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Patient's Facial Soft Tissue Changes Following The Orthodontics Treatment

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Abstract: *Facial soft tissue plays an important role in facial esthetics. Facial esthetics is an important goal of treatment for contemporary orthodontics and it is one of the patient's main reasons for seeking orthodontic treatment. Thus, the assessment of the patient's facial soft tissue is very important for orthodontic diagnosis and treatment planning. The appearance of the face is influenced by age, sex, race, and ethnicity, and the orthodontist is frequently questioned about facial changes after treatment. Thus, it is recognized by most orthodontists that success of orthodontic treatment is closely related to the improvement of the soft tissue profile. Analyzing the human face is a science and an art, using both aesthetic and anthropologic tools. Different strategies have been utilized to assess facial characteristics, like anthropometry, photogrammetry, and cephalometry. Many studies were created focusing on both numerical and subjective facial analysis, planning to set up reference values for facial photographic measurements and to confirm esthetical tendencies of the studied populations. Some authors assessed esthetics by clinical examination and measurements directly on the face. Other studies used computerized methods.*

Keyword: *Facial soft tissue analysis. Facial esthetics., orthodontics treatment*

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I. Introduction

Facial attractiveness is one of the main purposes of orthodontic treatment, and focus has been increased on it in latest years by both patients and orthodontists [1]. During orthodontic diagnosis and orthodontic treatment planning, it should evaluate the patient's facial soft tissue. Since the structure of the human face depends on both the structure of the hard tissue (bone) and the soft tissue that on it, soft tissue should be analyzed for the correct assessment of an essential skeletal discrepancy as a result of entity differences in soft tissue thickness. The quantitative evaluation of the size and shape of the facial soft tissue is extensively used in some medical fields like orthodontics, maxillofacial and plastic surgery, and clinical genetics for diagnosis, treatment planning, and postoperative assessment [2-5]. Through diagnosis, the proficient must attempt to recognize the unlikable facial characteristics that can be improved with the orthodontic treatment; besides, the aspects considered pleasant and must be conserved through orthodontic treatment. It is important, however, that this assessment considers the ethical and personal characteristics of the patient, attempting to use the same esthetic evaluation parameters of the patient and the society in which he or she belongs [6]. Previously, orthodontists were essentially concerned with the correction of skeletal and dental relationships [6, 7].

Nowadays, in the twentieth century, it has been noticed in orthodontics a big worry about esthetics, particularly involving concepts of facial proportions and balance. It has been recommended that maxillary, mandible, and dental morphologies indirectly effect on the view of facial beauty [7-9]. From the patient's view, the main cause for asking for orthodontic treatment is facial attractiveness[6]. Hence, it is suggested that orthodontic treatment is planned beginning from a global assessment of the face, paying attention to esthetic necessities and in addition to cephalometric and functional matters [10]. In this review, we summarized some studies about the assessment of the patient's facial soft tissue that is very important for orthodontic diagnosis and treatment planning.

ANATOMY OF FACIAL TISSUES

The human face is characterized by a strong interplay of several different muscles and the surrounding soft tissues, which account for our outer appearance and drives our perception of one another. In general, facial muscles are separated into two groups of superficial muscles and deep muscles. While superficial muscles are primarily associated with facial expressions and speech, deep muscles are responsible for controlling the position of the jaw as in speech, jaw movements, and most importantly for the generation of bite force in mastication[11].

THE ROLE OF FACIAL ESTHETICS IN ORTHODONTICS

The judgment of facial aesthetics is personal and without a doubt dependent on different cultural, social, geographic and mental foundations of individuals. Orthodontists should think carefully about these variables when establishing a diagnosis or formulate a treatment plan. Soft tissue analysis is the most critical method of interest in the improvement and choice of a potential orthodontic treatment plan[12].

