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Original Article

Correlation Between Cephalometric Values and Soft Tissue Profile in Class I and Class II Adult Patients based on Vertical Patterns

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Main Points

- The increase in the vertical dimension of the face leads to a more convex general and subnasal soft tissue profiles, and the effect is more significantly noticed in the hyperdivergent skeletal patterns.
- An increase in Class II sagittal skeletal discrepancy results in a retrusive lower lip and chin, and thus a more convex general soft tissue profile.
- Changes in the vertical dimension had a greater impact on the soft tissue profile in class II cases than other sagittal classifications.
- Intergender differences were limited to the subnasal profile, where females had a more convex subnasal soft tissue profile.

ABSTRACT

Objective: To compare soft tissue profile variations between Class I and Class II adult patients due to three vertical skeletal facial patterns (normodivergent, hypodivergent and hyperdivergent) and determine which skeletal variation has the most significant impact on soft tissue profile.

Methods: Retrospective soft tissue profile analysis was performed on lateral cephalograms of 131 adult patients. The analysis was divided into two categories correlated with subnasal and general soft tissue profiles. The sample was divided based on two sagittal skeletal patterns (Class I and II) and three vertical groups. In addition, comparisons were made between males and females. Viewbox 4 was used for the analysis. Descriptive, comparative, and correlation statistics were performed using SPSS software.

Results: Statistically significant inter-gender differences were found at the subnasal profile level, but not at the general profile level. No significant differences were observed when comparing subnasal profiles for the sagittal groups. However, significant differences were observed at the level of the general profile, especially at the level of Z-angle, lower lip, and chin prominence. In the vertical groups, hyperdivergent facial patterns had significant differences at the level of subnasal and general profiles compared with other vertical facial patterns.

Conclusion: Females had more convex subnasal profiles than males. Hyperdivergent facial patterns had an impact on both general and subnasal soft tissue profiles. The sagittal dimension affected only the general soft tissue profile. Therefore, changes in the vertical dimension had the greatest impact on facial esthetics.

Keywords: Soft tissue profile, facial esthetics, skeletal patterns, vertical dimension, cephalometric analysis

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INTRODUCTION

Soft tissue profile assessment has been historically implemented and has served as a blueprint for guiding orthodontists in harmonizing facial profile features with either jaw or tooth movement.[1] It plays a vital role in orthodontic treatment planning, and some orthodontists who initially overlooked the profile may eventually find it more pleasant before treatment.[2] Interest in facial profile assessment has increased over time. Other specialties, such as plastic surgery, continue to seek to define the ideal soft tissue profile, considering it as one of the main determinants of facial esthetics. In orthodontics, various methods have been used to evaluate facial soft tissue characteristics. Moreover, several studies have aimed at defining an ideal profile as a reference for planning orthodontic treatment.[3-7] One recent study relied on morphometric methods to assess shape variability and gender dimorphism in soft tissue profile.[8] Other studies have integrated the use of three-dimensional (3D) imaging, such as cone beam computed tomography (CBCT) scans, as a method for analyzing facial profiles. Most recent techniques involve non-invasive imaging such as stereophotogrammetry and laser facial scanning, to acquire 3D facial soft tissue.[9] However, lateral cephalograms have been the primary and most commonly used radiographs in evaluating both hard and soft tissue profiles for orthodontic patients.[10,11]

Several angles and reference planes have been described to analyze different aspects of the profile using lateral cephalograms.[12,13] Soft tissue cephalometric analysis has been divided into two parts: subnasal and general. The subnasal profile involves the area under the nose and evaluates lip position relative to the nose and chin. The general soft tissue profile includes the entire face and evaluates lip and chin positions accordingly. Ricketts and Holdaway described two different approaches for analyzing the subnasal profile. The general profile assessment is often performed using the nasolabial angle, Z-angle, 0-degree meridian, facial angle, and lip/chin prominence.[14]

