Review Article

A Cephalometric Review on Soft-Tissue Paradigm

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Abstract

Esthetics is most commonly the reason patients seek orthodontic treatment. A beautiful dentition and pleasant smile together with symmetric and balanced facial proportions identify perfect esthetics. Assessment of the soft tissues during orthodontic examination and an understanding of the changes associated with growth and treatment are essential. Quantitative analysis of the human face and identification of facial asymmetry is thus considered a major focus for orthodontic diagnosis. The clinical observation of abnormal facial features may indicate the presence of a particular trait or possible skeletal or occlusal discrepancy. This article critically reviews various soft-tissue cephalometric analyses which enhance the normal facial traits.

Keywords: Cephalometrics, Esthetics, Facial proportions, Balanced smile, Cephalometric landmarks.

Introduction

A lovely face can enhance one's personality, but a facial deformity can significantly impact social acceptance and behavior.[1] Throughout recorded history, and much before, as evidenced by archeological artifacts, humans have been aware of and concerned with beauty and facial esthetics.[2] Orthodontic treatment is sought to achieve a beautiful smile and correct dentition function; this leads to an overall improvement in body image, which has been shown to promote self-esteem and quality of life.[3,4]

The importance of soft tissues in orthodontic diagnosis and treatment has expanded since Angle's discovery in 1907. According to Angle, the soft tissues are an important part of face harmony, which might affect a child's psychological development.[5-9]

Holdaway supported this theory and stated that including the "soft tissue" of the face would improve the results and emphasized that adequate soft-tissue proportions were consistent with the harmonization of the facial line.[10]

Arnett suggested ideal values by studying both hard and soft-tissue parameters so that patient values could be compared. A few soft-tissue cephalometric analyses have been established in the past to measure facial postures. Because it provides information about sagittal and vertical craniofacial pattern and facial harmony, as well as a deeper assessment of soft-tissue profile characteristics, soft-tissue cephalometric analysis is considered a reliable diagnostic method not only for orthognathic surgeons but also for orthodontists.[10,11] This article critically reviews various soft-tissue cephalometric analyses which enhances the normal facial traits.

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Soft-Tissue Cephalometric Landmarks[12]

- Glabella (G): The most prominent point in the midsagittal plane of the forehead.
- Columella point (Cm): The most anterior point on the columella of the nose.
- Subnasale (Sn): The point at which the nasal septum merges with the upper cutaneous lip in the midsagittal plane.
- Labrale superius (Ls): A point indicating the mucocutaneous border of the upper lip.
- Stomion superius (Stm): The lowermost point on the vermilion of the upper lip.
- Stomion inferius: The uppermost point on the vermilion of the lower lip.
- Labrale inferius (Li): A point indicating the mucocutaneous border of the lower lip.

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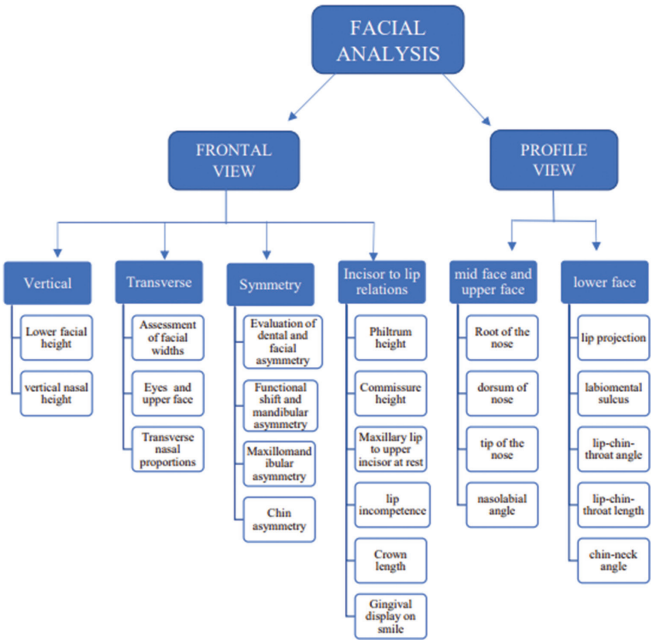
- Mentolabial sulcus (Si): The point of greatest concavity in the midline between the lower lip (Li) and chin (Pg).
- Soft-tissue pogonion (Pg): The most anterior point on soft tissue chin.
- Soft-tissue gnathion (Gn'): The constructed midpoint between soft-tissue pogonion and soft-tissue menton and can be located at the intersection of the subnasale to soft-tissue pogonion line and the line C to Me'.
- Soft-tissue menton (Me'): Lowest point on the contour of the soft-tissue chin; found by dropping a perpendicular from horizontal plane through menton.
- Cervical point (C): The innermost point between the submental area and the neck located at the intersection of lines drawn tangent to the neck and submental areas.

