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Evaluation of Facial Soft-Tissue Morphology among Different Vertical Skeletal Profile

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Abstract

The objective of this study was to compare facial groups classified according to their vertical skeletal characteristics (hypodivergent, normodivergent, and hyperdivergent) and to their respective soft tissue morphological features, particularly those relating to the lips and chin. 90 Lateral cephalometric x-rays were collected from the Orthodontic clinic at the Faculty of Dentistry, Beirut Arab University and divided into 3 equal groups based on mandibular plane angle, hypodivergent facial type (SN/MP <27°), normodivergent facial type (SN/MP between 27° and 37°), hyperdivergent facial type (SN/MP >37°). The mean upper and lower lips thickness was maximum among hypodivergent group (8.95 mm and 9.35 mm, respectively). The mean upper lip height was maximum among hyperdivergent group (11.3 mm), while lower lip height was maximum among hypodivergent group (25.32 mm). The mean procumbency of upper (PUL) and lower lips (PLL) was maximum among hypodivergent (2.08 mm and 0.87 mm, respectively).

However, the mean chin thickness was maximum among hyperdivergent group (7.84 mm). Statistically significant difference among the three groups were observed only in Hypo vs Normo-divergent groups in ULT. Concerning PUL and PLL, there was a statistically significant differences between the different groups in Hypo vs Normodivergent and Hypo vs Hyperdivergent groups. It was concluded that the thickness of upper and lower lip, height of lower lip, and procumbency of both lips showed to be greater in hypodivergent facial patterns.

Keywords: Lip thickness - Lip height - Lip procumbency - Chin thickness - Vertical dimensions

Introduction

Physical attractiveness is an important social issue in our culture, and one of the key features is the face. A proportionate relationship between different facial structures is key to an esthetic and pleasing facial appearance.

The importance of facial esthetics in the practice of orthodontics has its origins at the beginning of our specialty. Assessment of the facial harmony of the patient is an important factor for an accurate diagnosis and treatment plan. As medical professionals' ability to change people's faces has improved, the need to understand what is and isn't beautiful has developed (Parihar et al, 2019).

With standardized radiographs, the orientation of various anatomical structures can be studied using angular and linear measurements (Tikku et al, 2014). The soft tissue profile has been extensively studied in the orthodontic literature, primarily from lateral cephalometric radiographs, under the assumption that the form of the soft tissue outline largely dictates the esthetics of the whole face (Spyropoulos and Halazonetis, 2001).

The changes of hard tissue changes over time. Although early studies of esthetics in orthodontic treatment focused on how clinicians perceived their patients, changing demographics and cultural attitudes prompted researchers to look more closely at patients' preferences, public attitudes, and esthetics (Turley, 2015).

Since optimal facial aesthetics are closely related to vertical facial dimensions, achieving the ideal vertical facial profile is one of the primary goals of orthodontic treatment. Facial types are described in the orthodontic literature based on their vertical skeletal features, and classified patients as hypodivergent, normodivergent, or hyperdivergent.

A variety of methodologies have been proposed to judge vertical relationships. However, two commonly used measurements are mandibular plane inclination to the anterior cranial base and percentage of lower anterior to total anterior face height (Rasool et al., 2016).

Lower facial height is one of the hard tissue factors that are assessed in determining soft tissue morphology. According to Kasai (1998), a longer lower facial height and protruding lower incisors were associated with a thicker upper lip. Saxby and Freer (1985) found correlations between lower facial height and soft tissue forms in the horizontal and vertical planes. This relationship, however, varies because some soft tissue structures are highly correlated to hard tissue, while others are affected by their length, thickness, and function (Kasai, 1998).

Following the introduction of the soft tissue paradigm, various soft tissue parameters have become an essential part of the orthodontic problem list. The nose-lip-chin relationships are crucial in determining facial esthetics. Initially, it was assumed that the profile follows the underlying hard tissue. However, subsequent research revealed that the soft tissue had independent growth potential (Burstone, 1958; Subtelny, 1959). Furthermore, variations in soft tissue thickness, length, and tonicity may influence the position and relationship of facial structures (Ashraf et al., 2018).

