T.C.

İSTANBUL YENİ YÜZYIL UNIVERSITY

HEALTH SCIENCES INSTITUTE

DEPARTMENT OF ORTHODONTICS

Evaluation of Lips and Soft Tissue Chin Thickness In Saudi Adults With Hyperdivergent Mandibular Pattern

MASTER OF THESIS

Yasser RAJAB BASHA

Supervisor

Prof. Dr. Mustafa Haluk İŞERİ

İSTANBUL

2019

ACCEPTANCE AND APPROVAL

T.C.

İSTANBUL YENİ YÜZYIL UNIVERSITY

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This study which was conducted within the framework of the Orthodontics Department was accepted by the jury as a Master's thesis.

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Abstract

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Y RAJAB BASHA

Department of Orthodontics, İstanbul Yeni Yüzyıl Üniversitesi.

Purpose: To evaluate the association between soft tissue at the chin (STC) thickness, lips thickness in normal and mandibular hyperdivergent patients.

Materials and Methods: A random sample of 142 digital cephalometric radiographs of Saudi Arabian adults who seek orthodontic treatment with age ranging above 18 years selected randomly from Al-Rabwah Dental Center in Riyadh (Kingdom of Saudi Arabia). The samples were divided into two groups according to the mandibular divergence pattern. Group A consisted of hyperdivergent individuals (27 males and 44 female) with SN/MP >=37° and group B consisted normal divergence individuals (34 males and 37 females) with SN/MP 37°>=27°. The measurements were at five different levels (a-Ls, b-Li, Pg‑Pg’, Gn‑Gn’ and Me‑Me’) were measured manually on the x-ray images. For statistical analysis, an independent sample t‑test was used.

Results: Men have thicker soft tissue thickness than women in A group at all measurements with statistically significant difference. The men also have thicker soft tissue thickness at all measurements except Gn‑Gn’ in the B group. There was no statistically significant difference between hyperdivergent individuals and normal divergence individuals.

Conclusions: There is no statistically significant difference in soft tissue thickness between the long face and normal face groups. But women have thinner soft tissue thickness than men in long face group.

Key words: Lips; Chin; Soft tissue; Divergence; Mandible; Thickness; Saudi adults.

ÖZET

Hiperdiverjan Mandibuler Düzleme Sahip Suudi Yetişkin Bireylerde Dudak ve Çene Ucu Yumuşak Doku Kalınlığının Değerlendirilmesi

Y RAJAB BASHA

Department of Orthodontics, İstanbul Yeni Yüzyıl Üniversitesi.

Amaç: Dudaklar ve çene yumuşak doku kalınlığını normal ve hiperdiverjan bireylerde değerlendirmektir.

Gereç ve Yöntemler: 18 yaş üstü ortodontik tedavi olmak isteyen 142 Suudi Arabistanlı yetişkinine dijital sefalometrik radyografiler, Riyad'daki Al-Rabwah Diş Hekimliği Merkezi'nden (Suudi Arabistan Krallığı) rastgele seçildi.

Örnekler, mandibuler dizler eğimine göre iki gruba ayrıldı. A grubu, SN / MP> = 37 ° olan hiperdiverjan bireyleri (27 erkek ve 44 kadın) ve B grubu, SN / MP 37 °> = 27 ° olan normal bireyler (34 erkek ve 37 kadın) içermektedir.

Ölçümler, beş farklı seviyede (a-Ls, b-Li, Pg-Pg’, Gn-Gn’ ve Me-Me’) sefalometrik filmler üzerinde manuel olarak ölçüldü. İstatistiksel analiz için bağımsız örneklem t testi kullanıldı.

Bulgular: A grubundaki erkekler kadınlardan daha kalın yumuşak doku kalınlıklarına sahip olup, tüm ölçümlerde istatistiksel olarak anlamlı farklar bulunmaktadır. Ayrıca, B grubundaki erkekler Gn-Gn' seviyesi hariç, B grubunda bulunan kadınlardan tüm ölçümlerde daha kalın yumuşak doku kalınlığına sahiptir. Hiperdiverjanslı bireyler ile normal diverjanslı bireyler arasında istatistiksel olarak anlamlı bir fark yoktur.

