Section: Anatomy

Original Research Article

FACIAL SOFT TISSUE THICKNESS IN FORENSIC FACIAL RECONSTRUCTION USING MRI IN SOUTH EAST INDIAN POPULATION

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ABSTRACT

Background: Identification of human remains has been a major problem for the medico-legal system. There are many instances of human remains where the only remains available for identification will just be a skull. Forensic facial reconstruction is the process of recreating the face from the skeletal remains of an individual whose identity is unknown. Facial reconstruction includes the combined use of artistry, forensic science, anthropology, osteology and anatomy. Ultrasonography, CT, CBCT, and MRI have been used for facial reconstructions and facial soft tissue thickness measurements in the literature. The facial soft tissue thickness of South east Indian population using MRI have not been documented in the literature till date. **Aims & Objectives:** The present study was aimed to measure the facial soft tissue thickness in different anatomical landmarks to establish baseline data that may help in forensic facial reconstruction and in the other facial reconstructive procedures in South East Indian population.

Material and Methods: The study consisted of 60 MRI images of southeast Indian adults between ages of 18 and 70 years during the period from March 2021 to October 2021. The age and gender of the subjects were collected before the examination and ascertained all were representatives of racially and socially homogenous population, MRI images has been utilized to measure the 12 different landmarks in mid facial region. Radi Ant DICOM Viewer (64 bit) software was used to measure soft tissue thickness.

Results: Facial soft tissue thickness is more in males than females in many anatomical landmarks. There was significant differences noted between soft tissue thickness values among the different age groups.

Conclusion: Our compiled data set of FSTT is important in understanding craniofacial characteristics of southeast Indian population. The data achieved in the present study can be used for the forensic facial reconstruction and in the other facial reconstructive procedures.

Keywords: Facial soft tissue thickness, MRI, Forensic facial reconstruction.

INTRODUCTION

All objects in the universe are unique. No two things that happen by chance ever happen in exactly the same way. No two things are ever constructed or manufactured in exactly the same way. No two things wear in exactly the same way. No two things ever break in exactly the same way." — Joe Nickell

Identification of human remains has been a major problem for the medico-legal system.[1] There are many instances of human remains where the only remains available for identification will just be a skull. Detailed examination of recovered unknown skeletal remains answers the questions about basic characteristics such as sex, age and ethnicity and overcome traumas. Studying the unknown skeletal

remains mostly becomes the only way to find out more information about individual characteristics, which could lead to identification of potential victim. If there is no clue for potential identity the most precise comparative techniques fail, because of impossibility to compare questioned remains with possible familiar material. In such cases one of the last options is to recreate ante mortem appearance by facial reconstruction.[1]

Facial reconstruction includes the combined use of artistry, forensic science, anthropology, osteology and anatomy. It is most useful for probable facial recognition by reconstructing the contours of the skull's soft tissues where only skulls are found. The morphology of the skull is sufficiently distinctive and provides an efficient frame for unique facial appearance. Even small variations in the shape, form and proportions of the skull leads to significant variation in facial appearance. Utilizing this presumption, reconstruction of face can be carried out even by applying the average facial soft tissue thickness.[2]

Since the 19th century, different methods have been used for facial reconstruction ; 2D and 3D reconstructions and facial soft tissue thickness measurements have been commonly used.[3] The facial soft tissue thickness is measured using various techniques: needle puncture , which is applied on cadavers ; Ultrasonography ; Magnetic resonance imaging (MRI) ; Computed tomography (CT) and Cephalometry wherein the relationship between the bone and soft tissue surface of the entire face can be recorded in a single image.[3]

To the best of our knowledge, data on the facial soft tissue thickness of South Indian adults have not been documented. Therefore, the present study was aimed to measure the facial soft tissue thickness in different anatomical landmarks to establish baseline data that may help in forensic facial reconstruction and in the other facial reconstructive procedures.

MATERIALS AND METHODS

General procedure

The present study is based on measuring soft tissue thickness at various well established anthropological landmarks. The study consisted of 60 MRI images of southeast Indian adults between ages of 18 and 70 years, who visited the Department of General Radiology, Nellore, India, for MRI of brain needed for diagnostic purposes. The data was collected during the period from March 2021 to October 2021.The subjects with trauma of the head or any other pathology which could possibly distort the normal facial features were excluded from the study. The age and gender of the subjects were collected before the examination. As far as could be ascertained all were representatives of racially and socially homogenous population, drawn to southeast Indian state which was confirmed from the history of their forefathers. The subjects were divided into three age groups.

