RADIOGRAPHIC ASSESSMENT OF FACIAL SOFT TISSUE THICKNESS ON LATERAL CEPHALOGRAM IN YOUNG ADULT

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Abstract

Aims: The aims of present study are: 1.To assess Facial soft tissue thicknesses for males and females of different skeletal classes on Lateral cephalograms.2.To assess any possible correlation between Facial soft tissue thicknesses, gender and skeletal classes.3.To assess any possible correlation between Facial soft tissue thicknesses and Body Mass Index.

Materials & methods: Sample included patients reported to department of Orthodontics. Total sample of 200 patients including 100 males and 100 females was taken. Body mass index (BMI) of each individual was calculated and soft tissue thickness at different facial points was measured from lateral cephalograms.

Results and conclusion: Facial soft tissue thickness (FSTT) was significantly different among class I, II and III females for point Sn. Highly significant positive correlations between FSTT and BMI were obtained for points G, Lm, Po, Gn in males while in females, significant correlations were observed at points G, Na, Lm and Po.

Keywords: Body mass index, soft tissue, ultrasound, facial reconstruction.

Introduction

In cases of unknown dead, especially when skeletonized remains are concerned, conventional identification techniques such as DNA analysis, comparisons of fingerprints and dental records can be scarcely used.[1] In such scenarios, facial reconstruction (FR) maybe useful for the identification of unidentified decedents. Therefore, detailed information obtained from the physiological and osteological analysis of the remains along with sex, age and population-specific data on facial soft tissue thicknesses may promote the success of this approach.1 Variations in thickness, length, and tonicity of the soft tissues may affect the position of and the relationships among the facial structures thereby affecting facial esthetics.[2] The facial STTs are of importance for plastic surgeons and orthodontists in the planning of treatment procedures. Vanezis[3] defines markers of facial soft tissue thickness as lines projecting from cranial landmarks to facial landmarks. The length of these lines corresponds to the thickness of the soft tissue at that particular location.

Established methods for measuring FSTT include physical evaluation through puncture and through imaging techniques like conventional radiographs, Computer Tomography (CT) Imaging, Ultrasound, Magnetic Resonance Imaging (MRI), Cone Beam Computer Tomography (CBCT).[4] FSTT had been carried out in various races using cadavers through puncture. The accuracy of this method is questionable due to an inherent error, mainly because of degree of dehydration of human soft tissue which is marked during initial stages, the possibility of inaccurate positioning of the probe and difficulties in finding the correct underlying bone sites. Also, the hardness of the skin of cadaver can hinder the ability to perform accurate manual palpations during measurements. Moreover, these difficulties are compounded by limited numbers of suitable specimens representing individual ethnic groups and the time consuming nature of the methodology. Imaging-based methods which obtain measurements on living subjects are unquestionably a better approach and benefit from the availability of a much larger population of subjects and much greater accuracy.[5]

FSTT also depends on a number of factors like age, sex, BMI, occlusion and facial profile. Although examination of the skull can determine age, sex & ancestry, soft tissue characteristics such as nose profile, ear profile, eyelid shape and mouth profile are difficult to establish from skull profile alone. On the other hand, though facial profile i.e. convex, concave, or straight, equating to skeletal class II, III, is relatively easy to assess from the skull, it is not surprising that there are differences in soft tissue thickness among skeletal classes.[7] In the lower face region, measurement variation was observed in previous studies explained by the influence of skeletal class. As skeletal classes are defined according to the relationship between the maxillary and mandibular position, they are naturally influenced by factors that inhibit or boost the growth of these bones. It seems reasonable that factors that influence bone might also affect soft tissue thickness. [8]

A decrease in nutrition leads to smaller STTs, except for the tissues around the eyes, which could be due to the lack of subcutaneous fat in this area. It has been established that the "malar fat pad" is the thickest facial zone followed by the "premental fat pad", whereas the fat tissue in the forehead zone is almost non-existing.[9] The STTs located in the areas around the mandible and cheeks are the first to alter along with changes in body weight. Furthermore, the STTs located in the facial region with highest fat concentration increase proportionally with the increasing BMI.

Many authors [10] have reported significant sex differences in the midline landmarks. Dumont et al[11] reported soft tissue thickness classified by dental occlusion, while Starbuck et al[12] and Claes[13] reported soft tissue depth variation with body weight and body mass index (BMI). The present study was planned to estimate FSTT in Panchkula population using digital lateral cephalograms and to evaluate possible variations of FSTT with gender, skeletal classes & body mass index.

