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# Soft tissue paradigm in orthodontic diagnosis and treatment planning

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**Abstract**
Orthodontic diagnosis and treatment planning has been based on hard tissue relationships and on the Angle paradigm. But the new concept of importance of soft tissue for treatment and diagnosis is finding its basis. The soft tissues largely determine the limitations of orthodontic treatment, from the perspectives of function and stability, as well as esthetics, the orthodontist must plan treatment within the patient's limits of soft tissue adaptation and soft tissue contours. Our aim in this article is to emphasis the importance of soft tissue paradigm in diagnosis and treatment planning placing greater emphasis on clinical examination of soft tissue function and esthetics.

**Keywords:** Angle paradigm, soft tissue, smile, facial photography, facial videography

## Introduction

The orthodontic treatment is based on esthetics. The patients generally recognize the improvement in facial and smile appearance rather than underlying hard tissue changes. So the current trend of orthodontic diagnosis and treatment planning, treatment objectives and assessment of treatment outcomes is towards an increasing emphasis on soft tissue relationships rather than underlying hard tissue relations.

When this natural dentition state occurs, the face should also be in the perfect harmony and balance and the stomatognathic system should function ideally (Ackerman, 1999) [1]. According to MM Martha[2] *et al* while correcting the malocclusion orthodontically the facial balance may become worse. This could be due to ignored soft tissue relationship during diagnosis or lack of attention to the esthetic goals. So current trend in orthodontics is toward soft tissue relationship.

## Significance of soft tissue

Diagnosis and treatment planning are the keystones to orthodontic treatment and not the treatment procedures by itself. Hence, it is important to understand the role and importance of profile and soft tissue in arriving at a treatment plan. The importance of the position of nose and chin in relation to the lips is also realised. According to Proffit[1], the orthodontist at the end of treatment should be able to place the upper lip vermilion beyond the soft tissue point A and lower lip should be as prominent as the chin. Nose–lip-chin relationship is an essential esthetic criterion. The profile of middle and lower third of face should always be considered before deciding on a treatment plan.

Growth of every individual is different but on broad scale there is a general pattern of growth that we all follow. Growth of soft tissue similarly has a general trend and it is mandatory to study the growth of soft tissue to understand its behaviour during treatment and to forecast the changes, to prevent any untoward treatment result due to faulty treatment plan. Some of the objectives of soft tissue evaluation are as follows (Martha Meija *et al*. 2000) [3]

1. Retract, maintain or protract upper and/or lower lip.
2. Increase, maintain. or decrease vermilion display (lip thickness).
3. Reduce lip strain, mentalis muscle strain, and interlabial gap or maintain lip competence.
4. Increase, maintain or decrease nasolabial angle.
5. Increase, maintain or decrease mentolabial angle.
6. Increase or maintain cervicomental angle.
7. Reduce, maintain, or increase the gingival display on smiling.
8. Improve facial asymmetry
9. Increase, maintain or decrease width of alar base.
10. Increase, maintain or decrease the vertical and/or anterioposterior projection of the soft tissue chin.

## Diagnostic aids

In this article we will discuss about 4 of the most important diagnostic aides used in diagnoising soft tissue problems (as follows):

1. Clinical examination
2. Radiograph
3. Photograph
4. Videograph

## Clinical examination

The first step in evaluating facial proportions is to take a good look at the patient, examining him or her for developmental characteristics and a general impression. With faces as with everything else, looking too quickly at the details carries the risk of missing the big picture.

Assessment of Developmental Age, During the examination of the face, in a step particularly important for children around the age of puberty when most orthodontic treatment

is carried out, the patient's developmental age should be assessed.

The degree of physical development is much more important than chronologic age in determining how much growth remains.