Discrete MRI sections

The following sections of MRI of head were selected to take Facial soft tissue thickness at 12 standard landmarks:

Section 1: A midsagittal section, the landmarks from above downwards and forwards were vertex, supraglabella, glabella, nasion, end of nasalmidphiltrum, upper lip margin, lower lip margin, chin lip fold, mental eminence; from above backwards and downwards –opisthocranion. [Figure 1]

Section 2: Parasagittal sections at the level of mid orbit on one side. The landmark was frontal eminence. [Figure 2]

Statistical Analysis

RadiAnt DICOM Viewer (64 bit) software was used to measure soft tissue thickness. All collected data was analyzed using SPSS 2.0software. The mean, standard deviation (SD) and range were calculated for all the landmarks. Data was classified by differences between age and gender. Independent t-test and one-way analysis of variance (ANOVA) were used for statistical analysis.

RESULTS

Our study demonstrated that there was significant difference in soft tissue thickness between men and women in the age group of 18-24. Soft tissue thickness in men was significantly more than women except in vertex, chin lip fold, mental eminence and frontal eminence. In the age range of 25-45 years old, some thickness of soft tissue land marks including mid philtrum, opisthocranion showed significant difference between men and women. In other landmarks, there was no significant difference between two genders. Furthermore, in age range of≥ 46 years old, soft tissue thickness in landmarks of vertex, chin lip fold, mental eminence, midphiltrum, upper lip margin, lower lip margin, opisthocranion showed significant difference between men and women. [Table 1 and 2]

The comparison between age groups among males showed significant difference in the soft tissue landmarks including vertex, chin lip fold, mental eminence, mid-philtrum, frontal eminence and glabella. The comparison between age groups among females showed significant difference in the soft tissue landmarks including lower lip margin and the frontal eminence. [Table 1 and 2] Comparison between genders showed very high significant difference in the soft tissue landmarks including mid-philtrum and the upper lip margin and significant difference in the soft tissue landmarks including supraglabella, end of nasal, lower lip margin and mental eminence. [Table 3]

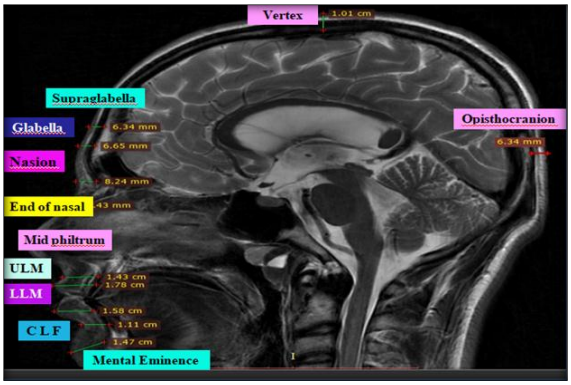

Figure: 1, A midsagittal section, the landmarks from above downwards and forwards were vertex, supraglabella, glabella, nasion, end of nasal mid philtrum, upper lip margin, lower lip margin, chin lip fold, mental eminence; from above backwards and downwards –opisthocranion

Figure 2: Parasagittal sections at the level of mid orbit on one side showing landmark of frontal eminence

Table 1: The comparison between age groups among males showed significant difference in the soft tissue landmarks including vertex, chin lip fold, mental eminence, mid-philtrum, frontal eminence and glabella

(A) Males	18 - 24		25 - 45		≥ 46		p -value
Landmarks	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	
Vertex	5.8	0.5	7.7	1.8	8.0	1.1	.020
Chin lip fold	7.8	1.4	10.8	1.6	11.5	1.8	.001
Mental eminence	9.2	1.2	13.9	3.4	14.07	2.7	.005
Mid philtrum	10.2	0.9	12.9	2.05	13.7	2.6	.012
Frontal eminence	7.09	1.5	9.7	2.1	9.8	1.1	.007
Glabella	5.3	0.8	6.3	1.01	6.2	1.1	.069
Supraglabella	5.4	0.3	5.6	0.87	5.9	0.5	.474
Nasion	11.8	1.6	10	2.5	11.1	1.9	.235
End of nasal	3.6	0.5	3.6	0.4	4.4	1.2	.062
Upper lip margin	12.5	0.8	12.9	2.6	14.6	1.6	.087
Lower lip margin	12.6	1.6	14.7	2.6	15.2	2.8	.139
Opisthocranion	6.9	1.2	6.4	1.0	7.9	1.8	.050

Table 2: the comparison between age groups among females showed significant difference in the soft tissue landmarks including lower lip margin and the frontal eminence