Aims & objectives

The aim of the present study was to assess facial soft tissue thickness from Lateral Cephalogram in young adults and to correlate possible variations with gender, skeletal classes & body mass index.

The objectives of the study were

- To assess Facial soft tissue thicknesses for males and females of different skeletal classes on Lateral cephalograms.
- To assess any possible correlation between Facial soft tissue thicknesses, gender and skeletal classes.
- To assess any possible correlation between Facial soft tissue thicknesses and Body Mass Index.

Materials and methods

Study samples were collected from consecutive patients presenting with orthodontic complaints and malocclusion between January 2017 to February. The study population consisted of 200 subjects divided into 2 groups:
Group 1: Males within 18-25 years of age (n=100)
Group 2: Females within 18-25 years of age (n=100)
Patients with facial fractures and syndromes of craniofacial anomalies of those having undergone orthognathic / orthodontic treatment were excluded from the study.
For the study, we used a Planmeca Proline Digital Panoramic Radiography Unit (PLANMECA, Finland), along with the Planmeca Romexis software 2.6.0.R. The Carestream Dry View 5700 laser imager was also used to study the Carestream Laser Imaging Films-(8X10 inch).
After obtaining the written informed consent from the patients (Annexure II, III) complete examination of the subject was done. Patients' representative of a racially and socially homogeneous population was taken. Body weight of the subjects was recorded to the nearest 0.1 kg using a digital weighing scale with patients wearing lightweight clothing and no shoes. Three measurements were taken consecutively, the average value was calculated and recorded. Body mass index was calculated as follows:
BMI=W/H2,W-Weight in kg;H-Height in meters.
The subjects were categorized according to their BMI values into the following categories as Underweight (≤ 18.5 kg/m2) ; Normal weight(=18.5–24.9 kg/m2); Overweight (=25–29.9kg/m2) Obesity (= BMI of 30kg/m2 or greater).

Measurement of soft tissue thickness with the help of anatomical landmarks:

A training exercise with the supervisors was carried out to standardize the measurement technique. The soft tissue thickness were measured at the following 10 facial anatomical points, as described above: (1) glabella (2) nasion (3) rhinion (4) subnasale (5)labralesuperius (6) stomion (7) labraleinferius (8) labiomentale (9) pogonion (10) gnathion. The FSTT at various anatomic landmarks was recorded as the Euclidean distance between the bony landmark and itshomologous cutaneous landmark. These distances were measured perpendicular to the bony surface except at subnasale, stomion, labralesuperius, labraleinferius, where the distance was measured as per the definition. The linear and angular measurements were entered into the proforma. The data was tabulated and subjected to statistical analysis. Descriptive data were expressed in mean ± SD. Frequencies were expressed in percentages or numbers. The variation between means of groups was estimated using Independent samples test. Comparison of frequencies between the groups was done by Chi-square test. Comparison of multiple variables was done by one-way ANOVA analysis, followed by post Hoc analysis. Correlations between parameters were estimated using Spearman's correlation. Intra-observer variability was assessed using intra class correlation and determining internal consistency using Cronbach's alpha. Software used for statistical analysis was SPSS (Statistical Package For Social Sciences),version 22.0 (Chicago, USA).

Results

Comparison of ANB angle, 10 FSST landmarks between the study groups:

When the soft tissue thicknesses at various points were compared between the groups by Independent samples test, highly significant differences (with higher values being recorded in males) were found for Na [$t(198) = 3.78, p < 0.001$], Rh [$t(198) = 3.5, p < 0.001$], Sn [$t(198) = 6.64, p < 0.001$], Ls [$t(198) = 7.77, p < 0.001$], S [$t(198) = 6.79, p < 0.001$], Li [$t(198) = 7.54, p < 0.001$], Po [$t(198) = 2.85, p = 0.005$] and Gn [$t(198) = 5.11, p < 0.001$].