Soft-Tissue Evaluation

A systematic examination of facial and dental appearance needs to be done to evaluate the soft-tissue profile. It can be analyzed in frontal view and profile view.[13]



Soft-Tissue Cephalometric Analysis

Various soft-tissue cephalometric analyses described in this article are as follows:

- Metric analysis
- Holdaway analysis
- Subtelny analysis
- Profile analysis of A.M. Schwarz
- Burstone soft-tissue analysis for orthognathic surgery
- Arnett and Bergman analysis.

Metric Analysis

It explains quantitatively about interpreting the facial profile and presents a number of findings by applying this method.[14]

Holdaway Analysis

This analysis is an attempt to express quantitatively those soft-tissue relationships which are pleasing and harmonious as well as those which are not, to differentiate one from the other, and to explain how this information is used in orthodontic treatment planning [12].

Subtelny Analysis

The primary objective if this analysis is to define soft-tissue profile on a longitudinal basis and also contributed information regarding differentials in growth associated with different aspects of soft-tissue profile and their effect on configuration of total profile, relation between soft-tissue profile and underlying skeletal profile.[15]

Convexity of facial profile

- Increase in angle of facial convexity - straight or reduced convexity of facial profile
- Decrease in angle of facial convexity - increase convexity of facial profile.

Lips and denture

- Length of the upper lip
- The posture of the upper lip in its vertical relationship to dentoalveolar structures
- Length of the lower lip is assessed.

Profile Analysis of A. M. Schwarz

The aim of this analysis is to obtain the ought to be profile which nature gave the patient, without malocclusion.[16]

Angle formed by Pn and SpP is known as angle of inclination or J angle.

Angle formed between NA plane and NSe plane is called the F angle or facial angle.

Nine Features of Human Profile with Respect to F and J Angle Values

Horizontal column A: Straight faces with J angle of 85°.
Horizontal column B: Retroinclination; oblique faces, jaws slanting backward with J angle <85°
Horizontal column C: Anteinclination; oblique faces, jaws slanting forward with J angle >85°.

- Vertical column 1: Antefaces with F > 85°
- Vertical column 2: Average faces with F = 85°
- Vertical column 3: Retrofaces with F < 85°.

Burstone Soft-Tissue Analysis for Orthognathic Surgery

Facial for	Mean	Standard deviation
Facial convexity angle	12°	4°
Maxillary prognathism	6	3
Mandibular prognathism	0	4
Vertical height ratio	1	…
Lower face-throat angle 100°		7°
Lower vertical height depth ratio	1.2	…

Lip form and position	Mean	Standard deviation
Nasolabial angle	102°	8
Upper lip protrusion	3	1
Lower lip protrusion	2	1
Mentolabial sulcus	4	2
Vertical lip chin ratio	0.5	…
Maxillary incisor exposure	2	2
Interlabial gap	2	2

Arnett and Bergman Analysis

In this analysis, five different areas are evaluated.[17]

1. Dentoskeletal factors
2. Soft-tissue components
3. Facial lengths
4. TVL projections
5. Harmony of parts.

Lip Analysis[18]

Length of the upper lip

It is measured from subnasale to stomion.

Length of the lower lip

It is measured as the distance between stomion and gnathion.

Thickness of red part of upper lip

It is from labial surface of most labial incisor to the most anterior point on the red part of the upper lip. Average value – 11.5 mm.