The influence of changes in the sagittal plane on the soft tissue profile has been previously investigated. For Class II malocclusion, one study showed that Class II subjects often have a convex facial appearance related to small mandibles rather than large maxillae. The ANB angles' value are relatively increased because of decreased SNB angles' value in those subjects.[15] Likewise, soft tissue profile changes following maxillary protraction in Class III patients were investigated. The concave soft tissue profile of the maxilla was primarily corrected by anterior movement of the maxilla and a concomitant increase in the fullness of the upper lip.[16]

However, the variation in soft tissue profile does not only come from the sagittal skeletal discrepancy. Furthermore, the vertical skeletal pattern impacts the surrounding tissues. Vertical growth at the level of the condyle may directly affect the rotation of the mandible; i.e., if condylar growth is slower than that at the level of the facial sutures or alveolar bone, the mandible will rotate clockwise. This will eventually impact the sagittal position of the chin and therefore alter the soft tissue facial profile.[17,18] Accordingly, the correlation between the hard and soft tissue profiles is of interest to the orthodontist. Any dentoskeletal alteration associated with growth or treatment may affect the overall soft tissue profile. Therefore, treatment decisions should be based on changes in facial esthetics due to alterations in skeletal and dental hard tissues.[19] Changes in both the sagittal and vertical facial dimensions should be considered when diagnosing orthodontic patients.

The majority of previous studies have focused on the effect of orthodontic treatment on the overall facial profile.[20-25] Therefore, the present study was conducted to comprehensively evaluate the combined effects of variations in both sagittal and vertical skeletal patterns on the soft tissue profile. The study further compared variations in soft tissue profiles between Class I and Class II adult patients for different vertical facial patterns. Moreover, analysis of the relationship between soft and underlying hard tissues was performed to specifically localize the skeletal parameters that might have an impact on the soft tissue profile.

METHODS

Data Collection

This retrospective cross-sectional study was approved by the Scientific Committee of Lebanese University Faculty of Dental Medicine (approval no: 34/2022, date: October 2019). Lateral cephalograms for 131 healthy adult patients (47 males and 84 females) at the Department of Orthodontics of Lebanese University were selected according to the following criteria: Lebanese origin, 18-30 years of age, complete maxillary and mandibular dentition with the exception of the third molars. The exclusion criteria comprised patients with rhinoplasty, facial surgical/non-surgical interventions, craniofacial syndromes, previous orthodontic treatment, prosthetic restorations, and severe skeletal discrepancies. Written consent was obtained from patients during the initial consultation to allow the use of records for educational and scientific purposes.

Cephalometric Analysis

Patients were asked to occlude with relaxed lips and remain immobile during the acquisition of the radiographs. X-rays with strained lips or mentalis muscle were excluded from the sample. Pre-treatment digital lateral cephalograms were transformed to digital imaging and communications in medicine format, and further analyzed via the Viewbox Cephalometric tracing software (Viewbox Version 4.0.1.7, 2013, dHAL Software, Kifissia, Greece).

The sagittal skeletal patterns of the subjects were identified and Classified using the ANB angle:

- Class I $0° \leq$ ANB $\leq 4°$
- Class II ANB $>4°$

The vertical skeletal patterns were identified and Classified according to the FMA angle:

- Hypodivergent pattern FMA <22°
- Normodivergent pattern 22°≤ FMA ≤28°
- Hyperdivergent pattern FMA >28°

Soft Tissue Profile Analysis

Pre-treatment digital lateral cephalograms were analyzed using Viewbox tracing software. Each lateral cephalogram was divided into two subgroups: general and subnasal profiles. General profile assessment (Figure 1A-C) was performed using the nasolabial angle, Merrifield's Z-angle, 0-degree meridian, facial angle, and lip/chin prominence.[14] The subnasal profile assessment (Figure 1D) adopted both Holdaway's H-line and Ricketts' E-line.[14]