Comparison of Facial soft tissue thickness in males & females according to BMI category:

Gender		Overjet	Overbite	ANB Angle	G	Na	Rh	Sn	Ls	S	Li	Lm	Po	Gn
Male	Mean	2.47	2.46	3.42	5.93	6.33	1.76	15.61	14.26	6.26	15.01	11.81	12.43	6.83
	Std. Deviation	1.92	1.18	2.09	1.15	1.53	0.65	2.73	2.08	2.01	1.69	1.89	2.29	1.91
	Minimum	-1	1	-4.19	3.5	3.4	0.5	6.8	8.6	2.0	11	7.8	4.7	2.3
	Maximum	10	8	8.46	8.9	11.3	3.5	21.5	19.0	12.0	21	16.7	18.8	12.6
Female	Mean	2.57	2.78	4.01	5.79	5.56	1.46	13.14	11.93	4.41	13.04	11.45	11.51	5.56
	Std. Deviation	2.14	1.31	2.70	1.21	1.36	0.57	2.52	2.16	1.84	1.97	1.61	2.29	1.59
	Minimum	-2	1	-7.09	2.9	2.1	0.4	5.2	6.8	0.4	6	7.1	5.4	2
	Maximum	10	6	10.50	8.5	9.2	2.7	17.1	17.5	9.2	18	15.7	17.8	9.2
Total	Mean	2.52	2.62	3.72	5.86	5.94	1.61	14.37	13.10	5.33	14.02	11.63	12	6.2
	Std. Deviation	2.03	1.26	2.43	1.18	1.50	.63	2.90	2.41	2.14	2.08	1.76	2.33	1.87
	Minimum	-2	1	-7.09	2.9	2.1	0.4	5.2	6.8	0.4	6	7.1	4.7	2
	Maximum	10	8	10.50	8.9	11.3	3.5	21.5	19.0	12.0	21	16.7	18.8	12.6

Table 1: Descriptive data of overjet, overbite, ANB angle, FSST at 10 landmarks in study groups

Underweight category: The mean soft tissue thickness in males in underweight BMI category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 5.7 ± 0.8, 6.55 ± 1.11, 1.84 ± 0.63, 15.95 ± 2.27, 14.78 ± 1.30, 6.44 ± 1.77, 15.07 ± 1.44, 11.19 ± 1.52, 11.08 ± 2.49 and 6.10 ± 1.32mm respectively. The mean soft tissue thickness in females in underweight BMI category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 5.76 ± 1.22, 5.05 ±1.74, 1.50 ±0.42, 13.12 ± 2.32, 11.05 ±1.81, 3.99 ±1.51, 12.99 ± 1.87, 11.06 ±1.62, 10.64 ± 1.79 and 5.01 ± 1.65 mm respectively.

When the differences between underweight Group 1 & 2 subjects were analysed statistically by Independent samples t test, highly significant differences were found for FSTT at points Na[t(32) = 3.01, p = 0.005], Sn [t (32) = 3.6, p < 0.001], Ls[t (32) = 6.9, p < 0.001], S [t (32) = 4.33, p < 0.001], Li [t (32) = 3.63, p < 0.001], while significant difference was found at Gn[t (32) = 2.57, p = 0.015].

Normal weight category: The mean soft tissue thickness in males in normal BMI category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 5.61 ± .90, 6.02 ± 1.50, 1.82 ± 0.67, 15.58 ± 2.50, 13.77 ± 2.35, 6.11 ± 2.27, 15.08 ± 1.73, 11.50 ± 1.77, 12.05 ± 2.15, 6.44 ± 1.64mm respectively. The mean soft tissue thickness in females in normal BMI category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 5.71 ± 1.26, 5.67 ± 1.23, 1.47 ± 0.58, 13.29 ± 2.38, 12.10 ± 2.15, 4.51 ± 2, 12.98 ± 2, 11.24 ± 1.41, 11.49 v 2.23, 5.59 ± 1.65 mm respectively.

When the differences between normal weight Group 1 & 2 subjects were analysed statistically by Independent samples t test, highly significant differences were found for FSTT at points Rh [t (116) = 3.05, p = 0.003], Sn [t (116) = 5.088, p < 0.001], Ls[t (116) = 4.04, p < 0.001], S [t (116) = 4.07, p < 0.001], Li [t (116) = 5.98, p < 0.001], and Gn[t (116) = 2.78, p = 0.006].

Overweight: The mean soft tissue thickness in males in overweight BMI category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 6.65 ± 1.66, 6.89 ± 2, 1.49 ± 0.50, 16.45 ± 2.62, 15.11 ± 1.53, 6.31 ± 1.92, 14.92 ± 2, 12.41 ± 1.73, 13.89 ± 1.78, 7.86 ± 2.26mm respectively. The mean soft tissue thickness in females in overweight BMI category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 5.96 ± 0.70, 5.31 ± 1.24, 1.36 ±0 .67, 12.33 ± 3.74, 12.12 ± 2.80, 4.49 ± 1.58, 13.14 ± 2.22, 12.26 ± 1.94, 12.75 ± 2.99, 5.75 ± 1.86mm respectively.