Thickness of red part of lower lip

It is from labial surface of the lower incisors to the most anterior point on the red part of the lower lip. Average value – 12.5 mm.

Smile Analysis

It is important to analyze the characteristics of the smile and relationship of dentition to the soft tissues as facial attractiveness is defined more by the smile than by soft-tissue relationships at rest.[19]

The followings are the eight major components of the smile.

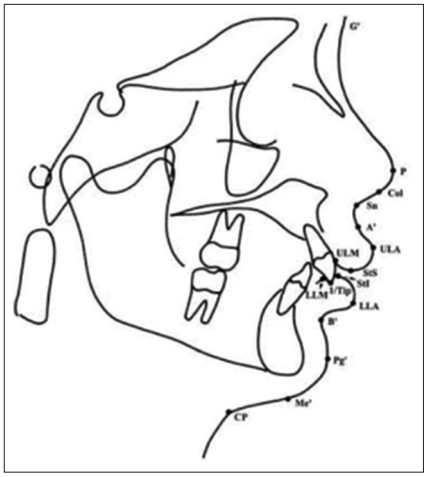


Figure 1: Soft-tissue cephalometric landmarks

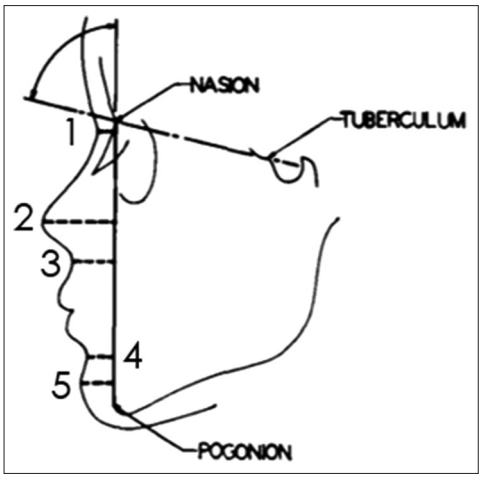


Figure 2: Reference points used in metric analysis

Level of dimension	In 5–14 years of age
Root of nose	6.3–7.1
Tip of nose	23.8–32.0
Concavity of upper lip	14.5–17.5
Labiomental groove	9.5–9.9
Convexity of chin	11.3–12.4

Measurement	In 5–14 of age
Nasion to root of the nose	1.9–3.7
Root of the nose to the tip of the nose	27.2–39.1
Tip of the nose to concavity of upper lip	12.5–18.0
Concavity of upper lip to labiomental groove	29.8–32.9
Labiomental groove to convexity of chin	7.4–11.6
Nasion to pogonion	86.7–111.0

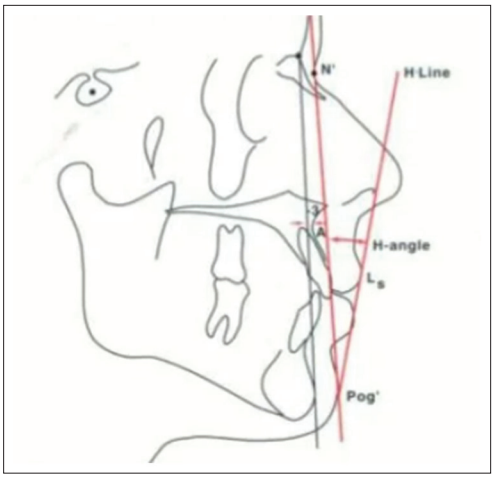


Figure 3: Landmarks and reference points used in Holdaway analysis

Facial angle: 91 ± 7°	Lower lip to H line: 0–0.5 mm anterior to H line
Nose prominence: 14–24 mm	Skeletal profile convexity: 0 mm
Superior sulcus depth: 1–4 mm	Basic upper lip thickness: 15 mm
Soft-tissue subnasale to H line: 3–7 mm	Inferior sulcus to H line: 5 mm
Soft-tissue chin thickness: 10–12 mm	Upper lip strain: 13–14 mm
H angle: 7–14°	

Tongue Analysis

Template for assessment of tongue position in the radiograph

It has a horizontal line and a vertical line which coincides with the horizontal and vertical reference lines, respectively.

