International Journal of Research in Health and Allied Sciences

Journal home page: www.ijrhas.com

Official Publication of "Society for Scientific Research and Studies" [Regd.]

ISSN: 2455-7803

Review Article

Cephalometric analysis and lip morphology: A comprehensive review

[1]Dr. Manvinder Kaur, [2]Dr Kishor B. Bagalkot, [3]Dr Gurinder Pal Singh Sandhu, [4]Dr.Vijay K. Sonawane, [5]Dr Lokendra Singh Dagur, [6]Dr Shivangi Mittal

[1]BDS, Private Practitioner, India;
[2]Consultant Orthodontist, Dr Kishor Bagalkot Dental Orthodontic and Implant Centre, Karnataka, India;
[3]Professor, Department of Orthodontics, DBDC Mandi, Gobindgarh, Punjab, India;
[4]Reader, RDC Loni, Maharashtra, India;
[5]Assistant Professor, Department of Orthodontics, Jaipur Dental College, Jaipur, Rajasthan, India;
[6]Senior lecturer, Department of Orthodontics, Jaipur Dental College, Jaipur, Rajasthan, India

ABSTRACT:
Orthodontics craniofacial "norms" vary and must be considered based upon the intended use or application. Facial attractiveness influences personality development and social interactions. People mainly focus on another person's eyes and mouth during interpersonal interactions, with little time spent on other facial features. An aesthetically pleasing and balanced face is one of the objectives of orthodontic treatment. An understanding of the soft tissues and their normal ranges enables a treatment plan to be formulated to normalize the facial traits for a given individual.
Key words: Lip, Cephalometric

Received: 22 October, 2021 Accepted: 25 November, 2021

Corresponding author: Dr. Manvinder Kaur, BDS, Private Practitioner, India

This article may be cited as: Kaur M, Bagalkot KB, Sandhu GPS, Sonawane VK, Dagur LS, Mittal S. Cephalometric analysis and lip morphology: A comprehensive review. Int J Res Health Allied Sci 2021; 7(6):44-47.

INTRODUCTION

Orthodontics craniofacial "norms" vary and must be considered based upon the intended use or application. Esthetic profile "norms" are dictated by temporal values as there is greater preference today for a protrusive lip posture compared to yester-year; facial soft tissue "norms" depend upon imaging technique as 3-D contour assessment enables a vastly different data set than 2-D profile analysis. When the focus is on comparing the morphological characteristics of different ethnic populations, however, 2-dimensional lateral cephalometric analysis is likely the best resource.[1- 3]

Facial attractiveness influences personality development and social interactions. People mainly focus on another person's eyes and mouth during interpersonal interactions, with little time spent on other facial features. Soft tissues are the most important aspect in orthodontic treatment planning and cephalometrics plays an important role to quantify this. Facial harmony and balance are maintained by the facial skeleton and its overlying soft tissue. Orthodontic diagnosis and treatment planning are based on evaluation of patient's soft tissue profile. Two-dimensional lateral cephalometric analysis persists as the orthodontic standard for identifying the problem sources in skeletal and/or dental malocclusion relationships. Because cephalometric analysis developed as a technology largely in the West, Euro-American Caucasian normative databases are typically used a reference to characterize craniofacial morphology in patients. Two well-known and commonly used Caucasian normal databases for comparison are from the Steiner and Eastman (MacAllister) samples based upon Class I normal faces and occlusions.[1, 2]

An aesthetically pleasing and balanced face is one of the objectives of orthodontic treatment. An understanding of the soft tissues and their normal ranges enables a treatment plan to be formulated to normalize the facial traits for a given individual. By knowing the soft tissue traits in relation to lips and their normal range, treatment plan can be designed to normalize the facial traits for a given individual. [1, 2]

Shift of paradigm from Angle to soft tissue and concepts of facial planning in orthodontics have stressed on significance of nose, lip and chin evaluation with emphasis and assessment of lip prominence which had been carried out by measuring different reference lines cephalometrically.[3- 6]

