**How to Cite**:
Bansal, A., Prakash, A., Singh, P., Khanam, S. J., Kannan, S., & Singh, R. K. (2022). A soft tissue analysis for central India population: A cephalometric study. *International Journal of Health Sciences*, *6*(S3), 2562–2571. https://doi.org/10.53730/ijhs.v6nS3.6131

# A soft tissue analysis for central India population: A cephalometric study

**Anushree Bansal**
MDS, Assistant Professor, Department of Orthodontics and Dentofacial Orthopedics, Sudha Rustagi College of Dental Sciences and Research, Faridabad 9752890533
Email: anushreebansal6@gmail.com

**Amit Prakash**
MDS, Professor, Department of Orthodontics and Dentofacial Orthopedics, Awadh Dental College and Hospital, Jamshedpur 9131538783
Email: amitprakash30@gmail.com

**Parul Singh**
MDS, Associate Professor, Department of Orthodontics and Dentofacial Orthopedics, Maharana Pratap College of Dentistry and Research Centre, Gwalior 9174413387
Email: drparulsingh5@gmail.com

**Sarwat Jahan Khanam**
Post Graduate student, Department of Orthodontics and Dentofacial Orthopedics, Sudha Rustagi College of Dental Sciences and Research, Faridabad 9560837882
Email: drsarwatkhan21@gmail.com

**Sridhar Kannan**
MDS, Professor, Department of Orthodontics and Dentofacial Orthopedics, Sudha Rustagi College of Dental Sciences and Research, Faridabad 9818212912
Email: sridharnoopur@gmail.com

**Raj Kumar Singh**
MDS, Associate Professor, Department of Orthodontics and Dentofacial Orthopedics, Sudha Rustagi College of Dental Sciences and Research, Faridabad 8745980967
Email: rajortho2010@gmail.com

***Abstract*---**Based on surgical-orthodontic treatment planning and prediction system Tony G. McCollum (TOMAC), the present study aims to determine surgical norms for Central India population and to evaluate the variation between Central India males and females.

International Journal of Health Sciences ISSN 2550-6978 E-ISSN 2550-696X © 2022.
***Corresponding author**: Singh, R. K.; Email: rajortho2010@gmail.com*
*Manuscript submitted: 18 Dec 2021, Manuscript revised: 27 March 2022, Accepted for publication: 09 April 2022*

Digital lateral cephalograms of hundred subjects (50 males and 50 females) of 15- 25 years of age were obtained. These radiographs were manually traced by single operator based on the parameterstaken from TOMAC soft tissue analysis. The data obtained was statistically analyzed using Mann-Whitney U test and One-sample Wilcoxon Signed Rank test. Statistically significant difference were observed between the Central India population and Caucasian population and also significant sexual dimorphism was noted among the population of Central India. There exist racial diversity between Central India population and the Caucasian population.Therefore, it becomes necessary to have separate norms for different ethnic groups and choose the norms carefully suited to the treatment needs of individual population.

***Keywords*---**soft tissue, India population, cephalometric study.

## Introduction

The prime objective of the orthodontic treatment is attainment of excellent facial form. Since the perception and quantification of beauty and facial balance has changed over time and differs from one population to another. Also, the esthetics of face depends upon soft and hard tissue contour, authors worked upon a number of hard tissue analyses and their effects in attaining an ideal facial form. Numerous hard tissue cephalometric analyses are reported in the literature to diagnose and plan orthognathic surgery.[1]Despite of so many hard tissue analysis & norms available, and treatment according to them, it was found that soft tissue of patient didn't respond as expected. Soft tissue analysis predicts the end results of treatment in a better way. The treatment planning based on soft tissue measurement has received greater attention only during recent times.

The soft tissue paradigm in orthodontic has started due to a rise in aesthetic demand. It has compelled clinicians to diagnose and plantreatment for the patient according to the soft tissueresponse. Assessment of soft tissue structures of considerable importance in establishing treatment goals for orthodontic and orthognathic surgery and various cephalometric analysis incorporating soft tissue parameters has evolved in recent times.[2] One such surgical-orthodontic treatment planning and prediction system TOMAC, developed by Dr. Tony G. McCollum is used to identify the best possible soft-tissue profile by testing the effects of various orthodontic and surgical options using VTO to predict the soft-to-hard-tissue response. The essential underlying principle behind the TOMAC analysis is that the soft-tissue profile is changed first, setting a goal toward which hard-tissue changes are adapted.