Lips determine the final facial profile of a patient after treatment, due to their location in the middle of the face. Many measurements are provided in the literature to evaluate the height, thickness, and position of the lips. Lip procumbency can also be evaluated by a line parallel to the true vertical line through subnasale and perpendicular to the natural horizontal head position.

Regarding the chin, it is an important factor in making the profile more acceptable. The soft tissue chin thickness influences diagnosis and treatment planning, and any dissociation between the underlying bony structures and the soft tissue can significantly affect the facial structure in such a way that the treatment may be shifted into the range of orthognathic and cosmetic surgery.

Searching the available literature, only a few studies describe and compare facial soft tissue components among different vertical skeletal groups. Most research in this area focuses on investigating soft tissue responses to movements resulting from orthodontic treatment (Ramos et al., 2005). However, few address soft tissue characteristics of malocclusions from a vertical perspective. These measurements may help in planning orthodontic cases and may establish a specific soft tissue prognosis for each facial vertical pattern.

Therefore, this study was designed to compare facial groups classified according to their vertical skeletal characteristics (hypodivergent, normodivergent, and hyperdivergent) to their respective soft tissue morphological features, particularly those relating to the lips and chin.

1. Previous Research

Taki et al. (2009) reported that significant differences were found in nose prominence, upper lip thickness, basic upper lip thickness, lower lip

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sulcus depth, and soft tissue chin thickness measurements in comparison of the sexes, and that the soft tissue chin thickness was significantly larger in males than in females.

Feres et al (2010), compared the soft tissue morphology of individuals according to their facial patterns using cephalograms of 90 patients of both genders, aged 12 to 16 years, which were divided into three distinct groups according to their morphological patterns, i.e. mesofacial, dolichofacial, and brachyfacial. The groups were compared in terms of the thickness and height of the upper and lower lips, as well as the thickness of the soft tissue chin. It was reported that thickness of upper lip, lower lip, and soft tissue chin showed no differences in all morphological groups. However, upper and lower lip heights were significantly greater in dolichofacials. Brachyfacials showed smaller upper lip heights compared with mesofacials, although no differences were found between those two groups in terms of lower lip height.

Al-Shayegh et al. (2011) conducted a study on 120 Iraqi adults with Class I normal occlusion to investigate the differences in soft tissue facial morphology in various groups of vertical facial patterns and to explore gender dimorphism within each type. A lateral cephalometric radiograph was taken and then divided into 3 groups according to vertical pattern; short, average, and long facial types. The study concluded that most of the differences among the 3 groups of facial types were in vertical soft tissue measurements. The only difference that was detected in the thickness of the soft tissue drape was in the lower lip thickness at point B. The short-faced subjects showed the smallest dimensions for lower facial height and lower lip height. Regarding thickness, the long face showed the greatest lower lip thickness at point B than the other two facial types.

Celikoglu et al. (2014) also compared the soft tissue thickness values at the lower anterior face among adult patients with different vertical growth patterns using cone-beam computed tomography and found that soft tissue thickness values were the thinnest in the high-angle group for both women and men. Women had statistically significantly thinner thickness at the labrale superius and pogonion in the high-angle group compared with the normal-angle group, whereas men had similar soft tissue thickness values at the lower anterior face in all groups.

Toth et al. (2016) gathered a sample of 110 white girls between the ages of 12 and 18 years. Measurements of SN/GoGn, anterior facial height, and lower and upper facial height percentages were obtained from lateral cephalograms to measure the 3-dimensional parameters of the posed smile and to see whether there are any correlations with vertical cephalometric skeletal measurements. The results stated that as lower facial height increased and upper facial height decreased, the lower lip became depressed and moved backward.

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A cross-sectional study was conducted by Jeelani et al. (2016) on the lateral cephalograms of 180 adult subjects, divided into three equal groups: short, average, and long faces according to the vertical facial pattern. Incisal display at rest, nose height, upper and lower lip lengths, degree of lip procumbency, and the nasolabial angle were measured for each individual to determine and compare various facial soft tissue parameters on lateral cephalograms among patients with short, average, and long facial patterns. In his study, he found that the vertical proportions of facial soft tissues follow the underlying vertical skeletal pattern. A long facial pattern is associated with excessive incisal display, long procumbent upper and lower lips, and an increased total nasal height with an obtuse nasolabial angle. The short facial pattern is associated with minimal incisal display, short recumbent upper and lower lips, and a decreased total nasal height with an acute nasolabial angle.

