

# Mean values of Arnett's soft tissue analysis in Maratha ethnic (Indian) population — A cephalometric study

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## Abstract

**Aim:** The aim of this article is to evaluate the mean cephalometric values for Arnett's soft tissue analysis in the Maratha ethnic (Indian) population. **Materials and Methods:** Lateral cephalograms of 60 patients (30 males and 30 females) aged 18–26 years were obtained with the patients in the Natural Head Position (NHP), with teeth in maximum intercuspation and lips in the rest position. Moreover, hand tracings were also done. The statistical analysis was performed with the help of a statistical software, the Statistical Package for the Social Sciences version 16, and Microsoft word and Excel (Microsoft office 2007) were used to generate the analytical data. **Results:** Statistical significance was tested at *P* level (1% and 5% level of significance). Statistical analysis using student's unpaired *t*-test were performed. Various cephalometric values for the Maratha ethnic (Indian) population differed from Caucasian cephalometric values such as nasolabial inclination, incisor proclination, and exposure, which may affect the outcome of the orthodontic and orthognathic treatment. **Conclusion:** Marathas have more proclined maxillary incisors, less prominent chin, less facial length, acute nasolabial angle, and all soft tissue thickness are greater in Marathas except lower lip thickness (in Maratha males and females) and upper lip angle (in Maratha males) than those of the Caucasian population. It is a fact that all different ethnic races have different facial characters. The variability of the soft tissue integument in people with different ethnic origin makes it necessary to study the soft tissue standards of a particular community and consider those norms when planning an orthodontic and orthognathic treatment for particular racial and ethnic patients.

**Key words:** Arnett's STCA, cephalometric, ethnic, Maratha (Indian) population, natural head position, The true vertical line

## INTRODUCTION

The ambit of orthodontics and Dentofacial orthopedics has increased manifold in the last few years, and similarly

the concept of beauty has also been redefined, although it varies from one population to another. A recent study conducted on Malaysian population<sup>[1]</sup> reported that

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only 17% of Malaysian facial proportion conformed to the golden ratio. Therefore, in the current scenario, to attain and preserve optimal facial attractiveness are prime objectives of orthodontic and orthognathic treatment; hence, it is mandatory for an orthodontist to conduct a thorough facial examination because balance and harmony of different parts of the face are determined by both hard and soft tissues. Almost two decades ago, soft tissue cephalometric analysis (STCA) was introduced by Dr. GW Arnett and Bergman,<sup>[2,3]</sup> and since then, the treatment planning based on soft tissue measurements has been receiving greater attention. The STCA is a cephalometric horizontal and vertical profile tool.

Indian population is polygenetic. The morphological features of an individual vary from race-to-race due to a complicated interaction of genetic and environmental factors, and therefore, different racial groups must be treated according to their own characteristics. This has been shown in various studies such as more proclined maxillary and mandibular incisors were seen in Mahabubnagar population<sup>[4]</sup> and more retrusive lower faces with convex profile were seen in central Indian ethnic population.<sup>[5]</sup> Another study conducted on the South Indian population<sup>[6]</sup> (Tamil Nadu, Pondicherry, Andhra Pradesh and Karnataka) showed more acute nasolabial angle than the Caucasian population. Similarly, Turkish people have different soft tissue norms than European-American adults.<sup>[7]</sup> All the studies had one common conclusion, that is, to develop standards for various populations and to consider those norms when formulating an orthodontic treatment plan for the patients of that particular ethnic group.

Because very few studies have been undertaken to establish the soft tissue norms for the Indian population, a comprehensive comparative study was required to investigate ethnic differences in the soft tissue profile of Indian population. Therefore, this study was conducted to obtain soft tissue cephalometric norms for the Maratha ethnic (Indian) population and to understand the ethnic differences in the soft tissue profile between Indian and Caucasian individuals.

### Aim

- To evaluate the mean cephalometric values for Arnett's STCA for the Maratha ethnic (Indian) population.

### Objectives

- To identify the values for soft tissue profile that can be used as guidelines in the diagnosis and treatment

planning of Maratha ethnic (Indian) population contemplating orthodontic treatment

- To identify possible gender difference in the values
- To compare established Maratha ethnic (Indian) standards with the earlier established norms for other populations.

## MATERIAL AND METHODS

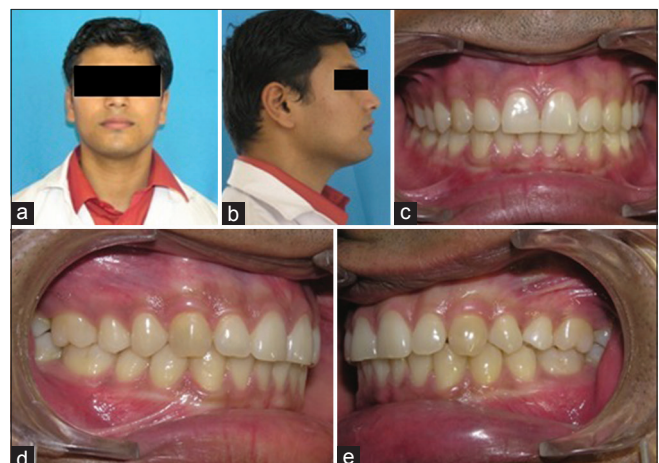
This study was carried out in the Department of Orthodontics and Dentofacial Orthopedics, Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune, Maharashtra. The participants were selected from the dental students studying in the same institute within a span of 2 years from 2009–2011. Sixty participants<sup>[4]</sup> (30 males and 30 females) were selected for the study who fulfilled the inclusion and exclusion criteria by a panel of 5 judges. Equal number of males and females were included in the study so that intragroup comparison could be done.