LITERATURE

Ab Talib M et al 2014 evaluated the cephalometric linear and angular measurements of lip morphology of Malaysian Malay population. A retrospective study of linear and angular cephalometric measurement of lip morphology among Malay population in Malaysia. Standardized cephalometric radiographs of 70 Malaysian Malay adults were analyzed. The samples comprised of 46 females and 24 males. Total 9 linear and 5 angular measurements were carried out on cephalometric radiographs using Winceph 8.0 software. Descriptive statistics and sexual dimorphism were analyzed using IBM SPSS Statistics Version 20.0. The reliability of the method was analyzed using Dahlberg's formula. Statistically significant disparities were found in the Malay population between males and female of lower lip to E line, upper lip thickness, lower lip thickness and nasolabial angle. Other measurements showed some similarities and variations but no significant differences were observed. They established cephalometric lip morphology for the Malay adults and sexual demorphism but these values should not be interpreted as treatment aim.[7]

Aziz AS et al 2014 evaluated the cephalometric linear and angular measurements of lip morphology among Malaysian Chinese population. A retrospective study involving the collection and analysis of lateral cephalometric radiographs of Malaysian Chinese. Standardized cephalometric radiographs of 70 Malaysian Chinese adults were analyzed. Among them are 37 females and 33 males aged from 18 to 25 years who did not undergo any orthodontic treatment. Total 9 linear and 5 angular measurements were carried out on cephalometric radiographs using Winceph 8.0 software. Descriptive statistics and sexual dimorphism were analyzed using IBM SPSS Statistics Version 20.0. The reliability of the method was analyzed using Dahlberg's formula. This study was an attempt to establish the description of cephalometric lip morphology for the Malaysian Chinese adults. Cephalometric lip morphology is precise for the ethnic group, but these values should not be interpreted as treatment aim.[8]

Alam MK et al 2016 analyzed sagittal and vertical occlusal cephalometric analyses of Pancherz among Malaysian Malay and Malaysian Chinese. Further comparisons of each area of interest are needed to know the differences between them. It was a cross sectional study and total 640 lateral cephalogram (Malay=407, Chinese=233) were randomly selected among orthodontic patients. All sagittal and vertical occlusal cephalometric parameters of Pancherz were measured digitally using Planmeca software. Descriptive statistics, gender and racial dimorphism were analyzed using IBM SPSS Statistics Version 22.0. Data were analyzed using independent t-test. Statistically significant disparities were found in the Malaysian Malay population between males and females for 3 of 10 in the vertical occlusal analysis but there were no significant disparities found in sagittal occlusal analysis. In the Malaysian Chinese population, significant disparities found between males and females for 1 of 11 in sagittal occlusal analysis and 6 of 10 vertical occlusal analysis. Statistically significant disparities were also found between Malaysian Malay and Malaysian Chinese population for 10 of 11 parameters in sagittal occlusal analysis and 5 of 10 parameters in vertical occlusal analysis. In conclusion, there were significant disparities between Malaysian Malay and Malaysian Chinese in general and also between genders of each race seen using cephalometric analyses of Pancherz.[9]

Alam MK et al 2017 calculated the cephalometric linear and angular measurements of lip morphology of Pakistani adults. This is an analytical cross sectional study which was carried out in the Department of Orthodontics, Baqai Medical University and Liaquat College of Medicine and Dentistry, Karachi, Pakistan from April 2014 to April 2015. The present study was carried out on 100 pretreatment subjects aged 18-24 were selected based on Class I incisor relationship with minimum crowding, have not undergone any orthodontic treatment, no skeletal abnormality and had at least second molar to second molar dentition. Lateral cephalometric radiographs were taken, traced and analyzed to assess the skeletal, dental, soft tissue, nose and chin positions and to measure the cephalometric lip morphology and the mean values of their linear and angular measurements were compared between males and females. Statistically no considerable disparities were found in the Pakistani sample between males and female though there is some dissimilarity in the mean difference of nasolabial angle, Mento labial angle and upper lip to esthetic line. They concluded that cephalometric lip morphology for the Pakistani adults in which majority of analysis there is no significant difference between male and females but nasolabial angle, mentolabial angle and upper lip to esthetic line shows some difference in the mean values in both the genders.[10]