The TOMAC prediction system offers the clinician an opportunity to identify treatment goals in the vertical and anteroposterior planes and allowing them to make more confident decision regarding whether a case can be treated by orthodontics alone or requires orthognathic surgery.[3-5] Most of the classical soft tissue cephalometric standards are based on the sample population with European-American ancestries (Caucasian population). The studies done by

various researchers has indicated that the 'norms' for cephalometric measurements should be based on factors such as ethnicity, sex, and age differences and normal measurements of one group cannot be considered normal for other racial groups. India is a subcontinent with large number of different racial groups. Therefore, different populations have to be traced according to their own individual characteristics, readings of which cannot be applied to another population.[6] As for all ethnic group's norms differ, the aim of this study was to assess the norms of TOMAC analysis for adult population of Central India and identify the possible soft tissue variation among males and females, to provide a holistic approach towards surgical orthodontic treatment planning.

**Materials and Method**

The frontal and profile photographs of the samples selected from different parts of Central India were shown to a panel of orthodontists. Hundred adults (50 males and 50 females) between the age group of 15-25 years were chosen for study,which fulfilled the following criterias.

**Inclusion criteria**

- Balanced face and pleasing facial esthetics not taking into account the skin color, beautiful eyes or skin texture.
- Angle's class I molar relationship with well aligned maxillary and mandibular arch.
- Full complement of teeth, 3rd molars were not taken into consideration.
- Patient should not present with a history of orthodontic treatment, orthognathic surgery, and plastic surgery.
- Subjects and their parents should be native of Central India.

**Exclusion criteria**

- Class II, Class III molar relation, malaligned teeth or any other severe malocclusion.
- Missing teeth, gross restorations, buildups, crowns, onlays, Class II amalgams, or composite restorations that affect the tooth's mesiodistal diameter.
- Congenital defects or deformed teeth.
- Previous history of orthodontic treatment or orthognathic surgery.
- Subjects belonging to geographic regions other than those of Central India.

**Soft tissue landmarks used in Tomac**

Glabella, Eye point, Subnasale, Superior labial sulcus, Labralesuperius, Stomion, Labraleinferius, Inferior labial sulcus, Pogonion, Menton, True menton, Throat. (Fig 1).

**Measurements used in Tomac (fig 2,3,4)**
**Angular measurements**

- Facial contour/convexity angle
- Nasofacial angle
- Nasolabial angle
- Lower-lip-chin-throat angle

**Linear measurements (Fig 5,6,7,8,9)**

- Lip protrusion
- Chin length
- Facial height
- Interlabial gap
- Maxillary incisor exposure
- Lip taper

Digital lateral cephalograms of the 100 chosen subjects were taken in natural head position (NHP), with the teeth in centric occlusion, maximum intercuspation, and lips in repose. To ensure natural head position ear rods were used.After ensuring the final position of the patient the X-ray wascaptured. The lateral cephalograms were taken on a standard cephalostat at 5 feet source to object distance at 73 Kvp and 12 mA with exposure time 0f 0.80 sec on XTROPAN 2000 digital panoramic and cephalometric system. The size of the film used was 8 x 10 inch. Identification of landmarks was based on TOMAC soft tissue surgical analysis. The radiographs were traced and analyzed manually by single examiner on acetate tracing paper of 50 microns thickness using lead pencil (0.3mm in diameter) under similar conditions of light box. The tracing of each radiograph was done three times by the single examiner at an interval of 15 days and their average value was taken. This was done to minimize the manual errors and increasing the accuracy of the calculations.

**Statistical analysis**

Data was entered in Microsoft excel 2016 for Windows. Frequency, percentages, mean, standard deviation (SD), minimum and maximum values of variables were calculated. Shapiro-Wilk test showed that observed values in Central India population did not follow normal distribution. Hence non-parametric tests were applied for further data analysis. For comparison of observed values between male and female, Mann-Whitney U test was applied. To compare observed values with original TOMAC values, One-sample Wilcoxon Signed Rank test was applied. P value $<0.05$ was considered statistically significant. Data analyses were performed using version 21.0 of the Statistical Package for Social Sciences (IBM Corporation, Armonk, New York, USA).