The next step in clinical evaluation is assessment of facial appearance. Checklist for clinical diagnosis of facial characteristics are given in table- 14

**Table 1:** Facial dimensions to evaluate

| Frontal at Rest | Frontal Smile | Frontal Widths | Profile |
|---|---|---|---|
| Nasal tip | Maxillary incisor display | Alar base | Maxillary projection |
| Maxillary dental midline | Maxillary incisor crown height | Nasal tip | Mandibular projection |
| Mandibular dental mid- line | Gingival display | Buccal corridor | Chin projection |
| Chin (mid-symphasis) | Smile arc | | Lower face height |
| Lip separation (lip relaxed) | Occlusal plane cant | | Nose radix |
| Lip vermilion display | | | Nasal dorsum contour |
| Maxillary incisor displayed (lips relaxed) | | | Nasal tip projection |
| Lower face height | | | Lip fullness |
| Philtrum length | | | Labiomental sulcus |
| Commisure height | | | Chin-throat angle |
| Chin Height | | | Throat length |
| | | | Submental contour (fat pad) |

**Radiaographs**

Cephalometric analysis plays an important role in diagnosis of soft tissue changes. The different cephalometric variables used for soft tissue analysis are as follows. :-

1. Merrifeild z- angle [5]
2. E-line [6]
3. S-line [7]
4. Zero meridian [8]
5. Holdaway soft tissue analysis [9]
6. Arnett and Bergman soft tissue analysis [10]
7. Burstone soft tissue analysis [11].

**Photographs**

The aim of dental photographs are documentation and evaluation of craniofacial and dental relationship, assessment of soft tissue profile, monitoring of treatment progress etc [12]. The major purpose of intra-oral photograph is to enable the orthodontist [13]:

- To review the hard and soft tissue at clinical examination.
- To record hard and soft tissue condition as they exist before treatment

(Patient with white spot lesions of enamel, hyperplastic areas and gingival cleft are essential to document)

One of the most important components of orthodontic diagnosis and treatment planning is the evaluation of the patient's facial soft tissue. Since the shape of the human face depends on both the structure of the hard tissue (bone) and the soft tissue that covers it, soft tissue should be analysed for the correct evaluation of an underlying skeletal discrepancy because of individual differences in soft tissue thickness. Obtaining measurements of the facial soft tissue is important in terms of achieving aesthetic criteria. Facial soft tissue analysis has been conducted using newer three-dimensional (3D) methods, such as laser surface and, more recently, scanning digital 3D photogrammetry. Photogrammetry has been introduced as an alternative to direct measurements to obtain distances between facial landmarks using both two-dimensional and three-dimensional methods [13].

27 landmarks are identified and registered on the frontal and profile pictures. The landmarks used should be on the basis that they should be readily visible, reproducible and available for use in analysis, and should be minimally altered by facial makeup. The landmarks are shown in Fig. 2.


**Fig 2:** The figure shows 27 landmarks on frontal and profile pictures.

**Landmarks definition [13]:**

**Trichion (Tri)**

The sagittal midpoint of the forehead that borders the hairline.

**Glabella (G)**

The most anterior point of the middle line of the forehead.

**Nasion (N)**

The point in the middle line located at the nasal root.

**Pronasal (Prn)**

The most prominent point of the tip of the nose.

**Midnasal (Mn)**

The middle point on the outer contour of the nose between the pronasal and nasion points.

**Columella (Cm)**

The most inferior and anterior point of the nose.

**Subnasal (Sn)**
The point where the upper lip joins the columella.

**Labial superior (Ls)**
The point that indicates the mucocutaneous limit of the upper lip.

**Stomion superior (Sts)**
The most inferior point of the upper lip.

**Stomion inferior (Sti)**
The most superior point of the lower lip.

**Labial inferior (Li)**
The point that indicates the mucocutaneous limit of the lower lip.

**Supramental (Sm)**
The deepest point of the inferior sublabial concavity.

**Pogonion (Pg)**
The most anterior point of the chin.

**Menton (Me)**
The most inferior point of the inferior edge of the chin.

**Cervical (C)**
The point at the junction of neck and throat borders.

**Tragus (Trg)**
The most posterior point of the auricular tragus.

**Alar (Al)**
The most lateral point of the alar contour of the nose.

**Ort**
The point joining the TV (true vertical) and the TH (true horizontal).

**Left canthus (Cthl)**
The entocanthion of the left eye.

**Right canthus (Cthr)**
The entocanthion of the right eye.

**Left lip commissure (Lcl)**
The point where the lips join together at the left side of the mouth.

**Right lip commissure (Lcr)**
The point where the lips join together at the right side of the mouth.

**Left alar base (Albl)**
The point on the lower margin of the left alar base where the ala disappears into the upper lip skin.