Overall, orthodontists, in addition, laypeople, seem to constantly choose the straight profile as being the most aesthetic for both sexes[13]. However, a slightly convex face is acceptable for females[14]. Furthermore, the position of the nose and the chin influences the amount of lip protrusion or retrusion that is considered esthetically satisfying[15]. It has been established that a larger chin or nose allows for more lip protrusion. However, a large chin permits three times more lip protrusion than a large nose. In any case, a fuller dentition and fuller lips are found to be more acceptable in females.

On the other hand, it is more acceptable for males to have more prominent noses and for females to have less prominent noses about their chins[16]. Although the amount and the direction of growth of the soft-tissue components of the face cannot be completely controlled through orthodontic treatment, treatment decisions may have an impact on the overall facial profile. Thus, the normal growth patterns of the integumental profile should not be neglected. Approximately 50% of the soft-tissue shape variability is attributed to hard-tissue components[17]. Nonetheless, it has been reported that skeletal relationships are partially reflected in the soft-tissue profile and that Class I and Class III jaw relationships are difficult to ascertain[18]. Moreover, a pleasing, straight profile does not necessarily accompany a normal occlusion, and an improvement in the soft-tissue profile does not always follow extensive dentition changes[19].

Soft tissue profile has been studied widely in orthodontics principally from lateral cephalometric radiographs. The analysis of the facial soft tissue profile was a concern for the pioneers of orthodontics such as Angle and Case at the end of the 19th and the beginning of the 20th centuries[20].

Sarver and Ackerman in 2000 detail the emergence of the "esthetic paradigm" with a short history. In the late 19th century, Norman Kingsley was a prominent orthodontist who emphasized the aesthetic objectives of orthodontics. Edward Angle changed the emphasis to occlusion. Angle believed that optimal occlusion leads to optimal facial esthetics. Tweed and Begg challenged this non-extraction philosophy partly on esthetic grounds. In the 1980s, with emphasis on aesthetic dentistry, the selection of orthodontic treatment was partly made based on its direct influence on esthetics. The authors propose three guidelines. One, the face must be evaluated clinically in dynamic and static states in three dimensions. Two, lip-tooth relationships and anterior tooth display are very important. Moreover, three, there must be an analysis of the hard tissues as they relate to the facial soft tissues [21].

Tweed (1944) gave special attention to aesthetics, using cephalometric standards in a cross-sectional study of 95 patients with good facial aesthetics. Following Tweed's article (1944) the 1950s saw a flourishing of research including cephalometric skeletal analysis and facial aesthetics[22]. Some authors such as Downs (1948)[23] incorporated measurements of the soft tissue profile in the cephalometric analysis, introducing filters in the table radiographical technique that allowed visualization of the soft tissues.

DIFFERENT SOFT TISSUE ANALYSIS

Advances in orthodontic equipment, particularly cephalometry in 1931,[24] [prompted a shift far from the orthodontic art of diagnosis and treatment planning as physicians depended more on science. In this manner, subjective clinical exams were expanded by quantitative assessments involving lateral cephalograms and plaster study models[25]. Burstone in 1958suggested a very comprehensive soft tissue profile analysis. Contour angles are formed by intersecting lines connecting different profile components, and these indicate the intricate morphology of the integumental profile. This B line was drawn from the soft tissue subnasal to soft tissue pogonion. In his study of 37 adult Caucasians, he concluded that the upper and lower lips lie behind this line at a mean distance of 3.5 mm and 2.2 mm, respectively. He regarded the facial contour angle, glabella-subnasal pogonion measured to the straight-line glabella-subnasale as the most important angle in soft tissue study. The average measurement is 11 ± 4 degrees for Caucasians, as the angle becomes less negative or even positive, this is indicative of a tendency towards a Class III[26].

In 1959, Burstone embraced a strategy for measuring soft tissue landmarks from underlying skeletal points proportionate to common planes. The horizontal reference plane was the nasal floor, and the vertical reference plane was a line perpendicular to the nasal floor. Utilizing this evaluation, he found that patients with various malocclusions had extensive differences in their soft tissue design. He also noticed that sexual dimorphism was available. For example, in males, the soft tissue of the areas inferior to the nose was thicker than females. Also, he noticed that the total face becomes less convex with maturation[27].