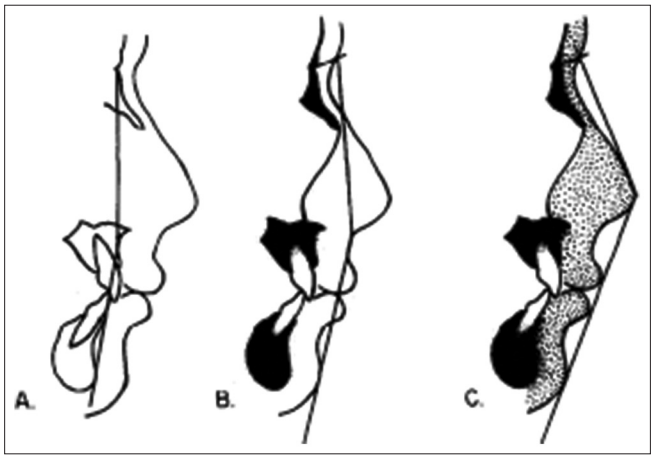


Figure 4: Convexity of facial profile

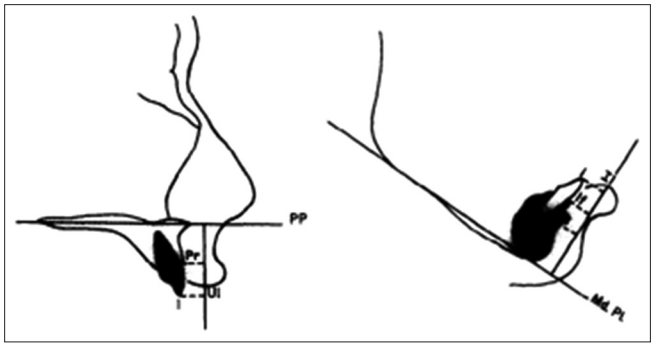


Figure 5: Lips and denture

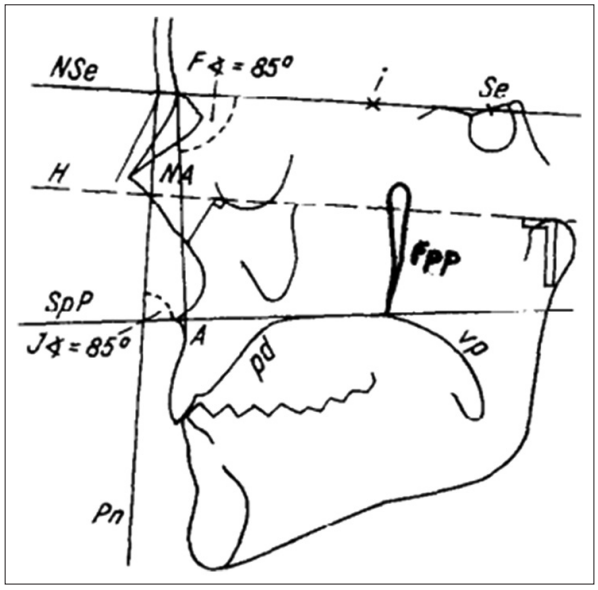


Figure 6: Reference planes used in Schwarz analysis

From point O on the template, where three lines now meet, we draw four more lines, all at 30° angles. This gives a total