**Right alar base (Albr)**
The point on the lower margin of the right alar base where the ala disappears into the upper lip skin.

**Left pupil (Pupl)**
The center point of the left eye pupil.

**Right pupil (Pupr)**
The centre point of the right eye pupil.

**Stomion (Stm)**
The midpoint of the labial fissure when the lips are closed naturally.

**Videograph**
The dynamic recording of smile and speech is accomplished with digital videography. Digital video and computer technology enables the clinician to record anterior tooth display during speech and smiling at the equivalent of 30 frames per second. We typically take 5 seconds of video for each patient, yielding 150 frames for comparison. The videos are recorded in standardized fashion with the camera at a fixed distance from the subject. One segment of video is taken in the frontal dimension and another segment of video is taken from the oblique view. These clips, taken before and after treatment for all patients, allow us to use matched frames to analyse changes in smile characteristics. The patient's head is placed in a cephalometric head holder to obtain natural head position, and the patient is asked to rehearse the phrase "Chelsea eats cheesecake on the Chesapeake," and then to smile. The video is downloaded to the computer, and the video clip is compressed. Each clip is approximately 4
MB. The video clip is reviewed, and the frame that best represents the patient's natural unstrained social smile is selected [14].

**Soft tissue changes due to growth**
Age-related changes of jaws and soft tissue profile are important both for orthodontists and general dentists. Behrents [15] reported that craniofacial growth does not stop in young adulthood but is a continuous process even into later ages.
Components of Soft Tissue Profile to be discussed are-

a. Nose
b. Lips
c. Soft tissue chin
d. Nasolabial angle

**a. Nose**
The soft tissue nose is short, rounded, and pug-like. The nasal bridge is low; the nasal profile is concave and the nares can be seen in a face on view. It protrudes very little and is vertically quite short. The human nose continues to grow in a downward and forward direction at least until early adulthood. There does not seem to be an appreciable decrease in the rate of nasal growth which is typical for the skeletal structures. Average yearly increase of 1–1.3mm in the overall length of the external nose is almost the same for males and females.
The lower dorsum rotates downwards and backwards in persons who show greater vertical and less horizontal growth changes. Rotational changes of the lower dorsum are most closely related with vertical changes at pronasale [16]. Chaconas [17] showed that Class I subjects have more forward growth of the nasal tip than Class II subjects; Class II subjects tend to have a pronounced elevation of the dorsum and Class III subjects tend to have a concave dorsum. Subtelny [18] showed Class II patients exhibited a more pronounced elevation of the bridge of the nose than Class I. Class I cases tended to have straighter noses.

**b. Lips**

In Subtelny's study, it was found that in both males and females, the upper lip increased in thickness from ages 1 to 14. After the age of 14 yrs, the lips continued to become thicker in males but not in females. Similarly, in the lower lip the gain in thickness was greater at vermillion border than at pogonion or point B. Lip thickness increase for males from ages 1 to 18 yrs was around 7mm while for females it was around 6 mm.

The differential in the two sexes with respect to lip thickness implies that the treatment result of extraction therapy of the facial profile will be more noticeable in female than male patients. Because female lips do not thicken with age, any extraction plan for females with straight to convex profiles should be cautiously considered. Lip fullness in relation to the nose which will continue to grow should also be noted [19] In spite of progressive increase in length, both lips show a fairly constant vertical relationship to their respective alveolar processes. After the full eruption of the central incisors, there is little increase in the vertical distance between the crest of the alveolar process and the vermillion border of the lip. The lips also maintain an equally constant relationship to the incisal edges of the anterior teeth. This is of great clinical importance because surgical overintrusion of maxilla results in an esthetically disastrous aging of the patient's face. The male profile generally was shown to straighten with age with a concomitant retrusion of the lips, whereas the female profile did not straighten nor were the lips retruded.