**Results**

Mann-Whitney U test was applied to observed data and mean values were compared between men and women of Central India population. Statistically

significant differences were found between genders in some measurements (Table 1). Angular measurements showed significantly higher values of facial contour angle (<0.001), lower lip-chin-throat angle(<0.01) for males than females suggesting a more convex facial profile in males. A significantly lower value of nasolabial angle (<0.001) in male suggested that males have more prominent upper lips than females. No significant difference was observed in the value of nasofacial angle (>0.05).

The assessment of linear measurements showed significant sexual dimorphism. The value of lip protrusion (<0.001), chin length (<0.05), upper lip length (<0.01), and maxillary incisor exposure (<0.01) showed significant difference whereas interlabial gapand lip tapershowed no significant difference (>0.05). When the lip form was assessed, the upper and lower lips were found to be more protrusive in males than in females which justify the acute nasolabial angle in males than in females. Chin length was observed to be significantly higher (<0.05) in males than females. A significantly higher value of upper lip length (<0.01) observed in males suggests that the facial height is more in males as compared to females. A significantly high value of maxillary incisor exposure was observed for females than males (<0.01).

One-sample Wilcoxon Signed Rank test was used to compare the values betweenCentral India population and the Caucasian population (Table 2) Statistical analysis showed that the value of facial contour angle (<0.01), and lower lip-chin-throat angle(<0.001) was found to be significantly higher for Central India males when compared to the Caucasian population. Central India females on the other hand showed significantly lower value for facial contour angle than Caucasian females (<0.001). On comparing the Nasolabial angle,it was seen that the original TOMAC values were significantly higher than the observed values for both the males and females of Central India population (<0.001) showing more prominent lips in Central India population than the Caucasian population. No significant difference was observed in nasofacial angle (>0.05).

The value for upper and lower lip protrusion in male population of Central India was significantly higher than the white population (<0.001) suggesting of more prominent lips in Central India males. Observed value for upper lip protrusion was significantly low (<0.01) and for lower lip protrusion was significantly high (<0.01) in Central India females when compared to the Caucasian population. The values for chin length (male-<0.001, female-<0.01), upper lip length (male-<0.001, female-<0.05), and interlabial gap(<0.001) werefound to be significantly less for both males and females ofCentral India population in comparison to that of Caucasian population suggesting increased facial height in white population.
The lip taper was found to be significantly low for Central India population. The maxillary incisor exposure was significantly higher inmales (<0.001) and lower in females (<0.001) of Central India population in comparison to white population.

Table 1
Comparison of angular and linear values between Central India males and females

| Parameters | Gender | Mean ± SD | Min-Max | Mann-Whitney U test |
|---|---|---|---|---|
| Facial contour angle (°) | Male | 13.74 ± 3.08 | 10.00-21.67 | MW = 627.000, P = 0.000 (<0.001), VHS |
| | Female | 11.61 ± 3.05 | 8.53-18.67 | |
| Nasolabial angle (°) | Male | 100.65 ± 3.43 | 94.33-107.00 | MW = 690.000, P = 0.000 (<0.001), VHS |
| | Female | 103.77 ± 3.46 | 99.00-110.00 | |
| Nasofacial angle (°) | Male | 34.55 ± 1.81 | 30.67-36.00 | MW = 1061.500, P = 0.537 (>0.05), NS |
| | Female | 35.09 ± 1.49 | 33.33-39.33 | |
| Lower lip-chin-throat angle (°) | Male | 112.01 ± 3.67 | 107.48-117.48 | MW = 795.000, P = 0.002 (<0.01), HS |
| | Female | 109.07 ± 4.92 | 102.33-119.33 | |
| Upper lip protrusion (mm) | Male | 4.02 ± 0.56 | 2.50-4.56 | MW = 342.500, P = 0.000 (<0.001), VHS |
| | Female | 3.18 ± 0.53 | 2.00-4.10 | |
| Lower lip protrusion (mm) | Male | 2.81 ± 0.63 | 2.24-4.74 | MW = 739.000, P = 0.000 (<0.001), VHS |
| | Female | 2.47 ± 0.45 | 2.00-3.00 | |
| Chin length (mm) | Male | 39.77 ± 2.80 | 34.33-42.33 | MW = 938.000, P = 0.030 (<0.05), S |
| | Female | 38.47 ± 2.55 | 35.00-44.67 | |
| Upper lip length (mm) | Male | 20.29 ± 1.27 | 18.00-22.33 | MW = 767.500, P = 0.001 (<0.01), HS |
| | Female | 19.31 ± 1.50 | 15.00-21.00 | |
| Interlabial gap (mm) | Male | 0.65 ± 0.79 | 0.00-2.33 | MW = 119.500, P = 0.302 (>0.05), NS |
| | Female | 0.55 ± 0.90 | 0.00-2.50 | |
| Maxillary incisor exposure (mm) | Male | 2.22 ± 0.76 | 1.00-4.00 | MW = 757.500, P = 0.001 (<0.01), HS |
| | Female | 2.71 ± 0.68 | 1.50-3.67 | |
| Lip taper (mm) | Male | 0.63 ± 0.42 | 0.00-1.33 | MW = 1056.000, P = 0.164 (>0.05), NS |
| | Female | 0.77 ± 0.52 | 0.00-2.00 | |