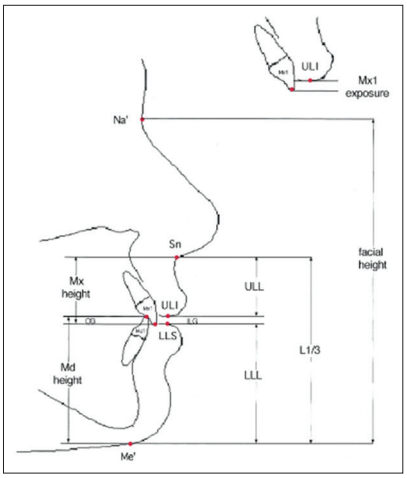


Figure 7: Reference planes used in Arnett and Bergman analysis

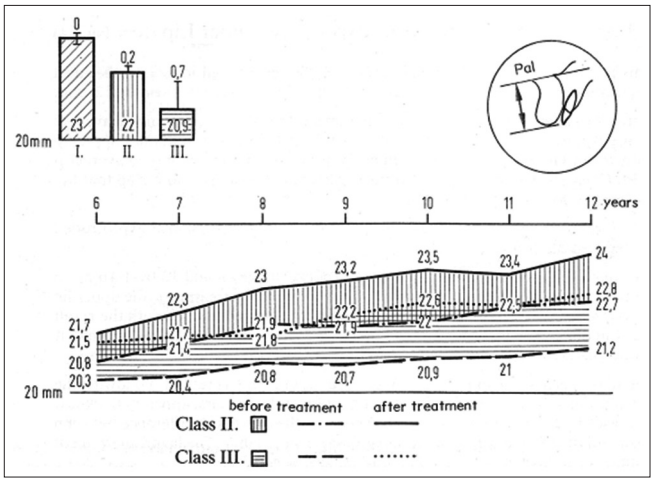


Figure 8: Length of the upper lip with Classes II and III malocclusion before and after treatment

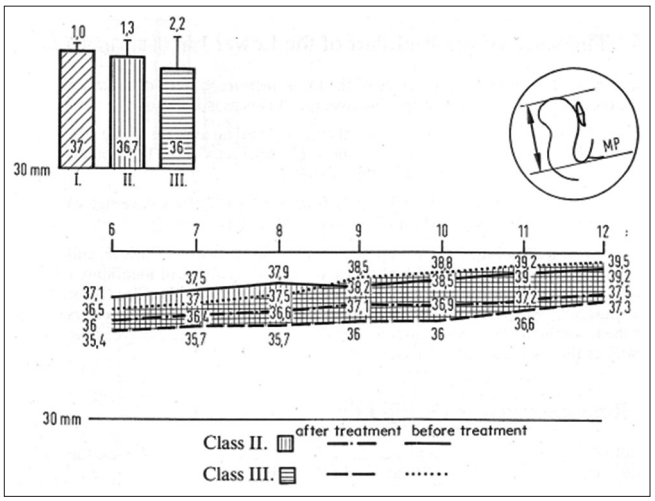


Figure 9: Length of the lower lip with Class II and III malocclusion before and after treatment

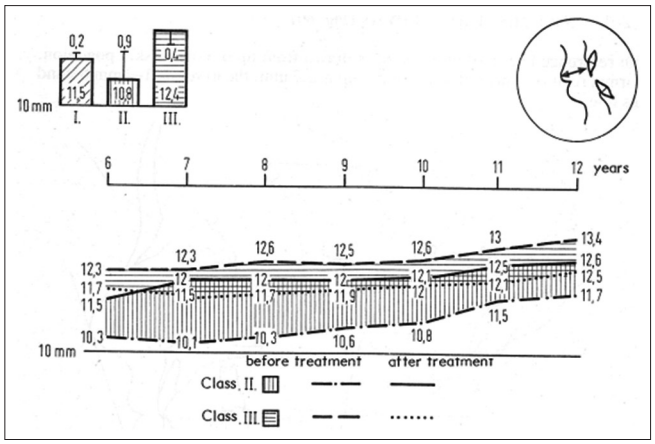


Figure 10: Thickness of red part of the upper lip with Classes II and III malocclusion before and after treatment

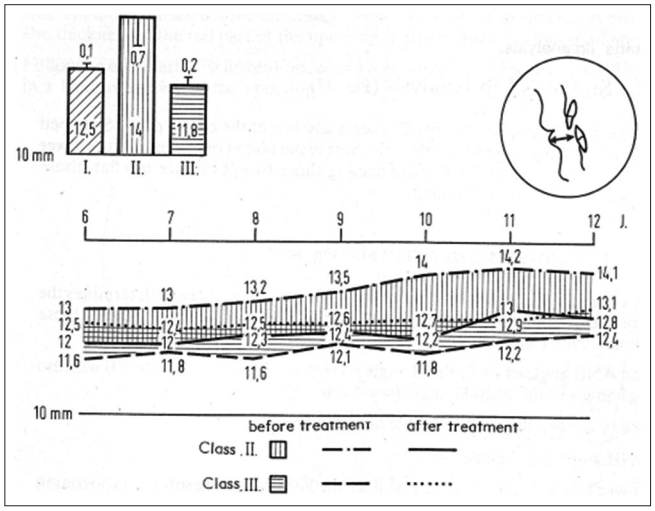


Figure 11: Thickness of red part of the lower lip with Classes II and III malocclusion before and after treatment