**c. Soft- tissue chin**

Bishara *et al* [20]. in a longitudinal study concluded that the timing of the greatest changes in the soft tissue profile occurs earlier in females (10 to 15 years) than in males (15 to 25 years) and the angle of soft tissue convexity that excludes the nose expresses little change between 5 and 45 years, Formby *et al* [21]. concluded that females showed more changes in soft and hard tissue measurements after 25 years of age than before, whereas most hard tissue changes in males had been accomplished by the age of 25 but not soft tissue changes.

**d. Nasolabial angle**

With decrease in lip prominence and lowering of the nasal tip, nasolabial angle becomes more acute. As nasal tip descends and rotates, the lip descends with it in what is termed as a clockwise rotation of the nasolabial complex. The nasolabial angle decreases slightly from7 to 18 years in both sexes. The mean at 7 years was 107.8 ± 9.4 degrees for males and 114.7 ± 9.5 degrees for the females. At 18 years, the mean was slightly reduced to 105.8 ± 9.0 and 110.7 ± 10.9 degrees

**Soft tissue changes due to treatment:**

Soft tissue objectives that must be considered in the treatment planning process include the following:

1. retract, maintain, or protract upper and/or lower lip;
2. increase, maintain, or decrease vermilion display (lip thickness);
3. reduce lip strain, mentalis muscle strain, and interlabial gap
4. maintain lip competence;
5. increase, maintain, or decrease nasolabial angle;
6. increase, maintain, or decrease mentolabial angle;
7. increase or maintain cervicomental angle;
8. reduce, maintain, or increase the gingival display on smiling;
9. improve facial asymmetry;
10. increase, maintain, or decrease width of the alar base;
11. increase, maintain, or decrease the vertical and/or antero-posterior projection of the soft tissue chin.
12. Some researchers have found a high degree of correlation between incisor retraction and upper and lower lip retraction [22-27] (Table 2).

**Table 2:** Co-relation of Incisor retraction and Lip position

| *Author* | *Sample* | *U Lip to U 1* | *L Lip to L 1* | *L Lip to U 1* |
|---|---|---|---|---|
| Garner | 16 African American children | 1:3.6 | 1:1 | |
| Hershey | 36 postadolescent white females | 1:2 | | 1:1.75 |
| Waldman | 41 Class II patients | 1:3.8 | | |
| Caplan and Shivapuja | 28 adult African American females | 1:1.2 | 1:1.75 | |
| Luecke and Johnston | 42 Class II patients | 1:3.5 | | |
| Yogosawa | 20 adult Japanese females | 1:2.5 | | 1:1.4 |

**Role of smile (Dynamic soft tissue)**

The "art of the smile" lies in the clinician's ability to recognize the positive elements of beauty in each patient and then create a strategy to enhance the attributes that fall outside the parameters of the prevailing esthetic concept.

There are 8 components of balanced smile as defined Sabre [28] (Fig 3)