Sonuç: Yumuşak doku kalınlığında uzun yüz grubu ile normal yüz grubu arasında istatistiksel olarak anlamlı bir fark yoktur. Ancak kadınlar, uzun yüz grubundaki erkeklerden daha ince yumuşak doku kalınlığına sahiptir.

Anahtar Kelimeler: Dudaklar; Çene; Yumuşak doku; Uyuşmazlık; altçene; Kalınlık; Suudi yetişkinler.

Dedication

I dedicate my thesis to

my great parents who are the candles which lighten my life

and to my beloved wife who supports me at every step

and to my lovely sisters and all my family.

I also dedicate this research to all my teachers who guided me in my learning life.

A special dedication to my country Syria .

Acknowledgments

First and foremost, I must acknowledge my thanks to İstanbul Yeni Yuzyil University. I owe a deep debt of gratitude to some people, who worked hard with me from the beginning till the completion of the present research particularly my supervisor Prof. Dr. Mustafa Haluk İŞERİ. And, I highly appreciate the efforts expended by, Prof. Dr. İlter Uzel, Assoc. Prof. Dr. Hüseyin ÖZKAN and Assoc. Prof. Dr. Göksu Trakyalı.

I would like to take this opportunity to say warm thanks to all my beloved friends, who have been so supportive along the way of doing my thesis. I also would like to express my wholehearted thanks to my family for the generous support they provided me throughout my entire life and particularly through the process of pursuing the master's degree. Because of their unconditional support, I have the chance to complete this thesis. I am very appreciative of my colleagues at the Istanbul Yeni Yüzyıl University.

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1. Introduction

Ab initio, the human aimed to embody and determine standards of face beauty and he expressed that through drawings and making statues. Over previous civilizations, many scientists and artists attempted to set standards of human face harmonization according to the dominant culture at that time; the Pharaohs, Romans and Greece and from East Asia civilizations to Europe till in the sixteenth century, the renaissance came when Leonardo da Vinci drew human body including ideal ratios and he deduced that there is harmony between human body dimensions at a standard ratio called the Golden ratio (1).

Orthodontists would use these previous civilizations to set standards of face harmony with teeth to make an orthodontic treatment plan. Also, through many studies, they discovered the interconnectedness of facial bones and soft tissue which covered it. The research is still ongoing in this field (1).

In the past, the main objective of orthodontists was to achieve the ideal occlusion regardless of the facial harmonic and that leads sometimes unattractive face after orthodontic therapy. Therefore, currently the true objective from this point of view is to treat the dentition to the face (2).

So, many types of soft tissue research have made of the relationship between soft tissue thickness and the face length in some societies as Indian and European population, but it was not comprehensive of different roots (3, 4).

Therefore, the aim of this study is to evaluate the lips and chin thickness in Saudi adults by cephalometric radiography.

2. Literature review

2.1 Historic revision

"*All developments achieved by applied science are measured by the degree of mastery of their research methods*" Claud Bernard.

During the last 150 years since the second industrial revolution, many inventions and discoveries had been invented and developed which in turn had a great effect on the medical and dental sciences. One benefit of that, orthodontics had seen a huge evolution in diagnosis and treatment procedures (1).

Before the twentieth century, the cephalometry science as used in anthropometry science only which studies human body's part and standards for benchmarking but this way hasn't taken any advanced degree of precision until the 20^{th} century (1).

In 1899 Edward H. Angle (Figure 1) the father of American orthodontics declared his classification of malocclusion which he put depending on the first molars relationship and classified into three classes and established a foundation stone of orthodontics, but he failed to explain the differential diagnosis between the different facial patterns which associated with malocclusion (5).