Parameter	
Length of the upper lip	Class I>Class II>Class III
Length of the lower lip	Class I>Class III>Class II
Thickness of red part of upper lip	Class III>Class I>Class II
Thickness of red part of lower lip	Class II>Class I>Class III

of seven lines. The template is placed on the radiograph and the measurements are obtained.[20]

Recent Advances

3D soft-tissue cephalometric landmarks: [21]

Bridge of nose, Bn: Midpoint on the midsagittal plane over the tip of the nasal bone – Midline

Endocanthion, En: The point at the inner commissure of the eye fissure – Bilateral

Exocanthion, Ex: The point at the outer commissure of the eye fissure – Bilateral

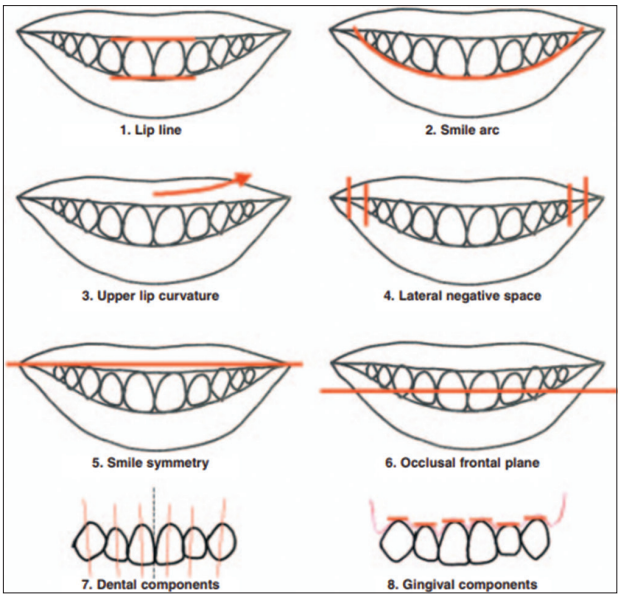


Figure 12: Eight components of balanced smile

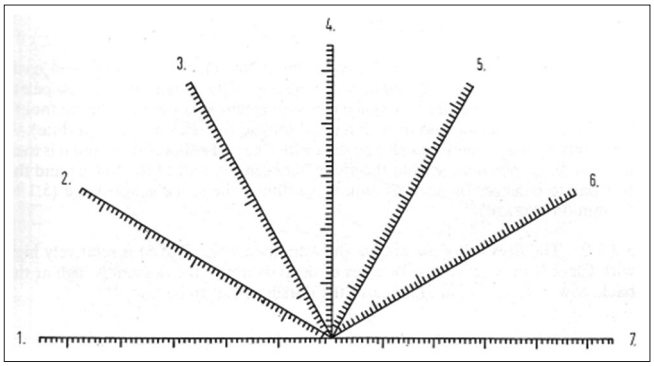


Figure 13: Template for the assessment of tongue position

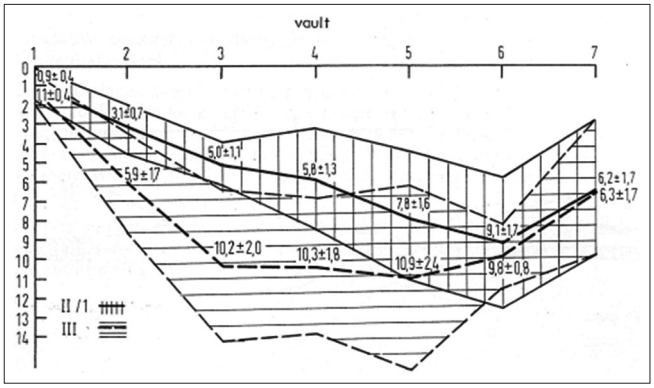


Figure 14: Analysis of tongue position in Classes II and III dysgnathia

Malocclusion	Measurements in mm						
	1	2	3	4	5	6	7
Class II	0.9	3.1	5.0	5.8	7.8	9.1	6.2
Class II with mouth breathing	5.1	8.3	10.2	11.7	12.3	12.2	10.0
Class III	1.1	5.9	10.2	10.3	10.9	9.8	6.3
Class III with mouth breathing	5.2	9.2	11.6	12.3	11.6	8.4	5.2
Open bite	1.9	5.7	8.5	8.8	11.2	9.2	2.4

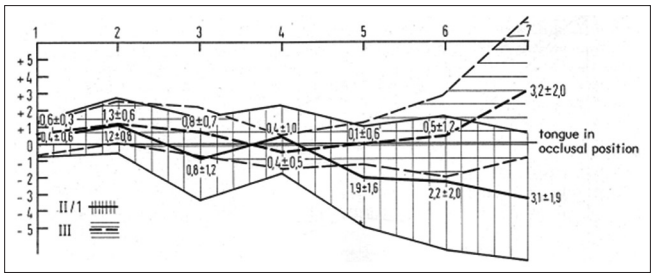


Figure 15: Analysis of tongue motility in Classes II and III dysgnathia

Malocclusion	Measurements in mm						
	1	2	3	4	5	6	7
Class II	0.4	1.2	−0.8	0.4	−1.9	−2.2	−3.2
Class II with mouth breathing	0.3	0.7	0.1	0.0	−0.1	−0.8	−0.3
Class III	0.6	1.3	0.8	−0.4	0.1	0.2	2.6
Class III with mouth breathing	−1.4	−1.5	0.1	0.4	0.1	0.2	2.6
Open bite	0.5	0.5	−0.2	−0.9	0.1	−0.2	0.8