Steiner was also worried about facial appearance. In 1959, he offered a system for assessing the position of normal upper and lower incisor. He developed a system of "acceptable compromises" that allowed orthodontists to measure the position of teeth before treatment in order to create a "good face" after treatment.

Thus, treatment plans could be individualized, with the general objective being good facial esthetics[28].

Studies by Ricketts (1960 and 1968) revealed new methods for analyzing soft tissue. Ricketts' (1968) lip analysis consisted of a line (E line) drawn from the tip of the nose to the soft tissue pogonion. He stated that perfect lip relationship was not possible, but he recognized a range of normal lip relations. In a sample of adults, the lower lip was found to be located at a mean distance of 2mm posterior to the line, with a standard deviation of ± 3mm and the upper lip was found to be 4mm posterior. In patients of orthodontic ages of 13 to 14 years, a mean distance of 2.0mm with a standard deviation of ± 3mm for the lower lip behind the "E" plane was acceptable. He stated that most patients objected to lips that were anterior to this line, referred to as the "aesthetic plane" [29].

In 1961, Ricketts used the golden divider in his morphology dentofacial analysis. He established divine or golden proportions (Ø = 1.618) between the different component of the face (width of the nose/width of the mouth, the length of the upper lip/nasal length and facial height). He modified Holdaway's H line by drawing a line which he called the "profile line" from soft tissue pogonion to the most procumbent lip. In addition, he found that in consideration of the chin to its relation to the face, it is important that the total chin is expressed. He also measured the bony chin lying anterior to the line NB by measuring to pogonion. He measured the integumental overlying at the same point and stated that the osseous chin and its soft tissue overlay varied significantly in individuals. He considered the overall assessment of the total chin to be more important in a study of facial aesthetics than an assessment of the bony chin alone[30].

A line (S2) which was drawn from soft tissue nation to soft tissue pogonion was developed by Sushner (1977). He stated that the lower and upper lips were anterior to this line in the black population compared to the white population. This measurement of the S line was 8.8mm/6.7mm in black females and 10.3mm/8mm in black males[31].

Holdaway in 1983 created an 11-measurement analysis. The H-line was a direct result of these measurements and was defined as a plane from soft tissue pogonion to the tip of the upper lip. From the H-line, the amount of lip protrusion was measured parallel to Frankfort Horizontal[32]. Using this analysis, Holdaway created a visual treatment objective (VTO) to aid in treatment planning. He emphasized that the best possible soft tissue profile should first be established, followed by tooth movement that will best develop the patient's ideal profile[33].

Park and Burrstone questioned treating to hard tissue standards in their 1986 article. They recognized that treating to hard tissue standards did not ensure good facial form. They further questioned the validity in producing desirable esthetics when a dental skeletal standard has been achieved. Their sample was thirty orthodontic cases treated to hard-tissue criteria of having the lower incisor positioned 1.5mm anterior to the A-pogonion plane. When the hard tissue goal was achieved, they found a very large variation in lip protrusion. When limiting the population to two standard deviations (95% of the malocclusions), they concluded that the protrusion of the lips varied more than +/- 5 mm from the mean. Upper lip inclination varied as much at 32 degrees and the lower lip inclination varied 52 degrees. In summary, they advocated consideration of soft-tissue factors as well as hard-tissue structures[34].

Nanda and Ghosh published an article in 1995 that criticized the excessive focus on the utilize of the dental and skeletal structures in treatment planning. They argue for "harmonized facial structures as a primary goal of treatment." They write that repositioning teeth have the greatest influence on lip posture and as orthodontists, we should always look at this carefully. A chin or nose change can only come from orthognathic surgery. In addition, they argue that numbers can never replace good clinical judgment [35].

Further emphasizing the necessity to consider the soft tissues during treatment planning, Bergman, in 1999, created a facial soft tissue analysis. In his analysis, 18 soft tissue traits were evaluated, measured, and categorized according to norms from previous studies. This allowed for individualized treatment plans to be created by measuring the soft tissues and balancing the traits to improve the esthetic outcome[9].