(B) Females	18 - 24		25 - 45		≥ 46		p value
Landmarks	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	
Vertex	5.9	1.1	7.9	2.2	6.6	2.8	.131
Chin lip fold	9.05	1.5	10.4	1.07	9.7	2.9	.308
Mental eminence	11.05	2.5	12.8	1.8	10.5	1.9	.142
Mid philtrum	9.5	1.3	10.6	1.6	9.0	1.8	.143
Frontal eminence	7.3	1.7	10.6	1.4	8.1	2.2	.002
Glabella	5.5	0.7	6.2	1.5	5.8	0.6	.365
Supraglabella	5.2	0.6	5.8	1.2	4.9	0.4	.111
Nasion	9.4	2.6	10.4	1.4	10.9	1.4	.248
End of nasal	3.3	0.4	3.6	0.4	3.7	0.13	.055
Upper lip margin	9.8	3.12	11.3	1.3	9.9	2.05	.387
Lower lip margin	11.5	3.1	15.4	0.86	11.9	2.8	.007
Opisthocranion	6.3	1.4	7.8	2.2	5.7	1.4	.050

Table 3: Comparison between genders showed very high significant difference in the soft tissue landmarks including mid-philtrum and the upper lip margin. It also showed a significant difference in the soft tissue landmarks including supraglabella, end of nasal, lower lip margin and mental eminence

Gender		Vertex	Supra glabella	Glabella	Nasion	End of nasal	Midphiltrum	Upper lip margin	Lower lip Margin
M	N	30	30	30	30	30	30	30	30
	Mean	7.4717	5.7247	6.2370	10.8350	3.9760	12.7180	13.5130	14.4947
	Std. Deviation	1.62675	.68454	1.11476	2.25631	.91793	2.44210	2.21303	2.64834
	Minimum	4.79	4.44	4.53	6.05	2.99	8.56	9.50	8.00

	Maximum	10.90	6.97	8.43	14.50	7.41	16.90	17.80	18.50
	Range P VALUE	6.11 .086	2.53 .036	3.90 .102	8.45 .215	4.42 .27	8.34 .000	8.30 <0.001	10.50 .000
F	N	30	30	30	30	30	30	30	30
	Mean	6.6137	5.3107	5.7937	10.1203	3.5443	9.6730	10.2113	12.3157
	Std. Deviation	2.14538	.80600	.94542	2.15580	.49137	1.63462	2.51185	3.13940
	Minimum	3.67	4.23	4.25	4.25	2.24	7.90	6.03	6.97
	Maximum	11.50	7.60	8.30	12.70	4.57	12.60	14.90	16.80
	Range P VALUE	7.83 .087	3.37 .036	4.05 .102	8.45 .215	2.33 .28	4.70 <0.0001	8.87 .000	9.83 .005
Total	N	60	60	60	60	60	60	60	60
	Mean	7.0427	5.5177	6.0153	10.4777	3.7602	11.1955	11.8622	13.4052
	Std. Deviation	1.93654	.77021	1.04887	2.21732	.76172	2.56944	2.87748	3.08203
	Minimum	3.67	4.23	4.25	4.25	2.24	7.90	6.03	6.97
	Maximum	11.50	7.60	8.43	14.50	7.41	16.90	17.80	18.50
	Range	7.83	3.37	4.18	10.25	5.17	9.00	11.77	11.53

DISCUSSION

Since 19th century till date, physical anthropologists or forensic scientists all over the world have been collecting data on facial soft tissue thickness by adopting various techniques.[4] For the purpose of individual identification, forensic facial reconstruction is an attempt to reproduce a likeness of facial features of an individual, based on characteristics of the skull.1,Earliest procedure being needle depth method which has its inherent errors including inaccuracy in locating landmarks superficially through palpation and shrinkage of tissue after death, making it impossible to measure tissue depth correctly. Some authors used lateral cephalometric radiographs to collect data in the living.[5-8] Lebedinskaya et al,[9] initiated the use of ultrasound for measuring Facial soft tissue thickness. Ultrasound suffers from subjective errors of variation in the angulation of ultrasound probe with bone. Also ultrasonic determination of Facial soft tissue thickness requires extensive training in the use of ultrasound equipment and an accurate interpretation of the films.[5] Phillips et al,[10] used axial computed tomography scans to measure Facial soft tissue thickness in south African population of mixed race. CT scans also did not become popular because the procedure involved the risk of radiation exposure to subjects.[5,10]