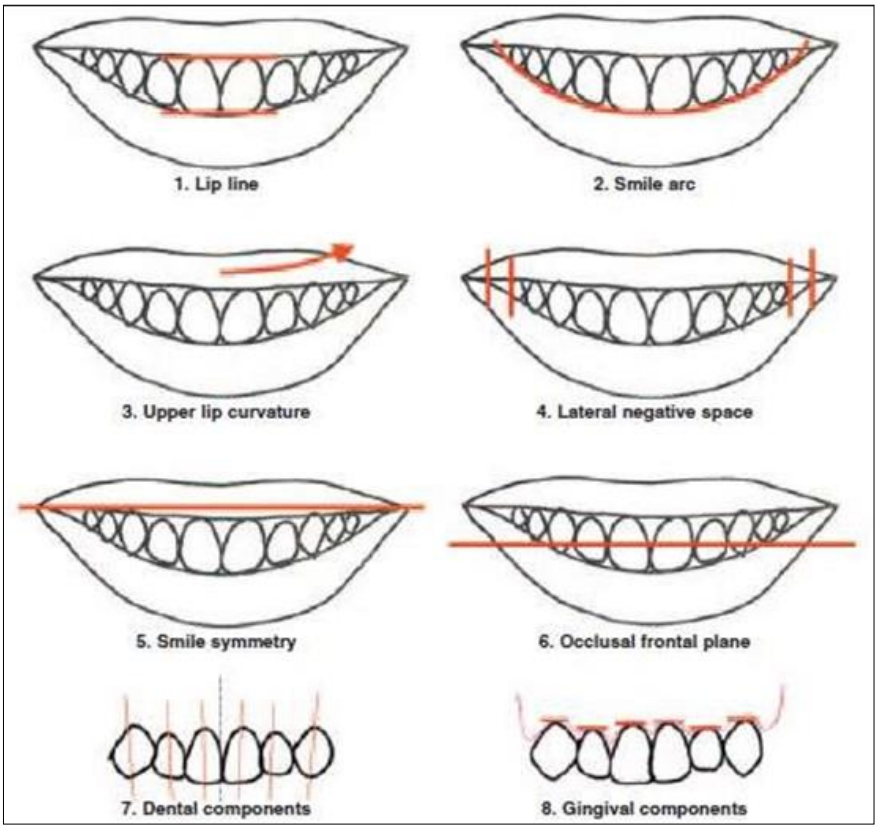


**Fig 3:** components of balanced smile

It is important to differentiate between the social smile and the enjoyment smile. The social smile is a voluntary smile a person uses in social settings or when posing for a photograph. The enjoyment smile is an involuntary smile and represents the emotion you are experiencing at that moment [29].

The differing visual presentations reflect inner emotions and are mechanically governed by all the facial muscles of expression and the differential nuances of recruitment and use of these muscle sets. When treating occlusal discrepancies, the orthodontist must have a repeatable position of tooth and jaw relationships to use as a reference point. In dentistry, the most accepted reference position in occlusion is the mandible placed in its most retruded contact position. In treating the smile, the social smile generally represents a repeatable smile [30].

Smile can be analysed in 4 dimensions: frontal, oblique, sagittal, and time-specific**.**

To visualize and quantify the frontal smile, Ackerman and Ackerman [31] developed a ratio, called the *smile index* that describes the area framed by the vermilion borders of the lips during the social smile. The smile index is determined by dividing the inter commissure width by the interlabial gap during smile**.**

In oblique view the palatal plane can be canted anteroposteriorly in a number of orientations. In the most desirable orientation, the occlusal plane is consonant with the curvature of the lower lip on smile. Deviations from this orientation include a downward cant of the posterior maxilla, upward cant of the anterior maxilla, or variations of both [32]. In the initial examination and diagnostic phase of treatment, it is important to visualize the occlusal plane in its relationship to the lower lip.

Computer imaging helps the clinician to see the plan and cogently present treatment options to the patient and family, as well as to communicate with other professionals involved in the care of the patient. The subsequent treatment strategy is (1) maintain the incisal edges in their current vertical position (2) extrude the maxillary canines to level the arch (3) finish with periodontal crown lengthening.

**Conclusion**

The treatment planning of facial esthetic changes is difficult. At times, to correct the malocclusion, facial balance may become worse. This could be the result of a lack of attention to esthetics or lack of understanding or agreement as to what is desirable as an esthetic goal. Also, the assumption that establishment of normal dental relationships, based on cephalometric standards, leads to balanced facial esthetics is not always true and in fact could lead to poor facial outcomes [33].

For treatment in the twenty-first century, these soft tissue effects should be reflected in what can be called the soft tissue paradigm in orthodontics. Soft tissue relationships, not hard tissue relationships or dental occlusion, are the major influences on both the esthetic outcomes of treatment and the stability of treatment outcomes. Soft tissue (neuromuscular) adaptation also determines whether satisfactory function has been achieved. This means that it is the orthodontist' stask in diagnosis and treatment planning

to ascertain an individual's available limits of soft tissue adaptation, given the dental, skeletal, and facial soft tissue changes that the orthodontist and the patient would like to create.

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