Table 2
Comparison of values between Central India population and TOMAC population

| Parameters | Central India males (mean ± SD) | TOMAC males (mean) | p value | Central India females (mean ± SD) | TOMAC females (mean) | p value |
|---|---|---|---|---|---|---|
| Facial contour angle (°) | 13.74 ± 3.08 | 12.00 | P = 0.001 (<0.01), HS | 11.61 ± 3.05 | 15.00 | P = 0.000 (<0.001), VHS |
| Nasolabial angle (°) | 100.65 ± 3.43 | 105.00 | P = 0.000 (<0.001), VHS | 103.77 ± 3.46 | 115.00 | P = 0.000 (<0.001), VHS |
| Nasofacial angle (°) | 34.55 ± 1.81 | 35.00 | P = 0.814 (>0.05), NS | 35.09 ± 1.49 | 35.00 | P = 0.466 (>0.05), NS |
| Lower lip- | 112.01 ± | 110.00 | P = 0.000 | 109.07 ± | 110.00 | P = 0.225 |

| | | | | | | |
|---|---|---|---|---|---|---|
| chin-throat angle (°) | 3.67 | | (<0.001), VHS | 4.92 | | (>0.05), NS |
| Upper lip protrusion (mm) | 4.02 ± 0.56 | 3.50 | P = 0.000 (<0.001), VHS | 3.18 ± 0.53 | 3.50 | P = 0.001 (<0.01), HS |
| Lower lip protrusion (mm) | 2.81 ± 0.63 | 2.20 | P = 0.000 (<0.001), VHS | 2.47 ± 0.45 | 2.20 | P = 0.003 (<0.01), HS |
| Chin length (mm) | 39.77 ± 2.80 | 42.00 | P = 0.000 (<0.001), VHS | 38.47 ± 2.55 | 40.00 | P = 0.001 (<0.01), HS |
| Upper lip length (mm) | 20.29 ± 1.27 | 24.00 | P = 0.000 (<0.001), VHS | 19.31 ± 1.50 | 20.00 | P = 0.011 (<0.05), S |
| Interlabial gap (mm) | 0.65 ± 0.79 | 1.50 | P = 0.000 (<0.001), VHS | 0.55 ± 0.90 | 1.50 | P = 0.000 (<0.001), VHS |
| Maxillary incisor exposure (mm) | 2.22 ± 0.76 | 1.50 | P = 0.000 (<0.001), VHS | 2.71 ± 0.68 | 4.00 | P = 0.000 (<0.001), VHS |
| Lip taper (mm) | 0.63 ± 0.42 | 1.00 | P = 0.000 (<0.001), VHS | 0.77 ± 0.52 | 1.00 | P = 0.006 (<0.01), HS |

*NS = Not significant, S = Significant, HS = Highly significant, VHS = Very high significant

**Discussion**

Achieving the optimal facial form is the prime objective of the orthodontic treatment. The assessmentof both hard and soft tissue of the face and obtaining harmony among them is necessary to achieve this goal. The soft tissue covering the teeth and bones can vary greatly in thickness, length, and postural tone, that the dentoskeletal pattern may be an inadequate guide in evaluating facial disharmony. Relyingsolely on cephalometric dentoskeletal analysis for treatment planning may lead to esthetic problems, especially when the orthodontist tries to predict soft tissue outcome using only hard tissue normal values. It is necessary therefore to study the soft tissue contour to adequately assess facial harmony. TOMAC is a radiographic instrument developed by Tony G McCollum in 2001. The uniqueness of the analysis lies in the fact that, in TOMAC analysis the soft tissue goals are traced in first, and the hard tissue are than adapted based on the known soft to hard tissue response.[3]