Statistical Analysis

All measurements were exported to Windows Microsoft Excel, where they were grouped and then transferred to SPSS software (SPSS Statistics, version 18.0 IBM, Chicago, Illinois, USA) where all statistical tests were performed. Several comparative analyses were performed to compare soft tissue values among different sagittal and vertical skeletal groups in males and females. Parametric tests were used to analyze normally distributed data, whereas non-parametric tests were used to analyze data showing an abnormal distribution. For the comparison of two independent groups, such as Class I and Class II, t-test was performed when normality was proven; otherwise, Mann-Whitney U test was conducted. As for vertical skeletal groups, the Kruskal-Wallis H test was adopted because the sample sizes between the groups were unevenly distributed. The Spearman correlation coefficient was calculated to check the association between two skeletal variables (FMA and ANB) and the soft tissue cephalometric values. The Shapiro-Wilk method was used to test for normality. The significance level was set at α=5%.

RESULTS

Comparison of Soft Tissue Variables Between Males and Females

Ricketts analysis showed significant differences between genders, with females displaying greater values for both upper and lower lips to the E-plane (p=0.043 and p=0.029 respectively). Additionally, the Holdaway analysis showed significant differences between genders. Nose projection (p=0.024) and soft tissue A to the Holdaway line (p=0.027) were greater in males, whereas soft tissue B to the Holdaway line was greater in females (p=0.000). No statistically significant differences were observed at the general profile level. Because significant intergender differences were found, the overall sample was divided based on gender, and comparative statistics between soft tissue variables and skeletal patterns were performed on each gender group individually (Table 1).

Comparison of Soft Tissue Variables Between Class I and Class II Males and Females

When comparing Class I and Class II males, significant differences were found at the level of the naso-labial angle (p=0.007), z-angle (p=0.018), lower lip (p=0.009), and chin (p=0.0039). Class I males showed greater values for the previously mentioned variables, except for the naso-labial angle (Table 2).

When females were assessed, significant differences were observed in z-angle (p=0.001), 0-degree meridian (p=0.014), facial angle (p=0.043), lower lip prominence (p=0.004), and chin prominence (p=0.001). They were found to be greater in Class I females (Table 2).

Comparison of Soft Tissue Variables Between Different Vertical Patterns in Males and Females

Hyperdivergent males had significantly greater values for lower lip to E-plane distance (p=0.008) and soft tissue B to Holdaway line (p=0.007) compared with the normodivergent group. There were no major differences in soft tissue variables between the hypodivergent and normodivergent groups. When comparing hyperdivergent to hypodivergent males, the latter exhibited significantly greater values for facial angle (p=0.031) and chin prominence (p=0.022). On the other hand, the hyperdivergent group displayed significantly greater values for the lower lip to

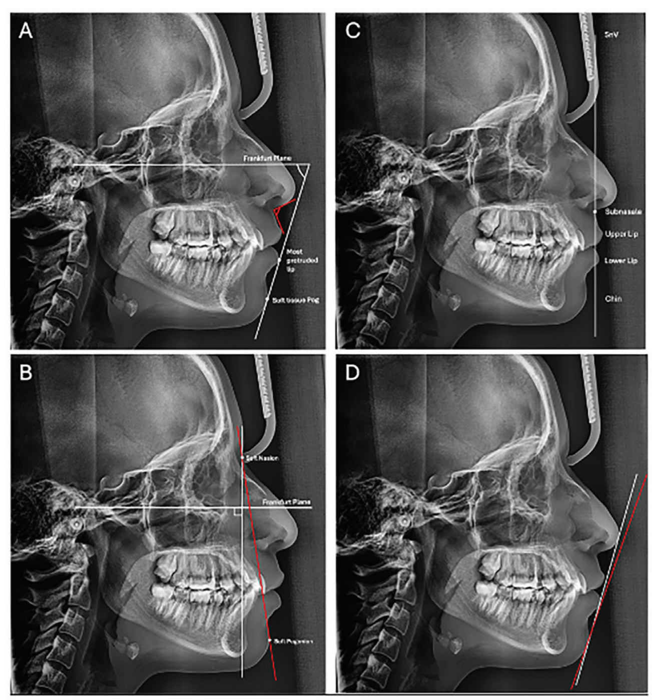

Figure 1. General Profile Analysis; **A**, Nasolabial angle (red), formed by columella and upper lip tangents; Z-angle (white), formed by line passing through soft pogonion and the most protruded lip and Frankfurt horizontal; **B**, 0-degree meridian (white), distance from soft pogonion to a line drawn perpendicular to Frankfurt horizontal through soft nasion; Facial angle (red), intersection of Frankfurt horizontal with a line extended from soft nasion to soft pogonion; **C**, Lip and chin prominence, distance from upper lip, lower lip and soft pogonion to SnV; **D**, Subnasal profile analysis; E-line (white); Holdaway line (red)