Kim et al. (2019) conducted research to evaluate the three-dimensional (3D) changes after mandibular setback surgery in skeletal Class III malocclusion using cone-beam computed tomography (CBCT) and a structured light-based scanner. There was a significant decrease in lower facial height after the surgery. In the anteroposterior direction, most landmarks of the lip and chin moved backward significantly (Ls, Stms, Me', Li, Stmi, B', and Pog'), except for A'. On the vertical axis, significant upward movement was observed in landmarks related to the chin (B', Pog', and Me'), but not in the nose and lips. There was a significant decrease in lip width (1.97 mm). Correlations between corresponding hard and soft tissue landmarks were observed in the lower lip and chin. On the anteroposterior axis, some soft tissue landmarks related to the lower lip (Stms, Stmi, and Li) and chin (B' and Pog') demonstrated a significant correlation with hard tissue landmarks.

2. Hypotheses

To evaluate the soft tissue morphology in different vertical profile among skeletal class I patients.

4. Research Methods

4.1. Hypotheses Testing

This study was carried out as a cross-sectional, comparative, and descriptive study where the samples were collected from the archives of orthodontic patients at Beirut Arab University treated at the specialty clinics. The patients were selected as the most recent files for each group.

Sample size estimation was performed using 80% power of the study and sample size using HTTP://www.raosoft.com/samplesize. The estimated sample size was calculated according to HTTP:// www.raosoft.com/samplesize, by taking the estimated population of 100 patients as conducted by Feres et al. (2010), assuming a confidence level of

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95% and a study power of 80%. Explanatory variables are SN/MP, TAFH, LAFH, ULH, ULT, LLH, LLT, CT, PUL, and PLL. The calculated sample size was 90 lateral cephalograms to be taken satisfying the following selected criteria based on their ANB angle being between 0 to 4°. Once selected, the radiographs were divided according to their vertical skeletal pattern into three groups based on the measurement of the mandibular plane angle. (Athanasiou, 1995): hypodivergent facial type (SN/MP <27°), normodivergent facial type (SN/MP between 27°- 37°), and hyperdivergent facial type (SN/MP >37°).

The protocol for this study was approved by the ethics committee of Beirut Arab University Faculty of Dentistry with IRB Number: 2020-H-0082-D-M-0421. Subjects receiving orthodontic treatment in the Postgraduate clinic of BAU Dental hospital sign a consent for the use of their medical records for consultation and scientific research purposes as part of the informed consent before commencing treatment.

Inclusion criteria included lateral cephalometric x-rays of subject, aged between 18 and 30, having a skeletal Class I relationship with ANB angle = 0 - 4°, fully erupted incisors, overjet is within normal range, and having all teeth except for the third molars. Patients with previous orthodontic treatment, orthognathic surgery, systemic diseases affecting growth and development, and craniofacial anomalies, facial traumatic injuries, and anterior or posterior crossbites. Subjects' records were consulted to ascertain the exclusion criteria.

All lateral cephalometric x-rays are taken by the same operator using the same device (Kodak 3D, Carestream Health, Inc., Rochester, NY, USA) and the same technical conditions to ensure a high degree of precision: the patient was standing, the head was fixed in such a way that the sagittal plane was at the right angle to the path of the x-rays and the Frankfort Horizontal Plane (FHP) was parallel to the horizontal plane. Teeth were occluded in a centric occlusion, and lips were maintained at rest with no lip strain.

The jpeg files of the radiographs were imported into the Adobe Photoshop CC program (2018, Version 20.0). The lateral cephalometric x-rays were adjusted according to a constructed horizontal plane drawn at 5.6° to SN inclination to approximate the natural head position (Lundstrom, 1992). The vertical plane was constructed perpendicular to the horizontal plane at Nasion (N). Both hard and soft tissue cephalometric landmarks were digitized according to the definitions of Rakosi (1982), Jacobson (1995), and Farkas (1994) (Table 1 and 2). All procedures have been done by the same investigator. The anterior cranial base plane and mandibular planes were drawn. Cephalometric landmarks, planes, and variables measured are shown in Figures 1 and 2 (Figures 1 and 2).