In 2004, Arnett and Gunson began their article with the statement "The bite designates a problem; the face indicates how to treat the bite." They outline their way of treatment planning for orthodontists and oral surgeons. In it, they advocate clinical, facial, and soft tissue cephalometrics as well as model analysis and

conventional cephalometrics. They do, however, concede that their soft tissue cephalometrics planning remains primarily subjective[14].

FACIAL SOFT TISSUE PROFILE EVALUATION

Before undertaking a soft tissue profile analysis, one must first identify the traits or parts of a profile that are important. Arnett et al. identified ten traits on a profile that are important and gave recommendations for general harmony. The profile angle is formed by the points glabella, sub nasale, and soft tissue pogonion. Generally, the profile angle should be between 165 and 175 degrees. The nasolabial angle should be 85 to 105 degrees. The maxillary sulcus contour should normally be slightly curved but will flatten when under slight tension. The mandibular sulcus contour also is a slight curve. However, maxillary incisor impingement may crease a deep curve. The orbital rim should be evaluated as it also correlates with the maxillary position. It should be 2 to 4 mm behind the front of the eye. Cheekbone contour is also evaluated, as osseous structures are often deficient as groups. It may be deficient in combination with the orbital rim, indicating maxillary retrusion. The authors advocated the nasal base-lip contour as an indicator of maxillary and mandibular skeletal anteroposterior position. Nasal projection is measured horizontally from subnasale to nasal tip and should be 16 to 20 mm. The throat length and contour should be subjectively evaluated. The authors warn that a mandibular setback may produce a sagging throat. Finally, the subnasale-pogonion line gives an important indicator of lip position. The upper lip should be 3.5mm in front of the line; the lower should be in front by 2.2 mm[8, 36].

Czarnecki et al. had 545 professionals evaluate soft tissue silhouettes to see what profile attributes were found in the most desirable profiles. The subjects favored straighter profiles in males than females. They also found that extremely recessive chins or convex faces fared worst. Lip protrusion was found to be acceptable when a large nose or chin was present. They suggested orthodontic goals be planned with balance and harmony of the face in mind rather than strict dental and skeletal ideals[15].

The Holdaway soft-tissue cephalometric analysis (1983) is one of the earliest full featured soft-tissue cephalometric analyzes proposed. Holdaway claimed that his analysis "demonstrates the inadequacy of using a hard-tissue analysis alone for treatment planning." Holdaway describes six lines and eleven measurements in his analysis: (1) The H line or harmony line is drawn tangent to the soft-tissue chin and the upper lip,(2) A soft-tissue facial line from soft-tissue nasion to the point on the soft-tissue chin overlying Rickett's supra pogonion,(3) The usual hard-tissue facial plane, (4) The sella-nasion line, (5) Frankfort horizontal plane, (6) A line was running at a right angle to the Frankfort plane down tangent to the vermilion border of the upper lip[32].

In 1997 Ackerman et al. outlined ten guidelines for soft tissue limitations during orthodontic treatment planning. First, if someone has a large nose or chin, moving incisors forward is better than retraction. Second, severe mid face deficiency or prognathism creates unattractive lip posture, and this can rarely be corrected with orthodontics alone. Third, Moderate mandibular deficiency is often acceptable, especially to patients. Fourth, an upper lip inclining back from a true vertical is un esthetic. Fifth, lack of a well-defined labiomental sulcus in unattractive. In this case, the retraction of incisors is better aesthetically. Sixth, a large amount of gingiva showing is unattractive. Seventh, a curled lower lip is unattractive. Eighth, a concave profile with thin lips is unesthetic when possible proclaiming the incisors are best. Ninth, the bilabial protrusion is unattractive, and finally, soft tissue surgical procedures will have a more dramatic effect on facial soft tissue contours than orthodontic tooth movement[37].