Table 1. Mann-Whitney test comparing soft tissue between males and females

Soft tissue variables	Males (n=47) Mean±SD	Females (n=84) Mean±SD	p value (0.05)
Upper lip to E-plane	-5.43±2.8	-4.43±2.04	0.043*
Lower lip to E-plane	-2.85±3.2	-1.70±2.5	0.029*
Nose	9.41±4.5	7.64±3.5	0.024*
Soft A to Holdaway	-3.64±1.6	-4.19±1.5	0.027*
Soft B to Holdaway	-6.53±2.4	-4.64±1.5	0.000*

*Significant difference (p value <0.05)
SD, standard deviation

the E-plane (p=0.003), lower lip to the Holdaway line (p=0.002), and soft tissue B to the Holdaway line (p=0.000) (Tables 3 and 4).

Compared with hypodivergent females, normodivergent females had significantly greater upper lip to E-plane (p=0.025) and lower lip to E-plane (p=0.006). Conversely, hypodivergent females displayed significantly greater nose projection (p=0.011), z-angle (p=0.009), and chin prominence (p=0.012). Significant differences were also observed between hypodivergent and hyperdivergent females; the latter presented greater values for the lower lip to the E-plane (p=0.000), lower lip to the Holdaway line (p=0.000), and soft tissue B to the Holdaway line (p=0.029). On the other hand, hypodivergent females displayed significantly greater values for nose projection (p=0.03), z-angle (p=0.000), 0-degree meridian (p=0.000), and chin prominence (p=0.000). Only one variable, the 0-degree meridian, displayed a significant difference (p=0.03) between hyperdivergent and normodivergent females (Tables 3 and 5).

Correlation Between Soft Tissue Variables and Vertical and Sagittal Skeletal Patterns in Males and Females

Weak to moderate negative correlations were observed between the soft tissue variables and the sagittal skeletal groups at the level of the general profile, specifically z-angle (-0.313 males and -0.571 females) and chin prominence (-0.337 males and -0.526 females). A weak positive correlation was observed at the level of the upper lip to the E-plane of the subnasal profile (0.307 males and 0.385 females) (Table 6).

The vertical groups displayed a moderate positive correlation at the level of the subnasal profile, specifically soft tissue B to the Holdaway line (0.555 males). Weak to moderate negative correlations were observed in both males and females at the level of the general profile, specifically Z-angle, 0-degree meridian, facial angle, and chin prominence (Table 6).

DISCUSSION

To maximize the accuracy of our results, measurements were performed on lateral cephalometric X-rays for the patients in the relaxed lip position. Arnett and Gunson[26] proposed that while evaluating a patient's soft tissue profile, his/her lips must be in the rest position. This relaxed lip posture best displays the patient's soft tissues without any strain or muscular contractions that might compensate for the dentoskeletal abnormalities.[26] Other studies have also adopted the same criteria in their evaluation for the soft tissue profile.[9,17,27] However, patients who had missing teeth and underwent previous orthodontic or extensive prosthodontic treatment were excluded from the study because of the presence of factors that may alter the natural soft tissue profile. Moreover, growing patients were excluded from the study, and the age range of the included subjects was between 18 and 30 years to guarantee the maturity of soft tissue profile.[28]

Jacob and Buschang[15] showed that Class II subjects are characterized by a smaller SNB angle compared with Class I subjects, whereas the SNA angle between two groups were similar. This indicates that Class II subjects are characterized by a retrognathic mandible, which impacts soft tissue profile.[15] The findings of Jacob and Buschang[15] are similar to our findings. The Class II group in our study displayed a significantly decreased SNB angle. Mandibular retrognathism in the absence of soft tissue compensation often results in posterior positioning of both the lower lip and chin, resulting in an expected convex general profile. Consequently, underlying sagittal skeletal variations in the Class II direction had an immediate impact on the general soft tissue profile in both males and females.