The study was done on 100 subjects (50 males and 50 females) in the age group 15-25 years, with natural Class I occlusion, and well-balanced facial profile. The results of the study are discussed under two headings: angular measurements and linear measurements. In each group the comparison was drawn and analyzed between male and female samples and the original TOMAC values. Of the Angular parameters, the comparison between males and females showed that, males had significantly higher values for Facial contour angle and Lower lip-chin-throat

angle than females. This indicates a more convex profile in males than females. The results were similar to the findings of Jain P et al[6] in her study on North Indian population, but were contrary to the TOMAC's[3] norms for Caucasian population.

Also in our sample, upper lip was more prominent in males than females shown by acute Nasolabial angle. The result was similar to that of TOMAC.[3] Similar results were also observed by Kalha et al[7] in his study on South Indian males and Jain P et al[6] in her study on North Indian population, showing significantly acute nasolabial angle in males. This result was contrary to that of Arnett's norms[8], where females showed significant upper lip prominence than males. Scheideman et al[2] also had similar results showing fuller and prominent upper lip in females.
When these mean values were compared with those of TOMAC's values, significantly higher values of Facial contour angle and Lower lip-chin-throat angle were observed for males whereas significantly lower value of Facial contour angle was observed for females. The mean value of Nasolabial angle was significantly low for both males and females on comparison with TOMAC[3] values which suggests that population of Central India has more convex profile than the Caucasian population. Nasofacial angle showed no significant finding.

Of the linear parameters, the comparison between males and females showed that the values of upper and lower lip protrusion were significantly higher in males than in females which shows that the Central India males have protruded lips in comparison to females. These results were similar to those of Jain P et al[6]. No such sexual dimorphism was observed in TOMAC[3] values for the same. These values were significantly higher for Central India population than the TOMAC values which suggest that Central India population have more protruded lips than Caucasian population. The value of chin length observed was less for females in comparison to males of Central India. The results were similar to those of TOMAC.[3] Similar sexual dimorphism is seen in Caucasian population. But the significantly low value of chin length for Central India population shows decreased size of chin in Central India population.

The value upper lip length in Central India males is higher than the females which show the increased facial height of males. The results are similar to those of Caucasian population.[9] The Arnett results were also similar to our present study. In the study of soft tissue facial profile, Scheideman2 also showed similar results. The results were similar to Tikku T et al[1] study on north Indian population and Kalha et al[7] study on South Indian population showing increased facial height in males. The values of our study were significantly lower than those of Caucasian population which shows that facial length in Caucasian population is more. The significant difference in facial heights between men and women is important in treatment planning because these differences can be indications to increase or decrease face height. The women in our study showed lesser value of interlabial gap than men. These findings are contrary to those of Arnett[8], Scheideman[2] and various other researchers. These values are also significantly lower than those of Caucasian population. The value of maxillary incisor exposure was more in female than in males. These results were statistically significant. The similar results were also noted by TOMAC[3], Arnett[8], Chhajed S et al[10], Kalha et al[7] etc.