The use of magnetic resonance imaging [MRI] has been strongly advocated in measuring facial soft tissue thickness.[5,11] Surveys about facial soft tissue thickness are increasing and they differ from each other by the selection of imaging techniques and level of statistic evaluation.[12] No agreement exists upon the number of chosen landmarks, name, and correct position of the landmarks. Variable authors call the same landmarks in different ways.[13] Degeef et al,[14] described the anatomical landmarks used for soft tissue depth measurement as follows: Midline Landmarks include Supraglabella, Glabella, Nasion, End of Nasal – Junction, Mid-philtrum, Upper lip margin, Lower lip margin, Chin –lip fold, , Mental Eminence and Bilateral landmarks include Frontal eminence, Lateral glabella, Lateral nostril, Naso-labial ridge, Supracanina, Subcanina, Supraglenoid, Zygomatic arch, Lateral orbit, Supra-M2 - Cheek region, lateral: lined up with nasal base; vertical: lined up beneath lateral border of the eye, Mid-masseter - Middle of the masseter, the halfway point between the supraglenoid and the gonion occlusal line - Border of the masseter, on vertical level of the cheilion, Sub-M2 - Below the second molar on horizontally lined up with supra-M2, Gonion, Mid-mandibular angle. In this study all the midline landmarks were measured and frontal eminence, a bilateral landmarks was measured unilaterally. MRI scans of the head are acquired as a series of two dimensional slices stored in digital form for facial soft tissue reconstruction. Sahni et al,[5] noted the advantages of MRI over other methods; it is multiplanar modality and scanning planes can be adjusted at any plane unlike CT scans which take usually transverse sections. The inherent soft tissue contrast in MRI is far superior to what is offered by CT. Hence we measured Facial soft tissue thickness on MRI images.

Sexual Dimorphism: Sexual dimorphism was marked in the present study. Craniofacial morphology is a complex interaction between inheritance and environment factors, therefore it is important to collect data from geographically distinct populations. In our study mid-philtrum, upper lip margin, supraglabella, end of nasal, lower lip margin and mental eminence showed significantly greater values in men than women. Previous studies among different populations have reported sexual dimorphism with greater facial soft tissue in men,[4,5,15] which was in accordance with present study.

Age: As humans age, the facial features undergoes many changes that we recognize as aging. Significant changes occur around the midface region by the fourth decade.[14] Wilkinson et al,[16] showed soft tissue thickness decreases in mouth and chin but increases around the eyes with aging.[16] Penenkova et al.[12] reported that in women, soft tissue thickness in mid-philtrum decreased with aging and our study demonstrated the same.In the present study significant differences were noted between soft tissue thickness values among different age groups in which the thickness increased or thinned with the increased age. Although the individual age influence facial soft tissue thickness, individual weight also plays a significant role in the soft tissue thickness,[12] One of the limitations of our study is that weight of the subjects were not included in the scope,

Racial differences: The mean soft tissue thickness values were varied significantly among Brazilian,[17] Iranian,[4] Slovok,[12] Portuguese,[18] Turkish,[19] population when compared with the values obtained in our study, supporting that geographic proximity between population groups doesn't necessarily mean similar soft tissue depths.Stephan et al,[20] stated that the population differences that do exist are likely overpowered by the differences caused between different measurement methods, meaning that linked to the limited tissue thickness data is the lack of a standard method for determining these tissue thickness values and approximating facial features. Using different measurement methods, each with its own advantages, disadvantages and measuring errors, contributes to the variation that occur in soft tissue thickness data, since if affects the magnitude and accuracy of the obtained values, as well as the confidence with which the values can be regarded as accurate.[21] Studies revealed that with strict adherence to the traditional tissue depths of white Europeans and racial origin, the accuracy of the facial approximation was compromised. Wilkinson et al,[16] suggested that strict adherence to the exact tissue depths should be avoided and that the morphology of the skull and the anatomy should be followed with tissue depth measurements being used only as guides.

CONCLUSION

In conclusion, this study provides the facial soft tissue thickness of southeast Indian adults from measurements obtained through MRI scans. General descriptive analysis was performed including considerations of age and gender of the individuals. The 6 out of 12 landmarks showed sex based differences where the males have thicker facial soft tissue thickens. The results of the present study suggest the significant difference in facial soft tissue thickens of southeast Indian adults compared to Northwest India, Slovak, Turkish, Portuguese and Brazilian population. Through this study we have provided the base line data set on Facial soft tissue thickness of southeast Indian population which is valuable information for Facial reconstruction.

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