Soft tissue profiles were analyzed dividing them into general and subnasal profiles. Subnasal analysis via Ricketts and H-line methods showed no significant differences between

Table 2. Comparison of soft tissue variables between Class I and Class II males and females

Soft tissue variables	Class I (n=26) Mean±SD Males	Class II (n=21) Mean±SD Males	p value (0.05)	Class I (n=35) Mean±SD Females	Class II (n=49) Mean±SD Females	p value (0.05)
Nasolabial angle	95.12±10.8	105.19±13.6	0.007*	97.71±12.5	102.61±9.7	0.087
Z-angle	78.62±5.2	74.95±4.8	0.018*	78.86±4.4	75.06±5.5	0.001*
0-degree meridian	2.19±8.2	2.62±6.1	0.845	5.29±4.3	2.47±6.7	0.014*
Facial angle	92.00±4.1	91.33±3.3	0.546	93.03±2.5	87.92±2.6	0.043*
Lower lip prominence	-0.92±3.6	-3.95±3.8	0.009*	-0.09±3.1	-2.10±2.9	0.004*
Chin prominence	-7.00±5.2	-9.95±3.9	0.039*	-5.03±4.3	-8.67±5.1	0.001*

*Significant difference (p value <0.05)
SD, standard deviation

Class I and Class II groups, indicating virtually identical profiles.[2] However, general profile analyses showed significant differences between the two groups. Thus, the H-line and the E-plane offered no additional information on chin projection or overall profile. The sagittal dimension had a minimal impact on the subnasal profile convexity. However, an increase in the sagittal dimension in the Class II direction led to a more convex general profile due to the backward projection of the lower lip and chin.

The increased nasolabial angle observed in Class II patients suggests a posterior subnasal region position, crucial for orthognathic surgical planning. It may have a negative implication on Class II distalization treatment protocols by worsening the nasolabial angle.[29] Our Class II sample comprised both divisions (1 and 2), which might have contributed to the results of our study. Often in a Class II division 1 sample, a decreased nasolabial angle is more likely to be observed due to proclined maxillary incisors. Hence, if the sample was further divided into Class II divisions 1 and 2, this could have resulted in more precise outcomes.

The literature has given minimal attention to the impact of the vertical dimension on the soft tissue profile. Jacob and Buschang[15] concluded that hyperdivergent patterns exhibit more retrusive profiles. Our study indicated that the vertical dimension affected all levels of the soft tissue profile, i.e., subnasal and general profiles. As the vertical dimension increased from hypodivergent to hyperdivergent, lip protrusion increased, resulting in hyperdivergent patients displaying a more convex subnasal profile. This could be related to the chin's a more backward position in high-angle cases due to clockwise

Table 3. Descriptive statistics showing soft tissue variables of vertical groups in males and females. 1, Normodivergent; 2, Hypodivergent; 3, Hyperdivergent