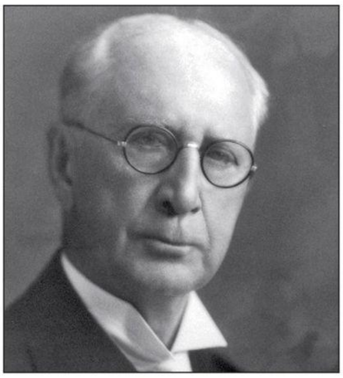

Figure 1. Edward Angle The father of American orthodontics

in 1907 Angle emphasized the important relation between the facial soft tissue and the facial aesthetics and harmony as he assumed that this will affect the psychological development of adolescents. However, he failed to understand the relationship between the soft tissue and hard tissue because he thought when he aligns the teeth in the ideal position, skeletal malocclusion will be spontaneously corrected which in turn will put the overlying soft tissue in a balanced position (5).

deBoer (7) stated that in 1915 Dr. Van Loon tried to establish a three-dimensional system to relate the teeth of the individual with his\her face by combining the dental plaster models and the facial impressions which included the forehead, nose and the upper lip (Figure 2). This was the first attempt in orthodontics diagnosis using the 3D perception (1, 6, 7).

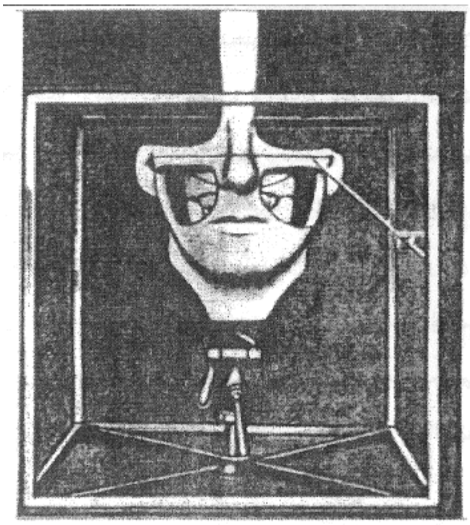

Figure 2. 3D impression of Van Loon

In the Late of 19th-century x-rays were discovered by Wilhelm Conrad Roentgen (1845-1923). After discovering the x-ray dentists started to use this technology to improve and make their practice easier and more precise. The orthodontists also benefited by the x-ray and started to understand skeletal malocclusion more than before (6).

However, the first lateral cephalometric image was in 1922 which was introduced by Pacini using gauze wrapped around the patient's head and the x-ray film holder cassette which fixes the patient's head in a certain position and a predetermined distance between the head and the x-ray source. By using that, orthodontists around the world started to make long-term studies based on these radiographic images about craniofacial growth and its changes during development. Qualitative boom was in 1931 by B Holly Broadbent who publicized an article in the first issue of the new Angle

Orthodontist Journal titled " A new x-rays technique and its application to orthodontia " which changed the diagnosis standards completely (1, 8).

He introduced the cephalometric roentgenography with cephalometric tracing and evaluation. He also invented the cephalometer, which is the instrument that accurately positions the head of the patient relative to the film and the x-ray source by standard measures. Due to these advances, different analyses and studies started to surface such as Steiner, Downs, and Tweed. They have studied the jaws relationships and its correlation to the cephalometric data extracted by applying their new principles in cephalometric analysis. Others studied the growth development of jaws and facial bones then classified the growth into vertical, transverse and anterior-posterior dimensions (8).

The vertical dimension of the face is an important factor that should be taken into consideration because it affects the diagnosis and treatment planning in growing and non-growing patients (9, 10).

The human face was divided into three equal parts according to the vertical dimension as the following:

1. The upper third: starts from the hairline to Glabella.
2. The middle third: starts from Glabella to subnasale.
3. The lower third: from subnasale to menton. The length of this part gives an indication whether the individual has vertical, normal or horizontal facial growth pattern (11).

2.2 The facial patterns

The facial type is considered one of the critical factors in treatment planning because it expresses the form and pattern of growing on the level of the maxillofacial structures, and it is connected to genetic factors and environmental factors as parafunctional habits (12).