Sahu A et al 2018 conducted study on a Cephalometric Analysis in Hazaribag Population. 58 (30 female and 28 male) Subjects for the present study has been selected randomly from patient treated in Department of Orthodontics and Dentofacial Orthopedics, Hazaribag College of Dental Sciences and Hospital, Hazaribag, Jharkhand. : Among the 58 subjects hyperdivergent pattern group found to be smallest (10.3%) with the neutral and hypodivergent patterns are 17.2% and 72.4 % show the distribution of malocclusion among morphological patterns. This study found mean values of all linear measurements in

males are larger than female. Relatively strong correlations are found between lower gonial angle, gonial angle, mandibular plane angle, palatal /mandibular plane angle, Frankfurt/ mandibular plane angle SNB, Y Axis , sum of saddle + articular + gonial angles and posterior facial height.[11]

Alshahrani I et al 2019 evaluated linear and angular measurement of lip morphology in Saudi adults and their comparison with the norms. After taking their history and physical examination, the patients were referred for a lateral Cephalograph using Dolphin Imaging Software. Linear and angular measurements related to lip morphology were recorded. Significant differences were found in the lower lip to E line, upper and lower lip protrusion, upper and lower lip to S line and upper and lower lip thickness, nasolabial angle, Z angle, with Saudi males having more prominent, thicker lips than the Saudi females. Comparison with the norms revealed that both lips are prominent among Saudi males, while in females there is an increased prominence of the lower lip. Value of the lower lip to H line is increased in both genders, males have prominent and thicker upper lips compared to the females and the lower lip in both genders is more prominent compared to the norms.[12]

Islam M et al 2021 assessed the soft tissue characteristics of Bangladeshi adults to formulate soft tissue 3D CT standards using Holdaway's (HA) and lip morphology (LM) analyses. Another aim of this study was to assess the gender dimorphism of Bangladeshi population. One hundred and seventeen (Eighty-five men and Thirty-two women) Bangladeshi adults have obtained their computed tomography (CT) scan at the Radiology Department for normal diagnosis. Craniofacial deformities were undetected in all cases. The CT images were prepared by a 3D imaging programming software (Mimics 11.02 Materialise). Parameters from the identified landmark points were measured in 3D through this software. Upper lip thickness (ULT) (vermillion UL-A point) measurement was significant in HA and in LM analyses, upper lip protrusion (ULP) (Ls to Sn-SPog) measurement has demonstrated significant difference among both genders, where p-value was less than 0.05. Mean measurements of Bangladeshi adults were relatively comparable except the face convexity (FC) when compared with the HA cephalometric soft tissue values. By using HA and LM analyses, 3D CT soft tissue standards were established for Bangladeshi adults. Measurements for all parameters have remained equivalent with the HA standard data apart from the FC measurement. This consequently may demonstrate that the Bangladeshi population retains a convex shape with a slight protrusive lip or retruded chin.[13]

Cheng JH et al 2021 developed smile measurements for lateral and oblique view photographs to help in orthodontic analysis and treatment planning, to quantitatively evaluate the relationship between smile esthetics and different types of malocclusion using lateral and oblique view photographs, to identify the cephalometric factors affecting smile measurements. Patients who came to orthodontic department of a university hospital from 2014 to 2017 and met the inclusion criteria were included and divided into three groups according to Angle's classification. Thirteen variables were measured for cephalometric analysis. Twenty-one variables were developed and measured on pretreatment photographs for lateral and oblique smile analysis. ANOVA and Scheffe post hoc test were used to compare cephalometric and smile variables among three groups. Multiple linear regression analysis was performed to identify cephalometric factors affecting smile measurements. Three-hundred and ninety patients (287 females, 103 males) with mean age of 24.5 ± 7.6 years reached the criteria. All cephalometric variables differed significantly among three groups. Except for maxillary teeth exposure number, visible maxillary width, and lip thickness ratio, all smile variables differed significantly. Smile characteristics had significant correlation with some cephalometric measurements. They suggested including lateral and oblique smile view photographs in the data collection for orthodontic treatment planning.[14]