### Inclusion criteria

- The participants should be Maratha ethnic individuals, traced back to 2 generations between 18–26 years of age
- The participants should have an acceptable and pleasing profile
- The participants should have Angle's Class I molar relationship on both sides
- The participants should have normal overjet and overbite with minimal crowding or spacing [Figures 1 and 2].

### Exclusion criteria

- Participants who underwent orthodontic treatment previously



**Figure 1:** (a and b) Extra oral photographs of the sample. (c-e) Intraoral photographs of the sample

- If there was presence of gross facial asymmetry or severe crowding and missing teeth except III molars
- If there was absence of good quality cephalometric records.

The ethical clearance was given by the ethical and scientific committee of Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune. An informed consent was obtained from all the volunteers after duly explaining the nature and purpose of the radiograph.

The lateral cephalometric radiographs were taken on a Planmeca Proline XC Dimax 3 x-ray machine (manufactured by Planmeca Oy Finland) machine in the Department of Oral Medicine Diagnosis and Radiology, Dr. D. Y. Patil Dental College and Hospital, Pune. This was performed with the participants looking straight ahead such that the visual axis was parallel to the floor or in the natural head position (NHP),<sup>[8,9]</sup> with teeth in maximum intercuspation and lips in the rest position. With the ear posts and a wall mirror as an external source of eye reference, patient positioning becomes quick, precise, and easy and minimizes the errors caused by incorrect positioning. Metallic markers in the form of small beads [Figure 2] were placed on the right side of the face with the help of a transparent gel or glue, namely the orbital rim marker, cheekbone marker, the alar base marker, the subpupil marker, and the neck-throat marker<sup>[10]</sup> [Figure 3]. The digital cephalograms were exposed at 80 kV/8mA for 0.8 s. Lacquered polyester papers (75 µm) were used for hand tracings. 0.05" lead pencil was used. The hand tracings were done by a single operator in a standardized manner so that interoperator variations/errors could be avoided. The true vertical line (TVL) was then established. TVL was drawn perpendicular to the Frankfort horizontal



**Figure 2:** Stainless steel beads, generally used for embedding of pressure moulding models

plane (FH) passing through the subnasale. The Arnett's STCA<sup>[10]</sup> were performed.

### Statistical analysis

The statistical methods employed in the present investigation were mean (Average) and standard deviation. Student's unpaired *t*-test was used to compare the mean values of the Maratha ethnic Population with the mean values of the Caucasian population. Intragroup (males and females) comparison was also made within the present study.

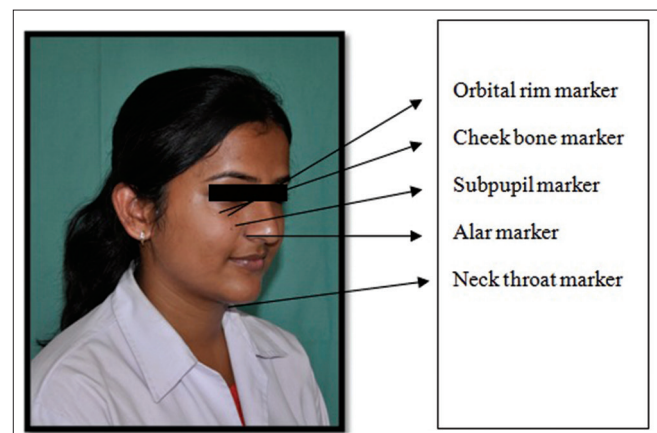
## RESULTS

Tables 1-3 show characteristic racial differences between the Maratha ethnic population and the original Arnett's Caucasian population as well as significant sexual dimorphism among this population.

In dentoskeletal factor, significant statistical difference is seen in Maratha females and males and Caucasian females and males in Md1 to Md Occ. plane in both males and females [Tables 1 and 2] and Mx 1 to Mx Occ. Plane [Table 2] in males and within sexes [Table 3].

In soft tissue structures, significant statistical difference is seen between Maratha females and males and Caucasian females and males in all parameters except lower lip thickness in both sexes [Tables 1 and 2] and upper lip angle in males [Table 2] and Menton–Menton' within the sexes [Table 3].