When the differences between overweight Group 1 & 2 subjects were analysed statistically by Independent samples t test, highly significant differences were found for FSTT at points Sn [t (30) = 3.64, p < 0.001], Ls [t (30) = 3.93, p < 0.001], while significant differences were found at points Na [t (30) = 2.38, p = 0.02], S [t (30) = 2.69, p = 0.012], Li [t (30) = 2.33, p = 0.027]and Gn [t (30) = 2.66, p = 0.012].

Obese: The mean soft tissue thickness in males in obese BMI category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 6.53 ± 0.54, 6.44 ±0 .83, 1.92 ± 0.75, 13.38 ± 3.83, 14.10 ± 2.10, 6.59 ± 1.16, 14.72 ± 1.40, 13.22 ± 2.53, 13.64 ± 1.58, 7.97 ± 2.14mm respectively.

When the differences between obese Group 1 & 2 subjects were analysed statistically by Independent samples t test, highly significant difference was found for FSTT at only point Sn [t (14) = 3.45, p = 0.004].

When the soft tissue thickness at different landmarks was compared in different BMI categories in males by one way ANOVA analysis, significant differences were observed between the various BMI groups for points G (p= 0.046), Sn (p=0.028), Lm (p=0.011), Po(<0.001) and Gn (p =0.002).

BMI	Gender (n)	G	Na	Rh	Sn	Ls	S	Li	Lm	Po	Gn
Underweight	Male (n=17)	5.7 ± 0.8	6.55 ± 1.11	1.84 ± 0.63	15.95 ±2.27	14.78 ± 1.30	6.44 ±1.77	15.07 ±1.44	11.19 ±1.52	11.08 ± 2.49	6.10 ± 1.32
	Female (n=17)	5.76 ± 1.22	5.05 ± 1.74	1.50 ± 0.42	13.12 ±2.32	11.05 ± 1.81	3.99 ±1.51	12.99 ±1.87	11.06 ±1.62	10.64 ± 1.79	5.01 ± 1.65
Normal Weight	Male (n=52)	5.61 ± 0.90	6.02 ± 1.50	1.82 ± 0.67	15.58 ±2.50	13.77 ± 2.35	6.11 ±2.27	15.08 ±1.73	11.50 ±1.77	12.05 ± 2.15	6.44 ± 1.64
	Female (n=66)	5.71 ± 1.26	5.67 ± 1.23	1.47 ± 0.58	13.29 ±2.38	12.10 ± 2.15	4.51 ±2	12.98 ±2	11.24 ±1.41	11.49 ± 2.23	5.59 ± 1.65
Overweight	Male (n=21)	6.65 ± 1.66	6.89 ± 2	1.49 ± 0.50	16.45 ±2.62	15.11 ± 1.53	6.31 ±1.92	14.92 ±2	12.41 ±1.73	13.89 ± 1.78	7.86 ± 2.26
	Female (n= 11)	5.96 ± 0.70	5.31 ± 1.24	1.36 ± 0.67	12.33 ±3.74	12.12 ± 2.80	4.49 ±1.58	13.14 ±2.22	12.26 ±1.94	12.75 ± 2.99	5.75 ± 1.86
Obese	Male (n=10)	6.53 ± 0.54	6.44 ± 0.83	1.92 ± 0.75	13.38 ±3.83	14.10 ± 2.10	6.95 ±1.16	14.72 ±1.40	13.22 ±2.53	13.64 ± 1.58	7.97 ± 2.14
	Female (n=6)	6.48 ± 1.38	6.20 ± 1.60	1.43 ± 0.79	13.02 ± 2.37	12.25 ± 1.76	4.25 ±1.56	13.68 ± 2.05	13.32 ± 1.71	11.87 ± 2.32	6.50 ± 1.16

Table 2: Facial soft tissue thickness in males & females according to BMI category

When the soft tissue thickness at different landmarks was compared in BMI categories in females by one way ANOVA analysis, highly significant difference was observed between the various BMI categories only for point Lm (p = 0.004). On further post Hoc analysis, highly significant differences were found in point Lm between normal & Obesity (p=0.012), obesity & underweight (p=0.015).