THE BENEFITS OF CLINICAL PHOTOGRAMMETRIC ANALYSIS

The photogrammetric analysis has advantages in terms of human face analysis. Firstly, angular measurements do not change by photographic enlargement in a photogrammetric analysis, as in cephalometric analysis[38]. Thus, the technique can be used clinically for both pre-treatment planning and assessment of a patient's post-operative results. Secondly, every profile fiducial point can be moved freely on a computer monitor utilizing the cephalometric software program to decide the most suitable profile points. Finally, angular photogrammetric profile analysis requires cheap equipment and simple procedures, and it gives us digitized results that are not difficult assessed. Moreover, the collected data can be set in the United charts[39]. In addition, photographs give a more indirect perfect evaluation of measurements and proportions. Photographs allow the observation of harmonious real social relation between soft and hard facial tissues without exposing the patient to unneeded radiation in addition to lower cost[40]

Appropriate clinical photographic records of the orthodontic patient have become more important for a good treatment `planning and follow-up. Clinical photographs permit orthodontists to study the current patient's soft-tissue patterns cautiously throughout the treatment planning. We can evaluate lip morphology and tonicity, the smile arc and smile esthetics from different angles. We can evaluate the degree of incisal during smiling as well. So, they permit us to study the patient in a so-called "social" setting, and all that without the presence of the patient. This information enormously helps the orthodontist in defining an ideal treatment plan for every patient and monitoring in consequent follow-ups. [41]. The use of photogrammetry in orthodontics was initially

proposed by Stoner who compared pre- and post-treatment profiles with perfect profiles[42]. Some authors have included soft tissue parameters in photogrammetry, and different facial soft tissue analyzes derived from standardized photogrammetric method have been described [3, 8, 43]. Other photographic ways also have been used to quantify facial aesthetics[44]. Facial soft tissue analyzes have been conducted using newer three-dimensional (3D) methods [45-47], like laser surface and, lately, scanning digital 3D photogrammetry [48].

HISTORY OF SOFT TISSUE PROFILE PHOTOGRAPHIC STUDIES

Photography has been utilized as an adjunct to direct measurements in anthropologic studies. However, it was in the 1940s that Sheldon proposed that accurate anthropometric measurements could be recorded from standardized photos[49]. Tanner and Weiner examined the reliability of an approach and cited several advantages of using utilizing photogrammetry more than direct measurement including the fact that photographs provide a permanent record of the patients on which an indefinite number of measurements may be made at the investigator leisure[50].

Gavan, Washburn, and Lewis wrote about some of the shortcomings of recording such measurements since photograph may be distorted by paper shrinkage and expansion or because the lens-subject distance was too short. A short lens-subject distance predisposes photograph to two types of error: the photographic parameters will be smaller than actual ones, and the parts of the subject closer to the lens will be extended. Another source of errors results from differences in lighting that can influence facial features. Gavan et al. suggest that these sources of error can be eliminated with proper planning of the photographic environment[51].

In 1955, Stoner described a technique for analyzing photographs to assess the effect of orthodontic treatment. He developed standards resultant from 34 post-treatment profile photos of patients exhibiting ‘‘ brilliant form and balance‘‘ [52 ,42]. Neger conducted a similar study using the same landmarks but reference different lines and angles. He compared a group of patients with ‘‘normal occlusion ‘‘to patients exhibiting class II, deviation 1, class II, deviation 2, and class III malocclusions types[19]. Farkas et al. evaluated 104 surface measurements both directly and from photos. The landmarks were showed on the face before measurements and photography. Sixty-two of the landmarks could be duplicated on the photos and of these 26 were judged to be reliable, more on the lateral than on the frontal photos[53].

Philips et al. evaluated the reliability of the photo cephalometrics method of superimposing coordinated cephalogram and photographs by using a grid analysis. They concluded that accurate comparison between soft and hard tissue anatomy by simply superimposing the images are not feasible because of the difference in the enlargement factors between the photographs and cephalogram. They also concluded that they could obtain quantitative information on the soft tissue from a standardized camera setup and enlarge photographs[54].