The orthodontists have interested in studying the facial growth and development because they believe that the facial growth type plays a huge role in the treatment plan and process to restrain or enhance the existing growth and also to understand the mechanism of malocclusion development, the intermaxillary relation and its reflection in the patient profile and the facial harmony (13).

In the beginning, the measurements were done on the human skulls to evaluate the dimensions of the face and some of its features. But after the discovery of X-ray and deploying it in orthodontics in 1931, the lateral cephalometric radiograph has become the most efficient way as the dimensions of the radiograph is almost equal to the sagittal projection of the cranial bone. Thereafter, researchers have tried to put a sum of cephalometric analyses that are meant to study and determine the growth pattern depending on standards and principles of normal growth pattern (9, 10).

Some of the researchers as Björk has tried to input metal implants within the bones of maxillae and then recorded the occurring changes that happened to the bones during the successive growth periods (10).

Many studies have been done to predict facial growth morphology and there are some of them in the following:

Bolton's concept:

In 1937, Bolton has run a long-term study on individuals aged between 13-18 year old who have normal occlusion depending on lateral cephalometric radiographs taken of the participants and then, he assumed Sella (S) point at cranial base as a reference landmark (Figure 3).

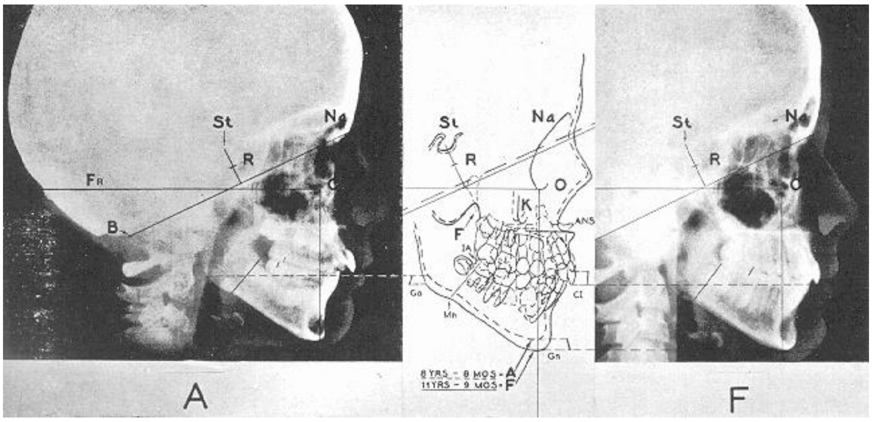

Figure 3. Bolton Studies

His study has concluded that:

1- The growth curve in females is very similar to the curve in males.
2- Growth does not accelerate steadily but it goes through rapid and slow phases (rest phases).
3- The most important growth spurt is that one which happens right before the puberty, most of the skeletal orthodontic therapies (orthopedic treatments) are best done in this period to get the most out of the growth of jaws.
4- Sometimes, this type of growth may not happen in a calibrated way.
5- A disturbance in direction of growth may occur in one of the skeletal portions relative to the other portions, within one or more of the three dimensions of space, for example, a disturbance may happen in the maxillary or mandibular rotation among the vertical dimension (which is the main concern in this thesis). If the maxilla grows forward more than downward this will, in turn, lead to anterior rotation in the upper jaw. If the maxilla grows downward more than forward this will lead to backward rotation of maxilla and the same goes for the mandible (14).

Björk's concept:

The studies of Björk have changed a lot of traditional aspects of maxillofacial growth (10). Between 1947-1969 Björk has done a cephalometric study on volunteers from Denmark. Through this study he integrated metal implants in different places of maxilla and mandible and registered the occurring changes during the consequent growth periods. By using the intramaxillary metal implants in the study of facial growth mechanism, Björk were able to distinguish the difference between bone movements resulting from facial sutures' growth and condylar growth and the movements resulting from the phenomena of bone remodeling which happen to different parts of the face and play role in giving the face its final shape.

