–106.90 for males and 75.21–97.99 for females[28].Mean Morphological facial length 11.07, Bizygomatic breadth 13.08, Facial index 86.09[29].In the present study there was no significant correlation between cephalic and facial anthropometric parameters. There is a significant positive correlation between width of face and Cranial index. Other parameters are not significantly correlating with each other. They are variable independently. Width of the cranium is directly proportional to the sum of upper and middle facial heights. In a similar study regarding the relationship between facial and cranial indices, 21.4% (67/313) of the infants were dolichocephalic and leptoprosopic, 21.1% (66/313) were mesocephalic and leptoprosopic, and 11.5% (36/313) were brachycephalic and mesoprosopic. The author concluded that there is no agreement between the cranial and facial anthropometry[30].Facial parameters like fWHR (Bizygomatic width divided by upper facial height) is measured as 2.65, which has been shown to predict aggression deception and untrustworthiness but also more positive behaviors such as achievement striving and self sacrifice towards the in-group.In whites, obstructive sleep apnoea (OSA) was associated with a higher CI (indicating a greater tendency towards brachycephaly)

and a shorter facial height. In contrast, neither the CI or the FI varied with OSA among the African-Americans[31].

Conclusion

The study carried out is to determine the cranio-facial symmetry and correlation among the anthropometric measurements of different cranial and facial parameters. With the above results it is concluded that, there is direct correlation among the measurements of cranial and facial skeleton. So the cranial and facial index would be within the specific range for the defined population. There is no significant correlation between the measurements of cranial with facial skeleton. They vary independently, which explains different morphology of face and head.The mean values, ratios and indices established for the various vertical and horizontal measurements can be used to determine cranio-facial variations in the South Indian population. This analysis can be used by clinicians, forensic experts and orthodontist for their clinical correlations and applications in the management of various conditions.

Summary

Various studies are being done on anthropometric evaluation of face and cranium in different conditions like dry bone, live individuals and cadavers of different region, population, ethnicity and race. In this study, the anthropometrical data in dry skulls of south Indian origin have been collected and compare it with some of the previous studies conducted in same and different region and population. The mean, standard deviation and range are calculated for the data will be useful for the future studies and clinical application.

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