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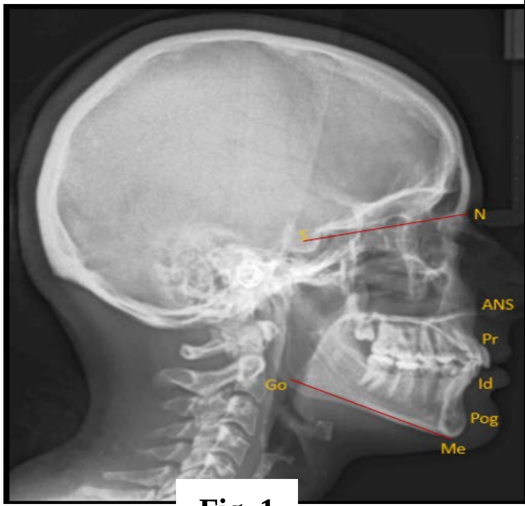

Fig. 1

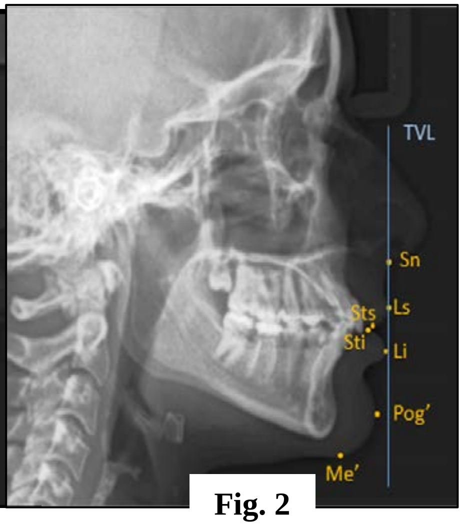

Fig. 2

Figure 1. Hard tissue landmarks and hard tissue planes identifications. Sella turciqua (S); Nasion (N); SN plane (SN); Anterior nasal spine (ANS); Supradental (Pr); Infradental (Id); Menton (Me); Gonion (Go); Pogonion (Pog); Mandibular plane (MP).
Figure 2. Soft tissue landmarks and TVL. Subnasale (Sn); Labiale superius (Ls); Labiale inferius (Li); Stomion superius (Sts); Stomion inferius (Sti); Soft tissue Pogonion (Pog'); Soft tissue Menton (Me'); True vertical Line (TVL)