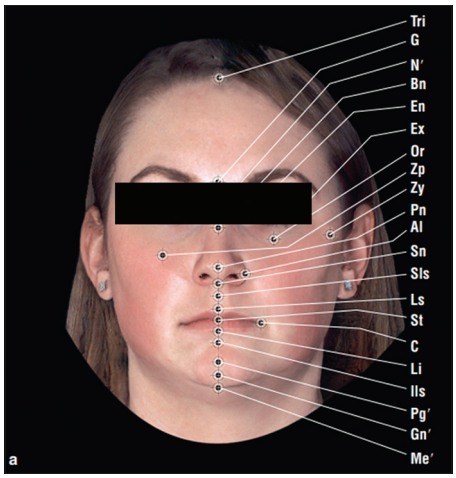


Figure 16: Soft-tissue landmarks in frontal view

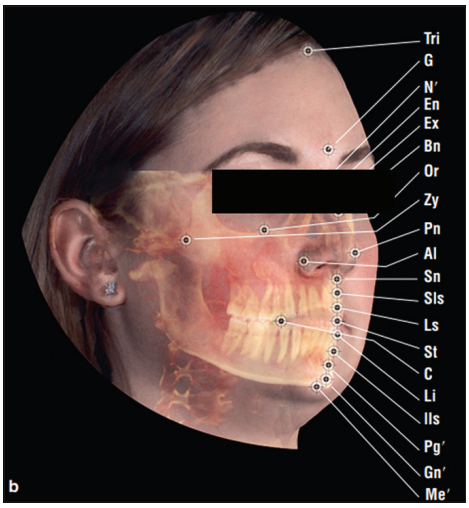


Figure 17: Soft-tissue landmarks in lateral oblique view

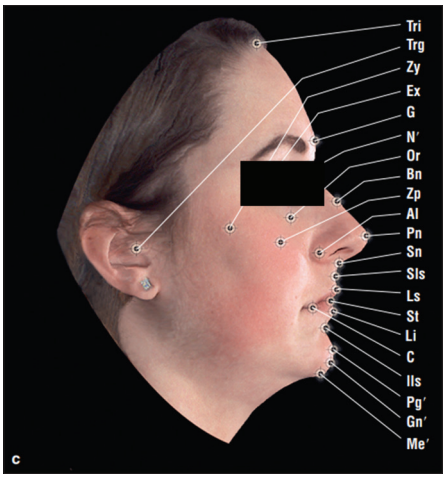


Figure 18: Soft-tissue landmarks in lateral or profile view

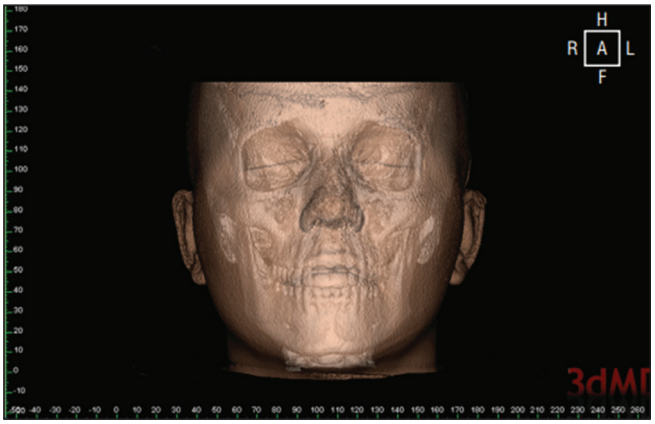


Figure 19: Superimposition of CBCT soft-tissue segmentation over hard tissue

Figure 20: Stereogrammatic image

Orbitale, Or: The most inferior point of the orbital floor below the center of the eye – Bilateral

Zygomatic prominence, Zp: The most protrusive anterior point on the zygomatic arch – Bilateral

Zygion, Zy: The most lateral point of each zygomatic arch – Bilateral

Tragion, T: The point located at the upper margin of each tragus – Bilateral

Pronasale, Pn: The most prominent midline point on the tip of the nose – Midline

Alare, Al: The most lateral point on each alar contour – Bilateral

Subnasale, Sn: The point at which the columella (nasal septum) merges with the upper lip in the midsagittal plane – Midline

Superior labial sulcus, Sls: The point of greatest concavity in the midsagittal plane of the upper lip between Sn and labrale superius – Midline

Labrale superius, Ls: A point indicating the mucocutaneous border of the upper lip (usually the most anterior point of the upper lip) – Midline

Stomion, St: The contact point between the upper and lower lip at the mouth slit – Midline Cheilion C: The most lateral point located at each labial commissure – Bilateral

Labrale inferior, Li: The most anterior aspect of the lower vermilion border of the lower lip in the centerline – Midline