In facial lengths, significant statistical difference is seen between Maratha females and males and Caucasian females and males; in females, all parameters showed difference except overbite, Mx 1 exposure, lower 1/3 of the face, and Md height [Table 1] whereas in males



**Figure 3:** Metallic markers on the right side of the face

**Table 1: Comparison of values of Maratha ethnic population and Arnett's original values: females**

Parameters	Mean±SD		t	P
	Female Arnett's STC analysis values	Female Maratha population values		
Dentoskeletal factors				
Mx Occlusal plane (degrees)	95.6±1.8	96.3±2.1	1.92	0.06*
Mx 1 to Mx Occlusal plane ( degrees)	56.8±2.5	57.3±2.3	1.12	0.27*
Md1 to Md Occ. Plane (degrees)	64.3±3.2	62.3±4.5	-2.42	<0.05**
Over jet (mm)	3.2±0.4	3.1±0.6	-1.32	0.19*
Over bite (mm)	3.2±0.7	3.5±0.9	1.62	0.11*
Soft tissue structures				
Upper lip thickness (mm)	12.6±1.8	13.9±1.3	5.42	<0.01***
Lower lip thickness (mm)	13.6±1.4	13.2±1.3	-1.77	0.08*
Pogo-Pogo' (mm)	11.8±1.5	12.6±1.6	2.64	<0.05**
Menton-Menton' (mm)	7.4±1.6	10.6±2.8	6.42	<0.01***
Nasolabial angle	103.5±6.8	107.1±5.1	3.82	<0.01***
Upper lip angle	12.1±5.1	8.0±4.8	-4.76	<0.01***
Facial lengths (mm)				
Nasion'-Menton'	124.6±4.7	122.3±5.0	-2.54	<0.05**
Upper lip length	21.0±1.9	22.1±2.8	2.16	<0.05**
Interlabial gap	3.3±1.3	0.03±0.1	141.04	<0.01***
Lower lip length	46.9±2.3	48.7±2.6	3.83	<0.01***
Lower 1/3 of face	71.1±3.5	70.9±5.1	-0.25	0.80*
Over bite	3.2±0.7	3.1±0.6	-1.09	0.28*
Mx1 exposure	4.7±1.6	3.1±1.3	-6.57	<0.01***
Maxillary height	25.7±2.1	25.2±3.2	-0.93	0.35*
Mandibular height	48.6±2.4	48.4±2.5	-0.51	0.61*
Projections to TVL				
Glabella	-8.5±2.4	-11.5±3.4	-4.79	<0.01***
Orbital rims	-18.7±2.0	-23.3±3.3	-7.72	<0.01***
Cheek bone	-20.6±2.4	-28.8±4.0	-11.27	<0.01***
Subpupil	-14.8±2.1	-18.1±2.8	-6.39	<0.01***
Alar base	-12.9±1.1	-13.36±1.4	-1.39	0.17*
Nasal projection	16.0±1.4	14.2±1.7	-5.80	<0.01***
Subnasale <sup>s</sup>	0±0.0	0±0.0	-	-
A point'	-1.0±1.0	-1.8±0.6	-6.59	<0.01***
Upper lip anterior	3.7±1.2	1.8±1.0	-10.10	<0.01***
Mx1	-9.2±2.2	-10.1±1.7	-2.92	<0.01***
Md1	-12.4±2.2	-8.3±11.3	1.97	0.06*
Lower-lip anterior	1.9±1.4	0.2±0.6	18.26	<0.01***
B point'	-5.3±1.5	-7.9±1.5	-9.64	<0.01***
Pogonion	-2.6±1.9	-5.3±2.0	-7.15	<0.01***
Harmony values				
Intra mandibular relations				
Md1-Pogonion'	9.8±2.6	8.3±2.0	-4.18	<0.01***
Lower lip anterior- Pog'	4.5±2.1	4.9±2.0	0.98	0.33*
B point'-Pogonion'	2.7±1.1	2.7±1.2	0.00	1.00*
Throat length	58.2±5.9	56.1±5.4	-2.11	<0.05**
Inter-jaw relations				
Subnasale'-Pogonion'	3.2±1.9	4.3±2.0	3.07	<0.01***
A point'-B point'	5.2±1.6	4.4±1.5	-2.91	<0.01***
Upper-Lower lip anterior	1.8±1.0	1.2±0.9	-3.68	<0.05**
Orbit to jaw relations				
Orbital rim'-A point'	18.5±2.3	22.0±2.9	6.65	<0.01***
Orbital rim'-Pogonion'	16.0±2.6	19.9±3.2	6.57	<0.01***

Contd...

Table 1: Contd...