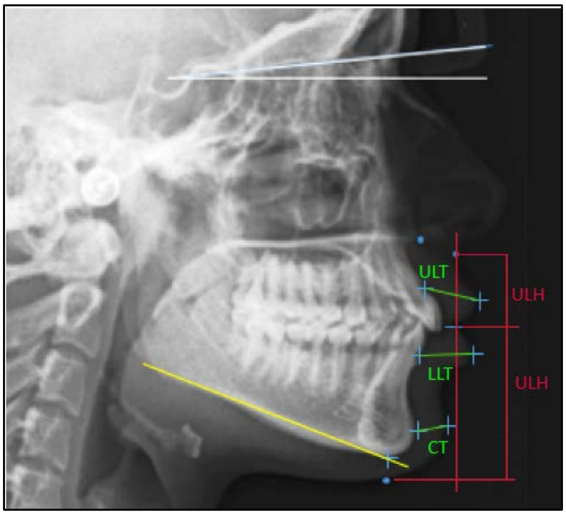

Fig. 3A

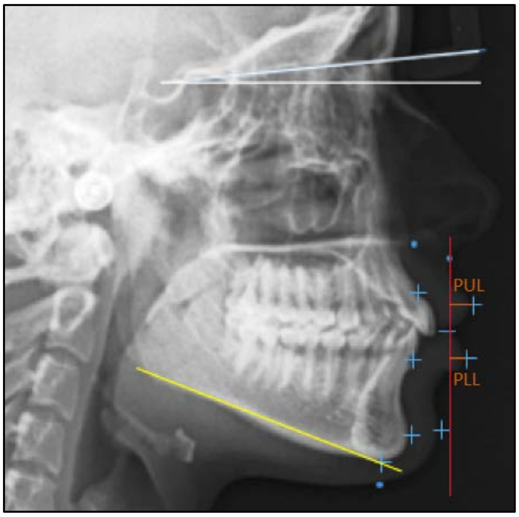

Fig. 3B

Figure 3. Soft tissue linear measurements. **A,** Upper lip thickness (ULT); Upper lip height (ULH); Lower lip thickness (LLT); Lower lip height (LLH); Chin thickness (CT). **B,** Procumbency of upper lip (PUL); Procumbency of lower lip (PLL).

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Table 1: Hard Tissue Landmarks and Planes

Sella (S)	The midpoint of the hypophysial fossa.
Nasion (N)	The intersection of the internasal and frontonasal sutures.
Anterior nasal spine (ANS)	The tip of the bony anterior nasal spine at the inferior margin of the piriform aperture.
Supradental (Pr)	The junction between the maxillary central incisor and the premaxilla (Superior prosthion).
Infradental (Id)	The junction between the mandibular alveolar process and the mandibular central incisors (Inferior prosthion).
Menton (Me)	The lowest point on the symphyseal shadow of the mandible seen on a lateral cephalogram.
Gonion (Go)	The most posterior inferior point on the outline of the angle of the mandible.
Pogonion (Pog)	The most anterior point on the bony chin
S-N plane (SN)	The plane formed by joining (S) and (N) points
Mandibular plane (MP)	The plane formed by joining (Go) and (Me) points

Table 2: Soft Tissue Landmarks and TVL

Subnasale (Sn)	The junction of the nasal columella and upper lip.
Labiale superius (Ls)	Outermost point of the upper lip contour.
Labiale inferius (Li)	Outermost point of the lower lip contour.
Stomion superius (Sts)	The most inferior point at the bottom of the upper lip contour.
Stomion inferius (Sti)	The most superior point of the upper border of the lower lip.
Soft tissue Pogonion (Pog’)	The most anterior point of soft tissue chin
Soft tissue Menton (Me’)	Lowest point on soft tissue over mandible
True vertical Line (TVL)	Vertical line passing through subnasale (Sn)

The soft tissue measurements (Figure 3; A and B) were defined as follows:

- *Upper lip thickness (ULT)- distance between Supradental (Pr) and Labiale superius (Ls).*
- *Upper lip height (ULH)- distance between Subnasale (Sn) and Stomion superius (Sts)*
- *Lower lip thickness (LLT)- distance between Infradental (Id) and Labiale inferius (Li)*
- *Lower lip height (LLH)- distance between Stomion inferius (Sti) and Soft tissue Menton (Me’)*

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- *Chin thickness (CT)- distance from hard tissue Pogonion (Pog) to soft tissue Pogonion (Pog')*
- *Procumbency of upper lip (PUL)- perpendicular distance between Labiale superius (Ls) and TVL passing through (Sn).*
- *Procumbency of lower lip (PLL)- perpendicular distance between Labiale inferius (Li) and TVL passing through (Sn).*
  ** A measurement was given a positive sign if the lip point was located anterior to TVL while the negative values were recorded for lip positioned posteriorly.*

4.2. Statistical Analyses

Collected data were statistically analyzed and processed using SPSS software. (SPSS, Version 25.0 Inc., Chicago, IL) for Windows. The alpha error was set at a p-value < 0.05. The data were tested for normality using the Kolmogorov-Simirnov test. Pearson product-moment correlation coefficients were calculated to assess the relationship between soft tissue parameters and hard tissue parameters.

The soft tissue measurements were compared among these groups using a one-way unpaired ANOVA followed by a Tukey post hoc test.

4.3. Method of Error

To asses tracing errors, 20 cephalometric x-rays were retraced after 1 month by the same operator under the same conditions.

Reproducibility was calculated for intra-examiner reliability using the intra-class Correlation Coefficient (ICC).