In an attempt to measure the facial changes that happen at age 4 to 13 years, Jorgensen assessed photos of 20 normal subject (10 males and ten females) from the Lowa Growth Study, in general, he found that landmark identification on photographs was reproducible[55]. Arnett et al. in 1993 defined frontal and lateral analysis from the photographic records of young adult Caucasians taken in the natural head position. They used, among others, the nasolabial angle and the angle of the contour of the maxillary and mandibular sulcus. They also described the facial profile in Class I (165-175 degrees), Class II (< 165 degrees) and Class III profiles (> 175 degrees) according to the angle of the facial convexity (Gl-Sn-Pog). Their goal was to measure the average parameters that identify the soft tissue profile[56]. Using computers for treatment planning and case presentation is increasing in popularity. Presently presented software for predicting profile changes with treatment relies on the capacity of the clinician to estimate the predictable dental and skeletal changes[57].

HISTORY OF ORTHODONTIC TREATMENT EFFECTS STUDIES

Orthodontic treatment can change facial shape and form, and thus facial esthetics. In 1961, Subtelny demonstrated the orthodontic treatment effects on the lip position. He offered five patients who showed a change in lip position because of treatment and growth and founded that lip posture was closely correlated with the posture of the underlying dental and alveolar structures[58].

Bloom in 1961 assessed profile changes because of orthodontic treatment. Sixty patients undergone for orthodontic were selected. Half of the patients were male, and the other half were female. One-quarter of the sample had four premolars extracted. Both hard and soft tissue landmarks were measured and analyzed. He found that as teeth were moved with treatment, there was a change in the soft tissue profile around the mouth. As the maxillary incisors changed so did the superior sulcus, upper lip, and lower lip. As the lower incisors changed so did the inferior sulcus and lower lip. He reported that it was probably to expect the soft tissue profile changes about incisor movement using regression analysis[59].

In a similar study, Rudee (1964) studied soft-tissue changes in eighty-five patients undergone for orthodontic. He reported that the average ratio of upper incisor retraction to the lower and upper lip retraction was 1:1, and 2.9:1 respectively. Correspondingly, the lower incisor to lower lip retraction ratio was 1:0.59.

Though his sample was selected regardless of age and sex, and no attempt was made to separate the growth effect from changes because of treatment[60].

Hershey in 1972, assessed profile changes because of incisor retraction in Class I and Class II female patients. He evaluated 34 post-adolescent Caucasian females and measured four hard and four soft tissue landmarks. He reported that movement of the upper incisor showed a moderately strong relationship with changes in the superior labial sulcus and labral superiors. The prominence of the lips decreases when the incisor retraction increased. However, gross lingual tooth movement may not result in gross lingual soft-tissue repositioning. Therefore, incisor retraction produced a decrease in lip protrusion, but it was unpredictable[61].

In 1973, Angelle compared soft-tissue profiles of orthodontically treated children with untreated "smile contest" winners having excellent occlusions and esthetically pleasing faces. Significant sexual differences were recorded in the soft tissue profile response because of orthodontic treatment. He concluded there was a clear trend for the upper lip to be retruded in the treated children. The amount of retrusion was restricted in boys but more significant in girls. The upper lip was thicker through orthodontic treatment, which was not noted in the untreated group. An important retrusion of the lower lip through treatment was noted in girls. However, the lower lip in treated boys continued to become more protrusive[62].

Anderson and associates in 1973 studied profile changes in patients undergone for orthodontic treatment ten years out of retention important retraction of both upper and lower lips relative to the esthetic plane were seen through orthodontic treatment. A change in the distance from the upper and lower lips and the chin to the ANS-B line occurred through treatment. Before treatment, lips were around 1 mm. Farther anterior to this reference line than the chin, while after treatment the relationship reversed. All of the soft-tissue changes that occurred following treatment had the effect of flattening the dental area of the facial profile due to a continued nose and chin growth in maturing faces.