Björk (10) has specified two different types of mandibular rotation: if the rotation is upward it can be called anterior rotation, and if the rotation is downward it can be called posterior rotation.

Also, he divided the rotations according to different planes into intramatrix rotation which happens to mandibular plane relative to the core of mandible and matrix rotation which happens to mandibular plane relative to the cranial base.

Björk (10) has found a collection of signs that can determine the rotation type, which is called the structural features of mandibular rotation during growth:

1- The inclination of the condylar head.
2- The curvature of the mandibular canal.
3- The shape of the lower border of the mandible.
4- The inclination of the symphysis.
5- Interincisal angle.
6- Inter- premolar or intermolar angles.
7- Anterior lower face height.

These signs are not clearly developed before puberty and both kinds of rotations greatly affect the teeth eruption paths.

Björk (10) noticed (Figure 4) in the forward rotation cases a group of variables:

1- Resorption of the inferior part of mandibular angle causing flattening of the mandibular lower border.
2- Face grows sagittally more than vertically.
3- Condylar growth direction is forward and upward in the situation of normal rotation.
4- Symphysis rotation forward with increased chin prominence.

5- Decreased anterior lower facial height.
6- Molars axis are semi- perpendicular.

In the backward rotation cases (Figure 4), Björk (10) found out that:

1- Condylar growth direction upward and backward.
2- The lower border of the mandible is concave (antigonial notch).
3- Symphysis rotation backward and the chin is retracted.
4- Increased lower anterior facial height.
5- Molars axis is tipping forward.

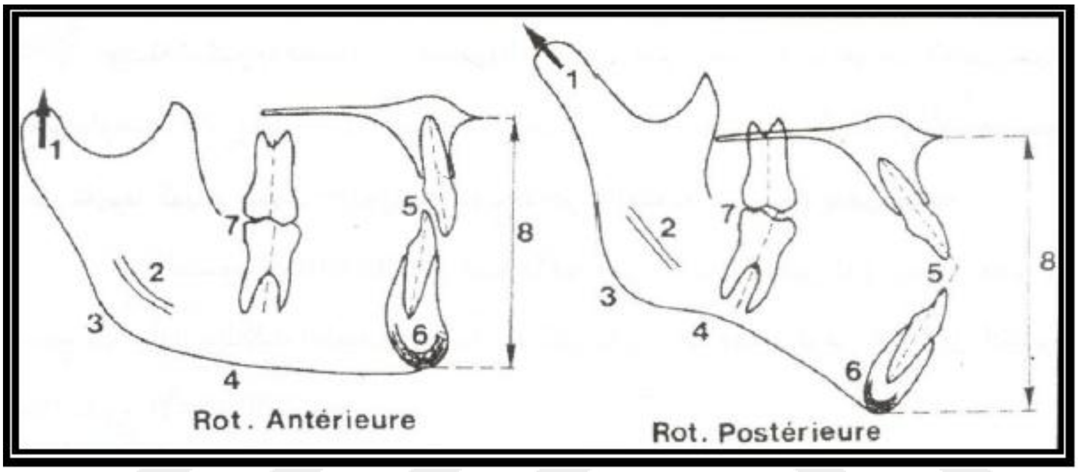

Figure 4. Björk concept

Proffit concept:

Proffit (15) divided the rotation of mandible to external rotation and internal rotation which happen in all face types but in different percentage. The hypodivergent patients have an increase in internal rotation of mandible and a decrease in external rotation of mandible which results in a low mandibular plane angle and a high gonial angle and he mentioned that the deep bite malocclusion and crowded incisors usually accompany this rotation.

While the hyperdivergent patients have a large mandibular angle results from a decrease in internal rotation of mandible and an open bite malocclusion with a mandibular deficiency usually accompany this type.

Also, he explained that 25% of rotation happens at the condyle and 75% occur within the body of the mandible (15).

Schudy concept:

In 1964 Schudy (9) suggested that there are two forces which playing as an opposite force for the directing of pogonion, vertical growth which tries to push pogonion downward and sagittal growth which attempts to push pogonion forward.