Comparison of Facial soft tissue thickness in males & females according to skeletal class category:

Skeletal Class I

The mean soft tissue thickness in males in skeletal class I category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 6.06 ± 1.34, 6.51 ± 1.52, 1.72 ± .63, 15.86 ± 2.11, 14.47 ± 2.20, 6.50 ± 1.95, 14.78 ± 1.52, 11.84 ± 1.95, 12.25 ± 2.29, 7.09 ± 2.04 mm respectively. The mean soft tissue thickness in females in skeletal class I category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 5.91 ± 1.30, 5.69 ± 1.54, 1.51 ± 0.56, 13.85 ± 1.92, 12.50 ± 1.97, 5 ± 1.86, 12.92 ± 1.71, 11.25 ± 1.09, 11.75 ± 2.20, 5.61 ± 1.62 mm respectively.

When the differences between Group 1 & 2 subjects of skeletal Class I category were analysed statistically by Independent samples t test, highly significant differences were found for FSTT at points Na[$t(96) = 2.66$, $p = 0.009$], Sn [$t(96) = 4.87$, $p < 0.001$], Ls [$t(96) = 4.61$, $p < 0.001$], S [$t(96) = 3.88$, $p < 0.001$], Li [$t(96) = 5.69$, $p < 0.001$] and Gn [$t(96) = 3.89$, $p < 0.001$].

Skeletal Class II

The mean soft tissue thickness in males in skeletal class II category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 5.69 ±0.89, 5.92 ± 1.52, 1.69 ±0.63, 15.35 ± 3.56, 13.97 ± 2.07, 6.13 ± 2.10, 15.33 ± 1.99, 12.01 ± 1.77, 12.95 ± 2.25, 6.51 ± 1.82 mm respectively. The mean soft tissue thickness in females in skeletal class II category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 5.74 ± 1.16, 5.43 ± 1.24, 1.39 ±0.57, 12.30 ± 2.70, 11.32 ± 2.22, 3.87 ± 1.73, 12.99 ± 2.11, 11.50 ± 1.95, 11.14 ± 2.32, 5.39 ± 1.56 mm respectively.

When the differences between Group 1 & 2 subjects of skeletal Class II category were analysed statistically by Independent samples t test, highly significant differences were found for FSTT at points, Sn [$t(89) = 4.64$, $p < 0.001$], Ls [$t(89) = 5.78$, $p < 0.001$], S [$t(89) = 5.64$, $p < 0.001$], Li [$t(89) = 5.35$, $p < 0.001$], Po [$t(89) = 3.73$, $p < 0.001$] and Gn [$t(89) = 3.16$, $p = 0.002$].

Skeletal Class III

The mean soft tissue thickness in males in skeletal class III category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 6.37 ±0.21, 7.29 ± 1.18, 2.56 ±0.41, 15.10 ± 1.36, 14.29 ±0.55, 5.09 ± 1.70, 14.94 ±0.74, 10.49 ± 1.77, 10.91 ± 1.86, 6.69 ± 1.12 mm respectively. The mean soft tissue thickness in females in skeletal class III category at G, Na, Rh, Sn, Ls, S, Li, Lm, Po, Gn were 5.23 ±0.76, 5.85 ±0.71, 1.90 ±0.54, 16.10 ± 1.41, 13.55 ± 0.17, 4.98 ±0.90, 15.05 ± 2.33, 12.95 ±0.94, 13.60 ± 2, 7.25 ±0.5 mm respectively.

When the differences between Group 1 & 2 subjects of skeletal Class III category were analysed statistically by Independent samples t test, highly significant differences were found for FSTT at points, G [$t(9) = 3.88$, $p = 0.004$], while significant differences were found at Rh [$t(9) = 2.31$, $p = 0.046$], Ls [$t(9) = 2.56$, $p = 0.031$] and Lm [$t(9) = 2.54$, $p = 0.032$].