Soft tissue variables	(1) Males (n=15) Mean±SD	(2) Males (n=25) Mean±SD	(3) Males (n=7) Mean±SD	(1) Females (n=32) Mean±SD	(2) Females (n=33) Mean±SD	(3) Females (n=19) Mean±SD
Upper lip to E-plane	-6.53±3	-5.24±2.5	-3.71±2.5	-3.91±2.1	-5.21±1.9	-3.95±1.6
Lower lip to E-plane	-3.40±2.6	-3.52±3.1	0.71±2.2	-1.19±2.4	-3.00±2.2	-0.32±1.9
Nose	10.89±4.7	9.41±4.3	6.26±4	6.70±3.6	9.11±3.2	6.65±3.1
Soft A to Holdaway	-3.40±1.3	-3.48±1.6	-4.71±1.8	-4.44±1.2	-3.70±1.4	-4.63±1.7
Lower lip to H-plane	0.40±2.1	-0.72±2.1	2.71±2.8	0.84±1.6	-0.09±1.6	1.89±1.5
Soft B to Holdaway	-6.40±2.2	-7.48±2	-3.43±1.2	-4.56±1.3	-5.09±1.4	-4.00±1.7
Nasolabial angle	99.47±10.5	101.68±14.1	92.5±13	100.41±10.8	100.12±11.9	101.63±10.8
Z-angle	76.60±4.8	78.20±4.9	73.43±6.9	75.78±4.4	79.45±4.1	73.21±6.6
0-degree meridian	0.67±6.7	4.36±6.7	-1.00±9.2	3.63±5.6	6.06±3.1	-0.53±8.1
Facial angle	91.20±3.1	92.80±3.1	88.86±5.2	92.13±2.8	93.58±2.1	80.42±4.1
Upper lip prominence	0.80±2.8	0.88±3.1	1.57±2.3	1.81±2.3	1.42±1.9	1.16±2.6
Lower lip prominence	-2.60±3.6	-2.44±4.1	-1.00±4.4	-1.19±3.2	-0.82±3.1	-2.16±3.2
Chin prominence	-8.93±5.1	-6.84±3.6	-12.29±6.6	-7.88±3.9	-4.52±3.9	-10.53±6.3

SD, standard deviation

Table 4. Comparison of the soft tissue variables between vertical groups in males. 1, Normodivergent; 2, Hypodivergent; 3, Hyperdivergent

Soft tissue variables	Vertical groups		p value (0.05)	Soft tissue variables	Vertical groups		p value (0.05)	Soft tissue variables	Vertical groups		p value (0.05)
Lower lip to E-plane	1	2	0.991	**Soft B to Holdaway**	1	2	0.248	**Facial angle**	1	2	0.353
		3	0.008*			3	0.007*			3	0.321
	2	1	0.991		2	1	0.248		2	1	0.353
		3	0.003*			3	0.000*			3	0.031*
	3	1	0.008*		3	1	0.007*		3	1	0.321
		2	0.003*			2	0.000*			2	0.031*
Lower lip to H-plane	1	2	0.266	**Chin prominence**	1	2	0.355				
		3	0.063			3	0.261				
	2	1	0.266		2	1	0.355				
		3	0.002*			3	0.022*				
	3	1	0.063		3	1	0.261				
		2	0.002*			2	0.022*				

*Significant difference (p value <0.05)

Table 5. Comparison of the soft tissue variables between vertical groups in females. 1, Normodivergent; 2, Hypodivergent; 3, Hyperdivergent

Soft tissue variables	Vertical groups		p value (0.05)	Soft tissue variables	Vertical groups		p value (0.05)	Soft tissue variables	Vertical groups		p value (0.05)
Upper lip to E-plane	1	2	0.025*	**Soft B to Holdaway**	1	2	0.312	**Chin prominence**	1	2	0.012*
		3	0.997			3	0.378			3	0.122
	2	1	0.025*		2	1	0.312		2	1	0.012*
		3	0.073			3	0.029*			3	0.000*
	3	1	0.997		3	1	0.378		3	1	0.122
		2	0.073			2	0.029*			2	0.000*
Lower lip to E-plane	1	2	0.006*	**Lower lip to H-plane**	1	2	0.057	**Z-angle**	1	2	0.009*
		3	0.390			3	0.069			3	0.170
	2	1	0.006*		2	1	0.057		2	1	0.009*
		3	0.000*			3	0.000*			3	0.000*
	3	1	0.390		3	1	0.069		3	1	0.170
		2	0.000*			2	0.000*			2	0.000*
Nose	1	2	0.011*	**0-degree meridian**	1	2	0.183				
		3	0.999			3	0.030*				
	2	1	0.011*		2	1	0.183				
		3	0.030*			3	0.000*				
	3	1	0.999		3	1	0.030*				
		2	0.030*			2	0.000*				