5. Results

The study design was a cross-sectional study that included 90 patients collected from the records of orthodontic patients stored in the archives of Beirut Arab University division of Orthodontics, Beirut, Lebanon. Descriptive statistics of the measured variables in the 3 groups are shown in the following (Table 3, Figure 4).

The mean upper lip thickness (ULT) among the hypodivergent group was found to be maximal (8.95 mm ± 1.62), followed by the hyperdivergent group (8.1 mm ± 1.27) while for the normodivergent group it was found to be minimal (7.89 mm ± 1.63). There was a statistically significant difference among the three groups, with a significant difference being observed only in the Hypo vs Normo-divergent groups (p = 0.023). On the other hand, the mean lower lip thickness (LLT) among the hypodivergent group was found to be maximal (9.35 mm ± 1.28), followed by the hyperdivergent group (9.13 mm ± 1.00), while for the normodivergent group, it was found to be minimal (8.66

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mm ± 1.05). No statistically significant difference was observed between the three different groups.

The mean upper lip height (ULH) among the hyperdivergent group was found to be maximal (11.3 mm ± 1.56), followed by the normodivergent group (10.89 mm ± 1.42), while for the hypodivergent group it was found to be minimal (10.85 mm ± 1.58). On the other hand, the mean lower lip height (LLH) among the hypodivergent group was found to be maximal (25.32 mm ± 3.25), followed by the hyperdivergent group (25.28 mm ± 2.43), while for the normodivergent group, it was found to be minimal (25.01 mm ± 1.96). For both ULH and LLH, no statistically significant difference was observed between the three different groups.

The mean procumbency of the upper lip (PUL) among the hypodivergent group was found to be maximal (2.08 mm ± 1.23), followed by the hyperdivergent group (1.06 mm ± 0.95), while for the normodivergent group it was found to be minimal (0.83 mm ± 1.35). On the other hand, the mean procumbency of lower lip (PLL) among the hypodivergent group was found to be maximal (0.87 mm ± 2.08), indicating that most of the lower lips were located anterior to the TVL, followed by the hyperdivergent group (0.44 mm ± 1.53), indicating that most of the lower lips were located posterior to the TVL, while for the normodivergent group, it was found to be minimal (0.73 mm ± 1.7), indicating that most of the lower lips were located posterior to TVL. A significant difference was observed only in Hypo vs Normodivergent and Hypo vs Hyperdivergent groups between the different groups for PUL ($p = 0.001$ and $p = 0.008$, respectively) and PLL ($p = 0.002$ and $p = 0.015$, respectively).

Finally, the mean chin thickness (CT) among the hyperdivergent group was found to be maximal (7.84 mm ± 1.79), followed by the normodivergent group (7.32 mm ± 1.12), while for the hypodivergent group, it was found to be minimal (7.08 mm ± 1.37). No statistically significant difference was observed between the three different groups for CT.

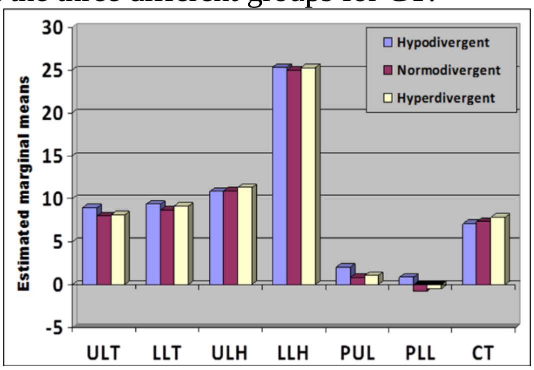

Figure 4: Estimated marginal means of soft tissue measurements between different morphological patterns

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Table 3: Comparison of soft tissue measurements between different morphological patterns