Inferior labial sulcus, Ils: The point of greatest concavity in the midsagittal plane of the lower lip between Li and soft-tissue pogonion (also known as labiomental sulcus) – Midline

Soft-tissue pogonion, Pg': The most anterior point on the chin in the midsagittal plane –Midline

Soft-tissue gnathion, Gn': The most anterior and inferior point on the soft-tissue chin in the midsagittal plane – Midline

Soft-tissue menton, Me': The most inferior point on the soft-tissue chin – Midline

2D cephalometry limits soft-tissue analysis to the patient's profile.

Advanced imaging techniques such as CBCT and 3D stereophotogrammetry allow the human face to be investigated in three dimensions, with a variety of applications ranging from esthetic facial parameter measurement to orthodontic diagnosis and craniofacial growth and development evaluation.

They also enable for the superimposition of craniofacial structures to demonstrate their relative positions.

Conclusion

Esthetics is most commonly the reason patients seek orthodontic treatment. A beautiful dentition and pleasant smile together with symmetric and balanced facial proportions identify perfect esthetics. Assessment of the soft tissues during orthodontic examination and an understanding of the changes associated with growth and treatment are essential.

Mere correction of the occlusion may give random and often poor results in terms of facial attractiveness. Esthetic guidelines must be followed when determining the orthodontic and/or surgical plan if optimal facial attractiveness is a treatment goal.

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