Skeletal Class	Gender (n)	G	Na	Rh	Sn	Ls	S	Li	Lm	Po	Gn
Skeletal Class I	Male (n)	6.06 ± 1.34	6.51 ± 1.52	1.72 ± 0.63	15.86 ± 2.11	14.47 ± 2.20	6.50 ± 1.95	14.78 ± 1.52	11.84 ± 1.95	12.25 ±2.29	7.09 ± 2.04
	Female (n)	5.91 ± 1.30	5.69 ± 1.54	1.51 ± 0.56	13.85 ± 1.92	12.50 ± 1.97	5 ± 1.86	12.92 ± 1.71	11.25 ±1.09	11.75 ± 2.20	5.61 ± 1.62
Skeletal Class II	Male (n)	5.69 ± 0.89	5.92 ± 1.52	1.69 ± 0.63	15.35 ± 3.56	13.97 ± 2.07	6.13 ± 2.10	15.33 ± 1.99	12.01 ± 1.77	12.95 ± 2.25	6.51 ± 1.82
	Female (n)	5.74 ± 1.16	5.43 ± 1.24	1.39 ± 0.57	12.30 ± 2.70	11.32 ± 2.22	3.87 ± 1.73	12.99 ± 2.11	11.50 ± 1.95	11.14 ± 2.32	5.39 ± 1.56
Skeletal Class III	Male (n)	6.37 ± 0.21	7.29 ± 1.18	2.56 ± 0.41	15.10 ± 1.36	14.29 ± 0.55	5.09 ± 1.70	14.94 ± .74	10.49 ± 1.77	10.91 ± 1.86	6.69 ± 1.12
	Female (n)	5.23 ± 0.76	5.85 ± 0.71	1.90 ± 0.54	16.10 ± 1.41	13.55 ± 0.17	4.98 ± 0.90	15.05 ± 2.33	12.95 ± 0.94	13.60 ± 2	7.25 ± 0.5

Table 3 :Facial soft tissue thickness in males & females according to skeletal class category

Correlation between BMI and FSTT parameters:

When the BMI was correlated with soft tissue thicknesses at various anatomical landmarks in males by Spearman's correlations, highly significant moderate positive correlations were found at points G ($r= 0.393$, $p<0.001$), Lm ($r= 0.319$, $p=0.001$), Po($r= 0.456$, $p<0.001$) and Gn ($r= 0.421$, $p <0.001$), reducing the correlation by chance.

Discussion

When the soft tissue thicknesses at various points were compared between the groups in the present study, significantly higher values were found in males for Na, Rh, Sn, Ls, S, Li, Po and Gn. Hence, the mean FSTT of males was more than that of females in the present study which is similar to the study done by Sahni et al10on North West Indians, South Indian population

by Kotrashetti VS et al.[17] However, the present results differ from those reported by El-Mehallawi et al[4] in Egyptian population who reported that females showed greater thickness than male. The differences could be explained by ethnic & racial differences.
In the present study, when the mean soft tissue thickness was evaluated and compared between 17 underweight males & females, significantly higher values were found in males at points Na, Sn, Ls, S, Gn. This was in contrast to study conducted by de Greef S et al,[10] who found higher values in females in majority of landmarks, which could be probably be explained by cut off value for BMI taken (< 18.5 in the present study vs <21 in their study) and racial differences.
According to de Greef S et al [10] in Caucasian population, the mean soft tissue thickness in males in BMI 20-25 category at Supraglabella, Glabella, Nasion, End of nasal, Mid-philtrum, Upper lip margin, Lower lip marign, Chin-lip fold, Mental eminence, Beneath chin were 4.1 ± 0.55, 5.0 ± 0.69, 5.9 ± 1.10, 2.8 ± 0.69, 11.2 ± 1.78, 11.0 ± 2.15, 12.5 ± 2.05, 10.1 ± 1.31, 9.5 ± 1.66, 6.1 ± 1.20 mm respectively, while corresponding values in females were 4.1 ± 0.6, 5.1 ±0.8, 6.3 ±1.2, 2.6 ± 0.8, 9.8 ±1.6, 10.0 ±1.7, 11.0 ± 2.0, 9.6±1.0, 9.6 ± 1.7 and 5.6 ± 1.3 mm respectively, which were comparable to the present study results.
In a study done by Ruiz NAP et al,[8] in Colombian adults, the mean soft tissue thickness in males in normal BMI category at Nasion, Rhinion, Mid philtrum, Supradentale, Infradentale, Supramentale, Eminence mental were 7.1 ± 1.2, 2.6 ± 0.4, 14.3 ± 2.0, 11.7 ± 1.0, 11.6 ± 1.0, 12.5 ± 1.3, 11.7 ± 1.4 mm respectively while the corresponding values in females in normal BMI category were 6.4 ± 0.4, 1.8 ± 0.2, 12.9 ± 1.7, 9.7 ± 1.5, 10.9 ± 1.4, 14.5 ± 1.5, 10.7 ± 1.5, mm respectively. The thicknesses measured at Na, Rh were higher in this population when compared with the present study which could be explained by the differences in methodology, wherein measurements in their study were based on CBCT as opposed to Lateral cephalogram in our study.
In the present study, when the mean soft tissue thickness was evaluated and compared between 57 males & 66 females with normal BMI, significantly higher values were found in males at points Rh, Sn, Ls, S, Li, Gn. The values found in our study were comparable with those reported by de Greef S et al [10] in a study of the Caucasian population.
In the present study, when the facial soft tissue thicknesses at various landmarks were compared between 10 obese males and 6 obese females, significantly higher values were found in males only at point Sn. Rest of the parameters did not show statistically significant differences between the groups, despite having higher mean values in males except for Lm which had a marginally higher value in females. Hence, it had been found that an increase in the BMI leads to a decrease in the number of the significant sex differences at these landmarks.