		N	Mean	Std. Deviation	*p*-value	*p-value of Pairwise Comparisons*
ULT	Hypodivergent	30	8.95$	1.62	0.02*	Hypo Vs Normo (p-value = 0.023) Hypo Vs Hyper (p-value = 0.082) Normo Vs Hyper (p-value = 0.859)
	Normodivergent	30	7.89$	1.63		
	Hyperdivergent	30	8.1	1.27		
LLT	Hypodivergent	30	9.357	1.28	0.057	Hypo Vs Normo (p-value = 0.05) Hypo Vs Hyper (p-value = 0.728) Normo Vs Hyper (p-value = 0.241)
	Normodivergent	30	8.66	1.05		
	Hyperdivergent	30	9.137	1.004		
ULH	Hypodivergent	30	10.85	1.58	0.463	Hypo Vs Normo (p-value = 0.995) Hypo Vs Hyper (p-value = 0.503) Normo Vs Hyper (p-value = 0.56)
	Normodivergent	30	10.89	1.42		
	Hyperdivergent	30	11.3	1.56		
LLH	Hypodivergent	30	25.32	3.25	0.88	Hypo Vs Normo (p-value = 0.89) Hypo Vs Hyper (p-value = 0.999) Normo Vs Hyper (p-value = 0.911)
	Normodivergent	30	25.01	1.96		
	Hyperdivergent	30	25.28	2.43		
PUL	Hypodivergent	30	2.01$,†	1.23	0.001**	Hypo Vs Normo (p-value = 0.001) Hypo Vs Hyper (p-value = 0.008) Normo Vs Hyper (p-value = 0.729)
	Normodivergent	30	0.83$	1.35		
	Hyperdivergent	30	1.06†	0.95		

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PLL	Hypodivergent Normodivergent Hyperdivergent	30 30 30	$0.87^{\$,\dagger}$ $0.73^{\$}$ $0.44^{\dagger}$	2.08 1.7 1.53	0.002**	Hypo Vs Normo (p-value = 0.002) Hypo Vs Hyper (p-value = 0.015) Normo Vs Hyper (p-value = 0.813)
CT	Hypodivergent Normodivergent Hyperdivergent	30 30 30	7.08 7.32 7.84	1.37 1.12 1.79	0.125	Hypo Vs Normo (p-value = 0.795) Hypo Vs Hyper (p-value = 0.113) Normo Vs Hyper (p-value = 0.359)

***p<0.05; **p<0.01**

$, † correspond to statistical significance in Hypo ***vs*** Normodivergent and Hypo ***vs*** Hyperdivergent groups respectively

6. Discussion

This study was conducted to compare facial groups classified according to their vertical skeletal characteristics (hypodivergent, normodivergent, and hyperdivergent) and to their respective soft tissue morphological features, particularly those relating to the lips and chin. The soft tissue measurements vary within the same skeletal class with a different vertical pattern. For this, the study was intended to evaluate soft tissue in different skeletal vertical profile with the same class I skeletal sagittal relationship with normal overjet. The results may help in planning orthodontic cases according to these characteristics and may establish a specific soft tissue prognosis for each facial vertical pattern before and after orthodontic intervention.

Greater values for upper lip thickness were observed for the hypodivergent group, followed by hyperdivergent, and then normodivergent (Figure 4). The difference in the upper lip thickness was found to be significant only in the Hypo versus Normo-divergent groups. (Table 3). In addition, the same results were observed for lower lip thickness (Figure 4, Table 3). However, no statistically significant difference was observed between the three different groups. This may be explained by a decrease in the SN/MP value that causes soft tissue collapse.

Similar results were achieved in other studies (Ashraf et al., 2018; Subramaniam et al., 2016; Celikoglu et al., 2014; Boneco and Jardim, 2005; and Lai et al., 2000). According to Feres's data in his investigation, the facial groups did not differ significantly concerning the thickness of the upper

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lip, lower lip, and soft tissue chin (Feres et al., 2010). On the contrary, the findings of the current study were in disagreement with Blanchette et al. (1996), Al Sayagh (2011), and Cezairli (2017), who found that dolichofacial individuals exhibit a greater thickness of the lip and soft tissue chin. They claimed that this was nature's way of compensating for the absence of underlying hard structure in the long-faced subjects to mask the condition and to provide a more normal facial appearance (Blanchette et al., 1996; Al-Sayagh et al., 2011; Shamlan and Aldrees, 2015; and Cezairli, 2017).