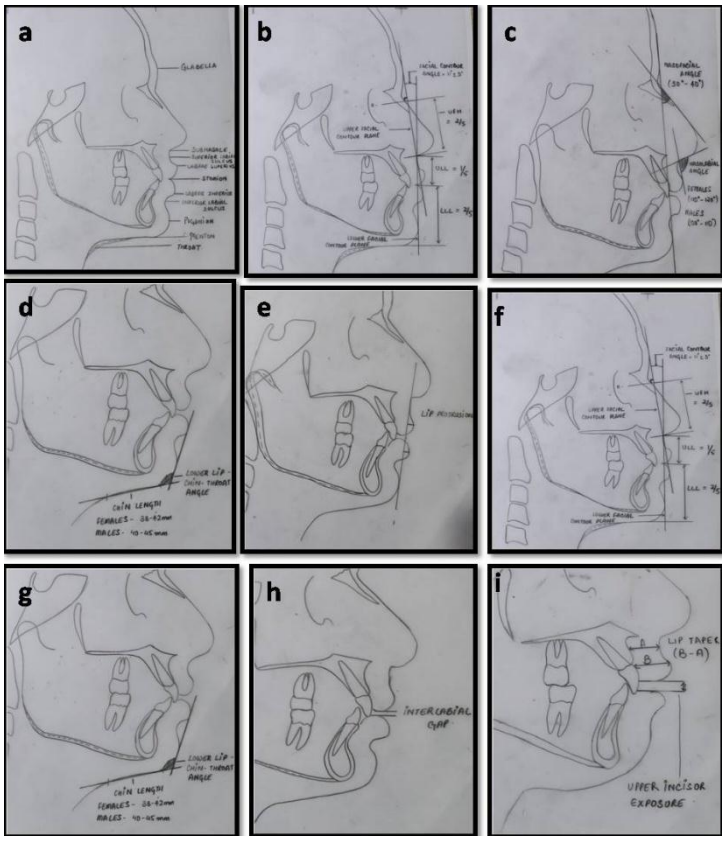
## Conclusion

The analysis of soft tissue is the critical step in orthodontic decision making. The TOMAC system is useful because, in the TOMAC VTO[4], the soft tissue goals are traced first, and the hard tissues are then adapted also it offers the opportunity to identify treatment goals in the vertical and anteroposterior planes, allowing the clinician to be more confident in decision making. The cephalometric comparison led us to the following outcome that diversity exists between the Caucasian population and the Central India population in that the Central India population had smaller facial length, more convex facial profile, protruded and prominent lips, small interlabial gap. Other than the racial differences there exists the sexual dimorphism within the population wit males having more convex profile, protrude lips, increased facial length, whereas females had increased incisor exposure.
Thus, we can conclude that there exist differences in the norms of different ethnic groups and also among the two genders within the same groups. Therefore, it becomes necessary to devise norms for individuals of different racial groups for accurate diagnosis and treatment planning.

## References


1. Tikku T, Khanna R, Maurya RP, Verma SL, Srivastava K, Kadu M. Cephalometric norms for orthognathic surgery in North Indian population using Nemoceph software. J Oral Bio Cran Res. 2014;4(2):94-103.
2. Scheideman GB, Bell WH, Legan HL, Finn RA, Reisch JS. Cephalometric analysis of dentofacialnormals. Am J Orthod. 1980;78(4):404-20.
3. McCollum TG. TOMAC: an orthognathic treatment planning system. Part 1 soft-tissue analysis. J ClinOrthod. 2001;35(6):356.
4. McCollum TG. TOMAC: an orthognathic treatment planning system. Part 2 VTO construction in the horizontal dimension. J ClinOrthod. 2001;35(7):434-43.
5. McCollum TG. TOMAC: an orthognathic treatment planning system. Part 3. VTO construction in the vertical dimension. J ClinOrthod. 2001;35(8):478.
6. Jain P, Kalra JP. Soft tissue cephalometric norms for a North Indian population group using Legan and Burstone analysis. Int J Oral Max Sur. 2011;40(3):255-9.
7. Kalha AS, Latif A, Govardhan SN. Soft-tissue cephalometric norms in a South Indian ethnic population. Am J OrthodDentofac Orthop.2008;133(6):876-81.
8. Arnett GW, Jelic JS, Kim J, Cummings DR, Beress A, Worley CM et al. Soft tissue cephalometric analysis: diagnosis and treatment planning of dentofacial deformity. Am J OrthodDentofacOrthop. 1999;116(3):239-53.
9. Worms FW, Isaacson RJ, Speidel M T. Surgical orthodontic treatment planning: profile analysis and mandibular surgery. Angle Orthodontist. 1976;46(1):1-25.
10. Chhajed S, Kodumuru S, Singh G, Arun AV, Cholleti SK, Kothari S. Facial soft tissue cephalometric norms in a central Indian ethnic population. J IndOrthod Soc. 2014;48(1):7.

Figure: 1




**Legends for figures**

- Soft tissue landmarks used in TOMAC.
- Facial contour angle.
- Nasofacial and nasolabial angle.
- Lower-lip-chin-throat angle.
- Lip protrusion.
- Facial height.
- Chin length.
- Interlabial gap.
- Lip taper and upper incisor exposure.