Parameters	Mean±SD		t	P
	Female Arnett's STC analysis values	Female Maratha population values		
Full facial to balance				
Facial angle	169.3±3.4	163.56±3.6	-8.68	<0.01***
Glabella'-A point'	8.4±2.7	11.86±3.9	4.85	<0.01***
Glabella'-Pogonion'	5.9±2.3	9.70±4.3	4.83	<0.01***

\*Not significant, \*\*Significant, \*\*\*Highly significant, <sup>§</sup>The t-values and P values can't be calculated, since the standard deviation in the male population is zero

Table 2: Comparison of values of Maratha ethnic population and Arnett's original values: males

Parameters	Mean±SD		t	P
	Female Arnett's STC analysis values	Female Maratha population values		
Dentoskeletal factors				
Mx Occlusal plane (degrees)	95.0±1.4	96.1±3.7	1.44	0.15*
Mx 1 to Mx Occlusal plane (degrees)	57.8±3.0	55.7±3.8	-3.04	<0.01***
Md1 to Md Occ. Plane (degrees)	64.0±4.0	66.2±5.3	2.28	<0.05**
Over jet (mm)	3.2±0.6	3.2±0.7	-0.24	0.80*
Over bite (mm)	3.2±0.7	3.3±1.1	0.32	0.75*
Soft tissue structures				
Upper lip thickness (mm)	14.8±1.4	16.0±2.4	2.69	<0.05**
Lower lip thickness (mm)	15.1±1.2	14.9±2.3	-0.56	0.57*
Pogo-Pogo' (mm)	13.5 2.3	14.3±2.0	2.25	<0.05**
Menton-Menton' (mm)	8.8±1.3	9.9±2.4	2.56	<0.05**
Nasolabial angle	106.4±7.7	99.9±8.8	-4.00	<0.01***
Upper lip angle	8.3±5.4	7.6±3.7	-1.04	0.30*
Facial lengths (mm)				
Nasion'-Menton'	137.7±6.5	132.7±11.1	-2.47	<0.05**
Upper lip length	24.4 2.5	24.5±3.6	0.10	0.90*
Interlabial gap <sup>§</sup>	2.4±1.1	0±0.0	-	-
Lower lip length	54.3±2.4	55.6±7.0	1.01	0.30*
Lower 1/3 of face	81.1±4.7	80.3±10.3	-0.44	0.66*
Over bite	3.2±0.7	3.0±1.0	-1.03	0.31*
Mx1 exposure	3.9±1.2	2.8±1.9	-3.32	<0.01***
Maxillary height	28.4±3.2	28.2±5.1	-0.21	0.83*
Mandibular height	56.0±3.0	55.3±5.8	-0.69	0.49*
Projections to TVL				
Glabella	-8.0±2.5	-10.5±2.0	-6.14	<0.01***
Orbital rims	-22.4±2.7	-28.6±1.5	-22.5	<0.01***
Cheek bone	-25.2±4.0	-37.0±2.3	-28.1	<0.01***
Subpupil	-18.4±1.9	-23.1±2.2	-11.6	<0.01***
Alar base	-15.0±1.7	-15.8±1.6	-2.6	<0.05**
Nasal projection	17.4±1.7	15.6±1.9	-5.1	<0.01***
Subnasale <sup>§</sup>	0±0	0±0	-	-
A point'	-3.0±1.0	-1.3±0.9	-26.5	<0.01***
Upper lip anterior	3.3±1.7	1.7±1.3	-6.7	<0.01***
Mx1	-12.1±1.8	-12.1±7.1	0.00	1.00*
Md1	-15.4±1.9	-15.1±8.7	0.16	0.86*
Lower-lip anterior	-1.0±2.2	-0.6±1.7	1.27	0.21*
B point'	-7.1±1.6	-8.8±3.1	-3.01	<0.01***
Pogonion'	-3.5±1.8	-4.1±5.3	-0.65	0.51*
Harmony values				
Intra mandibular relations				
Md1-Pogonion'	11.2±2.8	11.9±4.31	0.84	0.40*

Contd...



Table 2: Contd...

Parameters	Mean±SD		t	P
	Female Arnett's STC analysis values	Female Maratha population values		
Lower lip anterior-Pog'	4.4±2.5	4.5±2.71	0.26	0.79*
B point'-Pogonion'	3.6±1.3	4.3±1.44	2.52	<0.05**
Throat length	61.4±7.4	57.5±10.21	-2.09	<0.05**
Inter-jaw relations				
Subnasale'-Pogonion'	4.0±1.7	3.8±3.5	-0.52	0.60*
A point'-B point'	6.8±1.5	5.9±3.4	-1.46	0.15*
Upper-Lower lip anterior	2.3±1.2	1.6 1.3	-3.09	<0.01***
Orbit to jaw relations				
Orbital rim'-A point'	22.1±1.3	27.1±2.1	13.2	<0.01***
Orbital rim'-Pogonion'	18.9±2.8	25.3±4.2	8.39	<0.01***
Full facial to balance				
Facial angle	169.4±3.2	166.1±4.0	-4.51	<0.01***
Glabella'-A point'	7.8±2.8	10.0±1.9	6.27	<0.01***
Glabella'-Pogonion'	4.6±2.2	7.2±4.6	3.16	<0.01***

\*Not significant, \*\*Significant, \*\*\*Highly significant, †The t- values and P values can't be calculated, since the standard deviation in the male population is zero