Greater values for upper lip height were observed for the hyperdivergent group, followed by the normodivergent and then the hypodivergent (Figure 4). This can be explained by upper lip capability to compensate for an open bite and to attempt lip competency, as these individuals are more prone than others to develop lip incompetence and that smaller lip length in short face subjects was due to lip closure, which would lead to greater gathering of lip tissue and enhanced thickness. Many authors came to similar conclusions (Blanchette et al., 1996; Boneco and Jardim, 2005; Feres et al., 2010; Ashraf et al., 2018).

However, greater values for lower lip height were observed for the hypodivergent group, followed by hyperdivergent, and then normodivergent (Figure 4). These results can be due to collapsed soft tissue menton generating a double chin, which is used as a reference point in our study for measuring lower lip heights in hypodivergent groups. In contrast, these variables were in disagreement with other studies as a result of the criteria which they utilized for methodology (Feres et al., 2010).

In the present study, there was no significant statistical difference in the height of either lip considering the variable's type of face (Table 3). This means that vertical skeletal patterns do not interfere with lip height in the population of this study's sample. The same conclusion was revealed by a study by Daenecke (2006) who related the lips' sealing difficulties in subjects with long faces may not be directly related to the structure of the upper lip but to the increase of the maxilla height (Daenecke et al., 2006).

Greater values for upper lip procumbency were observed in the present investigation for the hypodivergent group, followed by the hyperdivergent group, and then the normodivergent (Figure 4). Same results were revealed for lower lip procumbency; however, in hypodivergent facial patterns, the lip is located anterior to the TVL while in hyperdivergent and normodivergent facial patterns it is located posterior to the TVL. This may be justified by the protruded lip position after soft tissue collapse in hypodivergent patients. The statistical analysis results concerning PUL and PLL revealed statistically significant differences being observed only in Hypo vs. Normodivergent and Hypo vs. Hyperdivergent groups (Table 3). Different outcomes were conducted by Mohammed et al. (2018) and Jeelani et al. (2016) in their studies.

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In our research, greater values for chin thickness were observed for the hyperdivergent group, followed by the normodivergent, and then the hypodivergent (Figure 4). The difference in chin thickness was found to be insignificant among the three facial types (Table 3). This can be explained by compensation of the backward skeletal chin position. Nanda et al. (1990) discovered the same results in their study However, the opposite results were revealed by Ashraf et al. (2018) and Celikoglu et al. (2014) in their study. It was concluded that the soft tissue chin thickness is less in the hyperdivergent group as compared to the hypodivergent group, because it appears to adapt to severe hyperdivergence, presumably through increased soft tissue stretching. In some instances, the soft tissue over the chin is not even in thickness (Al-Mashhadany, 2015; Macari and Hanna, 2014).

7. Conclusion

The soft tissue morphology varies in different vertical profile among patients with same horizontal skeletal classes. Thickness of upper and lower lip, height of lower lip, and procumbency of both lips showed to be greater in hypodivergent facial patterns. However, thickness of chin and height of upper lip have greater measurements in hyperdivergent facial patterns.

List of Abbreviations

ANB	Angle formed between AN line and NB line
BAU	Beirut Arab University
CT	Chin Thickness
FHP	Frankfort Horizontal Plane
Go	Gonion
Id	Infradantal point
IRB	Institutional Review Board
Li	Labrale inferius point
LLH	Lower lip height
LLT	Lower lip thickness
Ls	Labiale superius point
Me’	Soft tissue menton
MP	Mandibular Plane: Gonion-Menton Line

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N	Nasion
n	Sample size
p	Probability value
PLL	Procumbency of lower lip
Pog	Pogonion
Pog’	Soft tissue pogonion
Pr	Supradental
PUL	Procumbency of upper lip
S	Sella turcica
SD	Standard deviation
SN	Line joining Sella turcica and Nasion
Sn	Subnasale
SN/MP	Mandibular plane angle
SPSS	Statistical package for social sciences
Sti	Stomion inferius
Sts	Stomion superius
TVL	True vertical line
ULT	Upper lip thickness
ULH	Upper lip height

Declarations

Ethics approval and consent to participate: Approval for this cross-sectional study was obtained from the Ethics Committee of Beirut Arab University Dental Hospital, code (2020-H-0105-D-M-0376)
Consent for publication: None

Availy of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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