Moreover, for every 1.5 mm retraction of maxillary incisors, the thickness of the upper lip increased 1mm during treatment. However, during and after retention the lip thickness decreased, but not back to the original dimension, and an important increase stayed 10 years after retention was observed. Nevertheless, the thickness of the lower lip was not affected by orthodontic treatment[63].

Garner in 1974, studied soft tissue changes of black adolescents who underwent orthodontic treatment. The studied utilized Rudee's36 design, so all linear measurements were made at right angles to the facial plane (nasion-pogonion line). The ratios of tooth change to lip-posture change were similar to those reported in Caucasian samples. There was a 1:1 relationship of the lower lip to mandibular incisor retraction, but a 3.6:1 ratio of maxillary incisor to upper lip retraction[64].

Huggins and McBride in 1975 did a study on thirty-three randomly selected Class II Division 1 patient with overjet ranging from 3.0 mm to 12.0 mm. Without mentioning whether the lips were relaxed or closed during radiographic exposure. Their analysis showed that subnasal (Sn), labral superiors (Ls), and labral inferius (Li) moved closer to the facial plane because of the hard-tissue remodeling brought on by orthodontic treatment. Female patients showed an association between the decrease in prominence of the upper and lower lips and the upper incisor retraction. The male patients revealed no relationship between the upper incisor and the lip position. They attributed this to the continued mandibular growth in males[65-67].

Waldman et al. in 1982 also evaluated changes in lip contour with incisor retraction. A reference line, PM, was constructed by dropping a vertical line from the intersection of the greater wings of the sphenoid with the floor of the anterior cranial fossa to the inferior point of the pterygomaxillary fissure. Lip and tooth retraction and axial inclination of the incisors were measured parallel to the occlusal line, which was constructed perpendicular to the PM line through the first molars. He discovered there was no relationship between the horizontal movement of the maxillary incisal edge and change in the nasolabial angle, but there was an association between the change in angulation of the incisor and the nasolabial angle. There was an important association between a horizontal retraction of the maxillary incisor and the soft tissue at labialesuperiorus. A more obtuse nasolabial angle was found with incisor retraction in patients with steeper palates.[68] Retraction of the maxillary incisors had less effect on the soft tissue profile than previously reported by Rudee and Garner[62, 64].

Drobocky and Smith in 1989 studied profile changes in 160 patients treated with the extraction of four first premolars. They showed the nasolabial angle increased by 5.2 degrees, and the upper and lower lips retracted 3.4 and 3.6mm to the E line, respectively. However, some patients had more protrusive lips after treatment. They discussed that the growth of the chin and nose after treatment could alter profiles long-term, and there is big individual variability in the effects of treatment. Also, subjective assessment of attractive and unattractive profiles often does not happen together with differences measured cephalometrically. They found that, in general, extractions do not negatively affect the profile [69].

In a different study comparing extraction and non-extraction treatments, Paquette et al. recalled 63 patients 14.5 years post-treatment. All patients started with a Class II, division 1 malocclusion. At the recall appointment, every patient was shown tracings of their pre- and post-treatment profiles and was asked to select

the better-looking one. They were unaware it was their profile. The results showed that non-extraction treatment had 2mm more protrusion. Despite the flatter profile, the extraction attractiveness viewed their orthodontic outcome as much of an improvement to facial attractiveness as their non-extraction cohorts[70].

In 1998, Boley et al. studied whether or not general dentists and orthodontists could differentiate between extraction and non-extraction soft-tissue profiles post-treatment. Fifty patients' (25 treated with extractions, 25 treated non-extraction) profile and full-face photographs were evaluated. The distance from subnasale and the Holdaway H-line was utilized to evaluate the fullness of the lips. They demonstrated that the H values were not different in two groups and the profiles flattened. Surprisingly, non-extraction patients started with fuller profiles but flattened more than the profiles of the extraction patients. They concluded that it was not probable to determine from post-treatment photographs whether or not the patient had extractions[71].