Table 3: Comparison of values of Maratha males and females according to Arnett's soft tissue cephalometric analysis

Parameters	Mean±SD		t	P
	Female Arnett's STC analysis values	Female Maratha population values		
Dentoskeletal factors				
Mx Occlusal plane (degrees)	96.1±3.7	96.3±2.1	0.34	0.73*
Mx 1 to Mx Occlusal plane ( degrees)	55.7±3.8	57.3±2.3	1.96	0.054*
Md1 to Md Occ. Plane (degrees)	66.2±5.3	62.3±4.5	-3.06	<0.01***
Over jet (mm)	3.2±0.7	3.1±0.6	-0.60	0.55*
Over bite (mm)	3.3±1.1	3.5±0.9	0.75	0.45*
Soft tissue structures				
Upper lip thickness (mm)	16.0±2.4	13.9±1.3	-4.24	<0.01***
Lower lip thickness (mm)	14.9±2.3	13.2±1.3	-3.55	<0.01***
Pogo-Pogo' (mm)	14.3±2.0	12.6±1.6	-3.76	<0.01***
Menton-Menton' (mm)	9.9±2.4	10.6±2.8	1.04	0.30*
Nasolabial angle	99.9±8.8	107.1±5.1	3.82	<0.01***
Upper lip angle	7.6±3.7	8.0±4.8	0.33	0.73*
Facial lengths (mm)				
Nasion'-Menton'	132.7±11.1	122.3±5.0	-4.65	<0.01***
Upper lip length	24.5±3.6	22.1±2.8	-2.86	<0.01***
Interlabial gap <sup>§</sup>	0±0	0.03±0.1	1.43	0.15*
Lower lip length	55.6±7.0	48.7±2.6	-5.05	<0.01***
Lower 1/3 of face	80.3±10.3	70.9±5.1	-4.47	<0.01***
Over bite	3.0±1.0	3.1±0.7	0.26	0.78*
Mx1 exposure	2.8±1.9	3.1±1.3	0.88	0.38*
Maxillary height	28.2±5.1	25.2±3.2	-2.77	<0.01***
Mandibular height	55.3±5.8	48.4±2.5	-6.01	<0.01**
Projections to TVL				
Glabella	-10.5±2.0	-11.5±3.4	-1.38	0.71*
Orbital rims	-28.6±1.5	-23.3±3.3	8.03	<0.01***
Cheek bone	-37.0±2.3	-28.8±4.0	9.66	<0.01***
Subpupil	-23.1±2.2	-18.1±2.8	7.80	<0.01***
Alar base	-15.8±1.6	-13.3±1.4	6.44	<0.01***

Contd...

Table 3: Contd...

Parameters	Mean±SD		t	P
	Female Arnett's STC analysis values	Female Maratha population values		
Nasal projection	15.6±1.9	14.2±1.7	-3.14	<0.01***
Subnasale <sup>s</sup>	0±0	0±0	-	-
A point'	-1.3±0.9	-1.8±0.6	-2.58	<0.05**
Upper lip anterior	1.7±1.3	1.8±1.0	0.32	0.74*
Mx1	-12.1±7.1	-10.1±1.7	1.46	0.14*
Md1	-15.1±8.7	-8.3±11.3	2.61	<0.05**
Lower-lip anterior	-0.6±1.7	0.2±0.6	2.48	<0.05**
B point'	-8.8±3.1	-7.9±1.5	1.41	0.16*
Pogonion'	-4.1±5.3	-5.26±2.0	-1.09	0.27*
Harmony values				
Intra mandibular relations				
Md1-Pogonion'	11.9±4.3	8.3±2.0	-4.11	<0.01***
Lower lip anterior- Pog'	4.5±2.7	4.9±2.0	0.53	0.59*
B point'-Pogonion'	4.3±1.4	2.7±1.2	-4.49	<0.01***
Throat length	57.5±10.2	56.1±5.4	-0.66	0.51*
Inter-jaw relations				
Subnasale'- Pogonion	3.8±3.5	4.3±1.9	0.68	0.49*
A point'-B point'	5.9±3.4	4.4±1.5	-2.21	<0.05**
Upper-Lower lip anterior	1.6±1.3	1.2±0.9	-1.26	0.17*
Orbit to jaw relations				
Orbital rim'-A point'	27.1±2.1	22.0±2.9	-7.73	<0.01***
Orbital rim'-Pogonion'	25.3±4.2	20.0±3.2	-5.57	<0.01***
Full facial to balance				
Facial angle	166.0±4.0	163.6±3.6	-2.52	<0.05**
Glabella'-A point'	10.0±1.9	11.9±3.9	2.34	<0.05**
Glabella'-Pogonion'	7.2±4.6	9.7±4.3	2.15	<0.05**

\*Not significant, \*\*Significant, \*\*\*Highly significant, <sup>s</sup>The t- values and p-values can't be calculated, since the standard deviation in the male population is zero

this was noted in Nasion'-Menton' and Mx 1 exposure [Table 2]. Significant statistical difference was seen within the sexes [Table 3].