*Significant difference (p value <0.05)

Table 6. Correlation between soft tissue variables, sagittal and vertical skeletal patterns

	Soft tissue variables	ANB males	ANB females	FMA males	FMA females
Subnasal profile	**Upper lip to E-plane**	0.307	0.385	-0.053	0.282
	Lower lip to E-plane	0.176	0.090	0.041	0.229
	Soft A to Holdaway	-0.029	-0.204	-0.212	-0.256
	Lower lip to H-plane	-0.025	0.130	0.155	0.169
	Soft B to Holdaway	0.018	-0.054	0.555	0.262
General profile	**Nasolabial angle**	0.266	0.228	-0.214	0.052
	Z-angle	-0.313	-0.571	-0.312	-0.490
	0-degree meridian	0.112	-0.154	-0.379	-0.463
	Facial angle	-0.087	-0.293	-0.420	-0.221
	Upper lip prominence	-0.032	-0.021	0.044	0.025
	Lower lip prominence	-0.150	-0.202	-0.018	-0.123
	Chin prominence	-0.337	-0.526	-0.432	-0.509

mandibular rotation, giving the impression of protruding lips. This observation was not observed when comparing the sagittal groups because Class I and Class II patients had similar subnasal lip projection. Similar to the sagittal dimension, the vertical dimension also impacted the general profile. As the FMA angle increased, the profile was seen to be more convex. The chin was more retruded or least prominent in the hyperdivergent group and most prominent in the hypodivergent group. Therefore, we can infer that an increase in FMA and ANB angles have similar effects on the general profile, making it more convex as they increase.

Thus, a change in mandibular divergence will likely have a more widespread influence on the soft tissue profile compared with the anteroposterior relationship of the jaws. With regard to gender differences, females had more convex subnasal profiles, mainly due to lip protrusion. No difference in the general profile was found between the two genders. Clinically, careful attention must be paid to the vertical dimension when diagnosing and planning orthodontic treatment mechanics. In high-angle cases, clinicians should minimize mechanics that would potentially harm facial esthetics and lead to a further increase in mandibular divergence. According to our findings, any increase in the mandibular plane angle would worsen the overall profile convexity. Early intervention in high-angle cases to help minimize vertical growth and strict retention protocols to avoid relapse should be considered.

Study Limitations and Future Considerations

This study is retrospective and 2D cephalometric radiographs were used for the analysis. With the evolution of 3D radiographs, the use of CBCT scans for such analysis could have been more accurate. On the other hand, body mass index should be considered for future studies because it has a significant impact on soft tissues. Further division of the Class II group into divisions 1 and 2 could provide more information on the effect of the incisor position on the nasolabial angle. Finally, equal gender distribution and an age group older than 21 years should be considered for future evaluations to avoid confounding effects due to late growth, especially in males.

CONCLUSION

- The vertical dimension significantly impacts the soft tissue profile more than the sagittal dimension.

- Changes in the vertical dimension influence both subnasal and general profiles, resulting in in a more convex profile with increased vertical dimension.

- Chin projection was the most affected region for the soft tissue profile.

- The vertical dimension had the greatest influence on the soft tissue profile.

- When analyzing the general profile, Z-angle, facial angle, and subnasal prominence are highly accurate tools. However; H-line and E-line measurements should be limited to subnasal profile assessment because they provide no information regarding the general profile.

Ethics

Ethics Committee Approval: This retrospective cross-sectional study was approved by the Scientific Committee of Lebanese University Faculty of Dental Medicine (approval no: 34/2022, date: October 2019).

Informed Consent: Retrospective cross-sectional study.

Author Contributions: Concept - P.F., M.S.G.; Design - P.F., M.S.G.; Supervision - M.S.G.; Data Collection and/or Processing - P.F.; Analysis and/or Interpretation - P.F., M.S.G.; Literature Review - P.F., M.S.G., S.A.A.; Writing - P.F.; Critical Review - P.F., M.S.G., S.A.A.

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