In 2000, Bowman and Johnston studied the esthetic impact of extraction and non-extraction treatment. The sample consisted of 120 Caucasian patients (70 treated with extractions, 50 treated non-extraction). Dentists and laypersons were given pre- and post-treatment profiles to evaluate for facial esthetics. Both dentists and laypersons felt that non-extraction treatment had a little esthetic impact while extractions hurt retrusive profiles and benefited protrusive profiles. On average, extraction treatment was measured to be superior if the lower lip was more protrusive to 3.5mm behind the E-plane before treatment[72].

Zierhut et al. in 2000 evaluated long-term profile changes in Class II, division 1 malocclusions of the 63 Caucasian patients, 23 were treated with extractions while 40 were treated non-extraction. Long-term results were reported, on average, 14 years post-retention (mean age 31.6 years). The two groups show no statistically significant differences between the hard and soft tissue profile measurements. The chin and nose moved forward about the lips in two groups, leading to a flattening of the profile. Therefore, whether or not extractions were performed, the long-term profiles were the same[73].

Ramos and de Lima in 2003 evaluated 30 Brazilian Class II patients and compared them to 30 untreated Class II individuals from the Burlington Growth Study. They aimed to find out if the profiles were different with or without orthodontic treatment. Both linear and angular measurements were evaluated, including the angle of convexity (Nasion-A point-Pogonion). Both groups showed a reduction in the convexity of the profile, but this reduction was greater in the orthodontically treated group. The amount of reduction of convexity in the untreated group was not sufficient to correct the Class II malocclusion[74]. Bishara found similar results in 1998, in part, he compared treated Class II, division 1 patients to patients with normal Class I occlusion. He established that in treated patients there was an important reduction in the convexity of the profile. This reduction was significantly greater in the Class II extraction group than in the non-extraction group[75].

Wholly and Woods in 2003 studied the effects of premolar extractions on the curvature of the lips. Two reference lines were a constructed-the pterygomaxillary line (PM) through sphenoethmoidal and the pterygomaxillary fissure, and a line perpendicular to PM through sphenoethmoidal. Both hard and soft tissue landmarks were located concerning the PM line. They established that the depths of the lip curves were found to have reduced after treatment, but there were no differences in the depths among the different premolar extraction combinations. Nevertheless, of whether second or first premolars were extracted, there were minimal changes in upper or lower lip curvature. The pretreatment thickness of the upper and lower lips at the level of the vermilion tissue was the most important pretreatment characteristic that influenced lip curvature. Therefore, overlying soft tissues compensate for growth and treatment in any facial profile[76].

Stephens et al. in 2005 studied the long-term profile changes in extraction and non-extraction patients. Forty white Class, I and Class II patients, were evaluated post-treatment and 15 years post-treatment (mean age 29.8 years). They chose a sample that had similar post-treatment measurements so that any soft tissue profile changes were attributed to the type of treatment. Three main measurements were used; two for dental protrusion (U1-SN and L1-NB), and one for lip protrusion independent of nose length (Holdaway's H line). They discovered that in two groups the lips became more retruded and there was a reduction in facial convexity, with males showing greater changes than females. This is due to the greater growth of the male soft tissue nose and chin post-treatment. Most soft and hard tissue landmarks moved more forward and downward in males compared to females. There were no differences between the extraction and non-extraction groups in profile measurements, as the patients grew similarly during the post-treatment period. Therefore, long-term post-treatment changes were not due to the type of treatment rendered [77].

II. Conclusion

In conclusion facial esthetic still one of the mean reasons that lead many patients to seek for orthodontic treatment so many instances evaluations of facial esthetics seem to be especially influenced by the orthodontist's concept of a pleasing face and that lead them to create many techniques to assess the facial soft tissue. Despite a large number of studies on the short- and long-term effects of orthodontic treatment on patient's facial soft tissue, the accomplishment of soft-tissue profile changes by dental movement is limited but has a significant important in improving the esthetic of facial soft tissue.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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