In projection to TVL, all parameters showed significant statistical difference in females except Alar base, Md1 [Table 1] and in males Mx 1, Md1, lower lip anterior, and Pog' [Table 2]. Significant statistical difference was noted within the sexes [Table 3].

In Harmony values, all parameters showed significant statistical difference in females except lower lip anterior'-Pog' and B Point'-Pog' [Table 1] and in males Md1-Pog', lower lip anterior-Pog', Subnasale-Pog', and A point'-B point' [Table 2]. Significant difference was seen within both the sexes [Table 3].

## DISCUSSION

The results were categorized in five categories, namely, dentoskeletal factors, soft tissue structures,

facial lengths, projection to TVL, and Harmony values (45 parameters), as done in the original Arnett's STCA.<sup>[10]</sup>

### Dentoskeletal factors

Dentoskeletal factors have a major role in determining the facial profile and greatly rely on correct management by orthodontists.

Because slight maxillary incisors proclination is the norm, less retraction of maxillary incisors is required, and keeping the soft tissue paradigm in mind (increased soft tissue chin thickness), we can leave mandibular incisors more uprighted in Maratha males. Proclined maxillary incisors were also seen in Mahabubnagar population,<sup>[4]</sup> Maratha population,<sup>[11]</sup> and Andhra Pradesh population,<sup>[12]</sup> whereas in central Indian population,<sup>[5]</sup> the results were similar to the Caucasian population<sup>[10]</sup> but contrary to the South Indian ethnic population.<sup>[13]</sup>

In Maratha females, mandibular incisors are more protrusive ( $P < 0.05$ ) as compared to Caucasian females; more protrusive mandibular incisors were also noticed in North Indian<sup>[14]</sup> and Anatolian Turkish women.<sup>[15]</sup> Because slight proclined mandibular incisors is the norm, over-retraction of mandibular incisors should be avoided in Maratha females.

### Soft tissue thickness

The thickness of soft tissue structures along with dentoskeletal factors plays an important role in deciding facial esthetics.

All soft tissue thicknesses [(upper and lower lip thickness ( $P < 0.01$ ), Pogo–Pogo' ( $P < 0.01$ ), and nasolabial angle ( $P < 0.01$ )] are greater in Maratha ethnic males as compared to Caucasian males except lower lip thickness and upper lip angle. Thicker upper lip than Caucasians is not only found in the Maratha ethnic population but also in other parts of India.<sup>[12,13,16]</sup> The Nasolabial angle (one of the deciding factor in extractions cases) is acute in the Maratha ethnic male population, which might indicate increased dental protrusion; this result was also obtained in south Indian population,<sup>[6]</sup> Andhra males,<sup>[12]</sup> South Indian males,<sup>[13]</sup> and Koreans,<sup>[17]</sup> but obtuse nasolabial angle was found in North Indian population.<sup>[18]</sup> Nasolabial angle is not only influenced by dental protrusion but also by nasal inclination such as an obtuse nasolabial angle is seen in Japanese<sup>[19]</sup> because of superiorly inclined nose base. Increased soft tissue thickness at the chin region and acute nasolabial angle are the norms for Maratha ethnic males; this cautioned against more retraction of maxillary incisors which may result in flattening of the profile in Maratha males.

All soft tissue thicknesses [upper lip thickness ( $P < 0.01$ ), Pogo–Pogo' ( $P < 0.05$ ), nasolabial angle ( $P < 0.01$ ), upper lip angle ( $P < 0.01$ ) and Menton–Menton' ( $P < 0.01$ )] are greater in the Maratha ethnic females as compared to the Caucasian females except lower lip thickness. In Maratha ethnic females, nasolabial angle is more obtuse and upper lip angle is more acute than Caucasian females. Whereas, in Malwa females,<sup>[20]</sup> nasolabial angle is similar to the Caucasian females. North Indian females<sup>[21]</sup> had acute nasolabial angle than Caucasian females. The position of the upper incisor teeth and overlying soft tissues thickness are reflected by the nasolabial angle and upper lip angle, and therefore these angles play an important role in the decision of extraction. Nasolabial angle and upper lip angle showed that less protrusive maxillary

incisors is the norm for Maratha ethnic females, and hence more retraction is required.

### Total facial length

It is [Nasion'–Menton' ( $P < 0.05$ )] less in ethnic Maratha males as compared to Caucasian males. Maxillary incisor exposure ( $P < 0.01$ ) is also less in Maratha ethnic males, which is due to more dental proclination as compared to Caucasian males. Similar results were obtained in the South Indian population<sup>[13]</sup> and Andhra Pradesh population.<sup>[12]</sup> Maxillary incisor exposure is less at rest in Maratha males. The presence and location of vertical abnormalities is indicated by assessing the maxillary height, mandibular height, upper incisor exposure, and overbite. Here, maxillary incisor exposure is less which shows vertical abnormality, and hence, intrusion of maxillary incisors should be avoided otherwise it will result in lesser visibility of the teeth at rest and an unesthetic appearance.