In the present study, significant differences were observed at many points including G, Sn, Lm, Po and Gn in males among different classes of BMI, while there was difference noted only at point Lm in females. It was found that in general, underweight and normal groups had significantly lower mean values than overweight & obese groups in both genders. Our findings were similar to study conducted by Johari M et al[19] who found that there was a significant difference in three groups in males in some of the landmarks including mental eminence and vertex. On the other hand, comparison of the landmarks in women by weight groups (low weight, normal weight, overweight) showed that there was a significant difference in three groups in amount of soft tissue thickness in glabella, nasion, end of nasal, mental eminence, and beneath chin.
In the present study, when the FSTT parameters were categorised into skeletal classes and compared between 54 males &44 females of skeletal Class I, highly significant differences were found for FSTT at points Na, Sn, Ls, S, Li & Gn, with higher values being found in males. This was comparable to results reported by Kurkcuoglu A et al.[4]
In the present study, when the FSTT parameters were compared between 39 males & 52 females presenting with skeletal Class II, based on ANB angle, it was found that highly significant differences existed at points Sn, Ls, S, Li, Po and Gn, with higher values being noted in male subjects. This was similar to the findings reported by Kurkcuoglu A et al.[4]
In the present study, when FSTT parameters were compared between 7 males & 4 females presenting with skeletal Class III malocclusion, it was found that the thicknesses at points Sn, Li, Lm, Po, Gn were more in females than in males. However, statistically significant differences were found only at points G, Rh, Ls and Lm, wherein except at Lm, mean values of thicknesses were higher in males. This was similar to the findings of Kurkcuoglu A et al.[4]

In the present study, when FSTT were analyzed between different skeletal classes of males, it was found that significant differences were found between skeletal Class I,II, III for point Rh, with greatest thickness found in class III, followed by I and II. The other parameters did not show significant differences between skeletal classes. At the points Ls-Pr and St-Ul, the tissue depth values were significantly lower for individuals in Class II when compared with individuals in Classes I and III. However, at the point Sn-A, the soft tissue thickness was greater in the individuals from Classes II and III when compared with the individuals in Class I. Statistically significant differences between the three classes were also observed for tissue depth values at Li-Id and Mes-Me points. The differences could be due to variation in methodology and racial differences.
In the present study, when FSTT were analyzed between different skeletal classes of females, it was found that significant differences were found between skeletal Class I,II, III for point Sn, with greatest thickness found in class III, followed by I and II. The tissue depth values at these points were significantly greater in individuals with Class III type of occlusion when compared with the individuals with Class I and II occlusion types. The tissue depth at the Li-Id point for individuals in the Class II group was also significantly greater ($p < 0.01$) than for individuals in the other two groups. The differences between the results of the studies could be due to variation in methodology and racial differences.
In the present study, when correlation between FSTT & BMI was evaluated in male subjects, highly significant positive correlations were obtained for points G, Lm, Po, Gn, while in females, significant correlations were observed at points G, Na, Lm and Po. Hence in the present study, the null hypothesis stating that there is no correlation between FSTT &BMI was discarded, and alternate hypothesis was accepted. According to Sutton PRN,[21] the most affected facial regions with respect to the nutritional status of the individuals are those with high content of hypoder-

mic fat or well-developed muscles. Thus, a decrease in nutrition leads to smaller STTs, except for the tissues around the eyes, which could be due to the lack of subcutaneous fat in this area.[17]

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