Yan X et al 2021 evaluated the association between upper lip characteristics (ULCs) and skeletal patterns (SPs). 2079 patients were involved and grouped by sagittal and vertical. Class I, II, and III were identified by ANB angle, while normodivergent, hyperdivergent, and hypodivergent were identified by Facial Height Index and Sum of Angles. ULCs were evaluated by superior sulcus depth, nasolabial angle, upper lip length, basic upper lip thickness, and upper lip thickness. Confounders including demography, malocclusion, upper incisors, and upper lips were adjusted by multivariate linear regression to identify the association between ULCs and SPs. Group differences were evaluated with analysis of variance and Chi-square test. The mean value of ULCs and prevalence of SPs were explored in the Western China population. ULCs were significantly different in various sagittal, vertical, and combined SPs. Superior sulcus depth was negatively related to Class II, and positively related to Class III and the hypodivergent pattern after adjusted by confounders. ULCs significantly varied among different SPs, while only superior sulcus depth was independently associated with SPs, indicating superior sulcus depth is the only ULC that might be significantly corrected by intervention of skeletal growth.[15]

DISCUSSION

With the knowledge of standard facial traits and the patient's soft tissue features, an individualized norm can be established for each patient to optimize facial attractiveness. Over the years, several lines and angles have been used to evaluate soft tissue facial esthetics. Most of these analyses had the disadvantage that the horizontal reference planes taken were either the

Frankfort horizontal plane or the cranial base, the orientation of which could differ significantly from person to person. The vertical reference planes, which were related to the above horizontal planes, were obviously unreliable. Soft tissue mid-face landmarks were not given proper importance. To overcome these shortcomings, Arnett et al. developed a new method of cephalometric analysis in the year 1999, which assessed the patient from their soft tissue measurements for altering the dento-alveolar as well as skeletal components. The analysis has the added advantage that it is based on natural head position (NHP). They specified a true vertical line (TVL) as the vertical reference plane to measure the soft tissue norms. Hence, this analysis has proved useful in planning strategies for both orthodontic and orthognathic surgery treatment. It is essential to establish the norms for local population based on Arnett et al.'s cephalometric analysis as it may be inappropriate to apply directly the values of Arnett's analysis to local population because it is a known fact that facial features of different ethnic groups differ significantly.[12- 15]

The maxillary and mandibular lips, forming the lower part of the soft-tissue facial profile and being closely associated to the teeth, have been studied by many orthodontists. In most studies', the investigation was related to the effect of orthodontic treatment on lip positions as a result of incisal retraction, while the remaining studies were related to lip posture,' growth effect' and the effect of training on the lips as measured linearly. Assessment of soft tissues in one dimension (for example, lip length or lip width) should be done with caution, as minor changes in the position of the lips may affect their linear dimensions considerably." One way to minimize the error resulting from changes in lip position is to assess the total lip area. Since the lips, as they appear in the lateral cephalogram, represent areas with variable nongeometric shapes, the assessment of lip area by conventional means is difficult. [12- 15]

The importance of the upper lip position before treatment lies in the assessment of soft tissue lip changes following retraction of the upper incisors. The overall tendency of thickening of the upper lip following upper incisor retraction is a function of its initial strain, as stated by Ricketts. Merrifield came up with a similar idea of a profile line, which was tangent to the soft tissue pogonion and the most procumbent lip. While the Holdaway H-line touches the upper lip and intersects the SN line, the Tweed-Merrifield's profile line touches the most procumbent lip and intersects the Frankfort horizontal (FH) plane. The upper lip thickness was higher in men (14.4 mm)than that in women (13.4 mm) with a broader range in female subjects (13-16 mm in men and 9-18 mm in women). Burstone introduced two lip posture definitions: the relaxed lip posture and the closed-lip posture. The former is a muscledictated position and does not rely on hard tissues. [12- 15]

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