Total facial length [Nasion'–Menton' ( $P < 0.05$ )] is less in ethnic Maratha females as compared to Caucasian females. Maratha ethnic females have less interlabial gap ( $P < 0.01$ ) and maxillary incisor exposure ( $P < 0.01$ ) as compared to Caucasian females. Maratha ethnic females have increased upper ( $P < 0.05$ ) and lower lip length ( $P < 0.01$ ). Less interlabial gap is due to longer upper lip length, and hence, proclination of the upper incisors should not be done otherwise it will create lesser visibility of teeth at rest leading to unacceptable esthetic appearance.

### Projection to true vertical line

Anteroposterior discrepancies are measured by projection to TVL. Midface deficiency [Orbital rims ( $P < 0.01$ ), cheek bone ( $P < 0.01$ ), Subpupil ( $P < 0.01$ ), and Alar base ( $P < 0.05$ )] is more in Maratha ethnic males when compared to Caucasian males. Forehead [Glabella ( $P < 0.01$ )] is situated more posteriorly in Maratha ethnic males as compared to Caucasian males. The nasolabial projection ( $P < 0.01$ ) is less in Maratha ethnic males, and similar results were found with Lucknow population<sup>[16]</sup> and Andhra Pradesh population.<sup>[12]</sup> Upper lip anterior ( $P < 0.01$ ) is less that shows less everted lip in Maratha males whereas other studies showed that upper lip is more protrusive in other populations such as South Indian population<sup>[13]</sup> and Andhra Pradesh population.<sup>[12]</sup> Deep mentolabial sulcus ( $P < 0.01$ ) is observed in Maratha ethnic males and it was also seen in Korean male population.<sup>[16]</sup> Upper lip is less protrusive in Maratha ethnic males



whereas other studies showed that upper lip is more protrusive in other populations such as South Indian population<sup>[13]</sup> and Andhra Pradesh population.<sup>[12]</sup> These parameters again warn against an excessive retraction of maxillary incisors [other supporting reading is A-point' ( $P < 0.01$ )]. Protrusion of the mandibular incisors should be avoided as the deep mentolabial sulcus is the norm in Maratha males. Midface deficiency is the norm for Maratha males and hence maxillary surgeries should be done accordingly.

Midface deficiency [orbital rims ( $P < 0.01$ ), cheekbone ( $P < 0.01$ ), and subpupil ( $p < 0.01$ )] is more in Maratha ethnic females as compared to Caucasian females, similar finding was found in South Indian females.<sup>[13]</sup> Forehead [Glabella ( $P < 0.01$ )] is situated more posteriorly in Maratha ethnic females as compared to Caucasian females. Nasal projection ( $P < 0.01$ ) is less which indicates less prominent nose in Maratha ethnic females than Caucasian females. Less prominence of the nose was also noted in Maratha females<sup>[22]</sup> and Lucknow females,<sup>[16]</sup> as compared to Caucasian females. The upper and lower lips ( $P < 0.01$ ) in the Caucasian females are more protrusive than Maratha ethnic females. Maratha ethnic females have deeper mentolabial sulcus ( $P < 0.01$ ) and less protrusive soft tissue chin ( $P < 0.01$ ) than those of Caucasian females. Midface deficiency is the norm and hence maxillary surgeries should be planned accordingly. The upper lip anterior ( $P < 0.01$ ), A-point' ( $P < 0.01$ ), and Maxillary incisor ( $P < 0.01$ ), all these parameters showed that the upper dentition is less protrusive in Maratha females as compared to Caucasian females; hence, more retraction of maxillary incisors is required in Maratha females. Because retrusive chin is the norm for Maratha females, genioplasty should be planned accordingly.

### Harmony values

Intramandibular relations show that the throat length ( $P < 0.05$ ) is less in Maratha males than Caucasian males. B point'–Pogonion' ( $P < 0.05$ ) is more in Maratha ethnic males due to increased soft tissue thickness or hard tissue pogonion enlargement. Interjaw relation shows that upper lower lip anterior ( $P < 0.01$ ) is less in Maratha ethnic males due to less protrusive upper lip than white males. Orbit to jaw relation values showed that Maratha ethnic males have more retrusive orbital ring in relation to A-point' ( $P < 0.01$ ) and pogonion' ( $P < 0.01$ ). Total face harmony values showed that forehead is situated more posteriorly in relation to A-point' ( $P < 0.01$ ) and Pog-point' ( $P < 0.01$ ) in Maratha ethnic males than Caucasian males. Maratha males have more convex profile [Facial

angle ( $P < 0.01$ )] than Caucasian males; more convex profile was also noticed in Egyptian population.<sup>[23]</sup> Less throat length warns against mandibular advancement and advancement genioplasty procedures in Maratha males.

Intramandibular relations showed that Maratha females have more protrusive lower incisors ( $P < 0.01$ ) in relation to soft tissue chin and less throat length ( $P < 0.05$ ) than Caucasian females. Interjaw relation showed that soft tissue chin is less protrusive [Subnasale'–Pogonion' ( $P < 0.05$ )] in comparison to upper jaw in Maratha females and less horizontal distance was measured between A point'–B point' ( $P < 0.05$ ) than Caucasian females and upper lower lip anterior ( $P < 0.05$ ) is less in Maratha ethnic females because the lips are less protrusive white females. Orbit-to-jaw relation values showed that Maratha ethnic males have more retrusive orbital ring in relation to A-point' ( $P < 0.01$ ) and pogonion' ( $P < 0.01$ ). Total face harmony values showed that forehead is situated more posteriorly in relation to A-point' ( $P < 0.01$ ) and pogonion' ( $P < 0.01$ ) in Maratha ethnic females than those in Caucasian females. Maratha females have more convex profile [facial angle ( $P < 0.01$ )] than Caucasian females, and this was also observed among Iranian females.<sup>[24]</sup>

Thus, Sexual dimorphism was seen in this study.

### Summary of key findings

When compared to Caucasian population, the major differences seen in Maratha ethnic population are

- Maxillary incisors are more proclined and mandibular incisors are uprighted in Maratha males as compared to Caucasian males, whereas mandibular incisors are more protrusive in Maratha females as compared to Caucasian females
- All soft tissue thickness, i.e., upper lip thickness, Pog–Pog', Menton–Menton' are more in Maratha males and females as compared to Caucasian population
- The nasolabial angle is acute in Maratha males whereas it is obtuse in Maratha females compared to Caucasian population
- Maxillary incisor exposure is less in Maratha males whereas both the interlabial gap and maxillary incisor exposure are less in Maratha females as compared to Caucasian females. Upper and lower lip length is greater in Maratha females as compared to Caucasian females
- Total facial length is less in both Maratha males and females as compared to the Caucasian population
- Midface deficiency is more in Maratha males and

- females as compared to Caucasian population
- The nasal projection and upper lip protrusion are less and the mentolabial sulcus is deeper in Maratha males and females as compared to Caucasian population whereas lower lip protrusion is more Maratha population as compared to the Caucasian population
- Maratha males and females have more convex profile than Caucasian population
- Maratha females have more retrognathic chin as compare to Caucasian females
- Forehead is situated more posteriorly in the Maratha population as compared to Caucasian population
- Maratha males have more flaccid upper and lower lip than Caucasian males whereas only upper lip is more flaccid in Maratha females as compared to Caucasian females
- Maratha population have less prominent chin as compared to Caucasian population.

These findings show that ethnic specific norms are an essential prerequisite for accurate evaluation of orthodontic and orthognathic patient. What is normal for one specific ethnic group may not be for another, which has been reported by many other authors for different populations.<sup>[4-7,11-16,18,20-24]</sup> Single sets of norms cannot be applied to each and every racial and ethnic group, and thus it is necessary to study the soft tissue standards of a particular community and consider those norms when formulating an orthodontic and orthognathic treatment plan for the particular racial and ethnic patients.

### Strengths of the study

- The main strength of this study is to provide standard soft tissues measurements for ethnic Maratha male and female population
- Single operator ability to perform both hard and soft tissue analysis
- Using same samples for hard and soft tissue analysis
- Possibility of intragroup comparison (male and female) for hard and soft tissue analysis.

### Limitations of the study

Like any other lateral cephalometric study, our study is also subject to the limitations that are inherent in radiographic cephalometry

- First, a radiograph is a two-dimensional representation of a three-dimensional structure, which, in itself, can lead to various inaccuracies

- Different set-ups may not have an exactly identical projection geometry and magnification factor, which may lead to error in the comparison of the groups
- Landmark identification error can occur, depending on the particular landmark
- In comparative studies, similar to this study, the mean values used for comparison are developed by a different investigator, who may have used slightly different landmark definitions and measurement techniques. Therefore, the two sets of results may not be directly comparable.

### Suggestions for future studies

Following considerations can be kept in mind for future studies:

- A large sample size can be used for more accuracy and better representation of the test population
- Minimizing identification errors by averaging multiple measurements obtained by different operators
- Three-dimensional reconstruction of the dentofacial structures using cone-beam computed tomography can facilitate in arriving at norms for ethnic population.

### CONCLUSION

It is a fact that all different ethnic races have different facial characters. The variability of the soft tissue integument in people with different ethnic origin makes it necessary to study the soft tissue standards of a particular community. An effort has been made to set the norms of Arnett's STCA for Maratha population (Indian population). The above findings should be taken into consideration while treating Maratha ethnic population such as over-retraction of maxillary incisors must be avoided in Maratha males and chin prominence is less in Maratha ethnic population warning against the surgical procedures that reduce its prominence such as mandibular setback. Keeping these norms in view, during an orthodontic and orthognathic treatment, a more esthetically suitable treatment plan can be devised for better results.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand

that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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### Conflicts of interest

There are no conflicts of interest.

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