And he divided the facial vertical growth into:

1. Growth in the vertical dimension of the maxilla body and anterior process of the maxilla.
2. Growth in the vertical dimension of the maxillary alveolar process supported by tooth length.
3. Growth in the vertical dimension of the mandible body.
4. Growth in the vertical dimension of the mandibular alveolar process supported by tooth length.

And divided the vertical facial dysplasia to:

1. Hyperdivergent.
2. Hypodivergent.
3. Normodivergent.

The hypodivergent individuals have a forward mandibular rotation resulting of the vertical growth of the condylar and vertical growth deficit on the alveolar process level and the anterior facial structures while the hyperdivergent individuals have a backward mandibular rotation resulting of adverse growth pattern (9).

Nielsen concept:

Nielsen (16) view in the face morphologies during growth periods are affected by many factors such as maxilla and mandible growth, alveolar development, teeth eruption and lips, and tongue function. When the vertical growth of the condylar is less than the vertical growth of the facial structures and alveolar processes, backward rotation of mandible results. However, if the condylar vertical growth exceeds the sum vertical growth of facial structures and alveolar processes, forward rotation of mandible will happen.

Usually, the hyperdivergence is associated with decreased the ratio of posterior facial height to anterior height, increased the lower facial height and anterior open bite while hypodivergence pretends adverse characteristics (16).

Ricketts concept:

Also, Ricketts concerned with the facial growth patterns in his analyses and confirmed the importance of face type during the diagnosis because the therapy strategy is connected and affected with the morphology (13).

He differentiated three types of facial growth (Figure 5):

1. Mesofacial: Facial growth goes normal and balanced manner forward and downward, the vertical and horizontal movements are consistent.
2. Brachyfacial: Facial growth occurs forward with a horizontal direction more than the vertical direction. The skeletal, facial and occlusal features of this morphology are very similar to those features which Björk (10) has described under anterior mandibular rotation aspect.
3. Dolichofacial: Growth goes essentially downward and the vertical sum of growth is more than the horizontal sum. The skeletal and facial features are similar to those features of posterior mandibular rotation according to Björk (10).

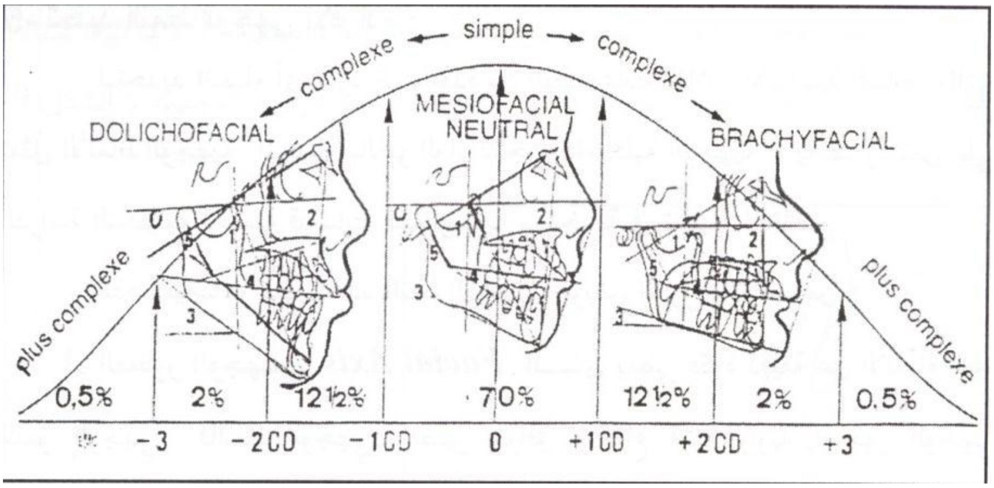

Figure 5. Ricketts Concept

Ricketts (17) indicated 3 tips to ensure a true treatment plan:

1. Growth pattern of the individual.
2. Growth variation during the time.

3. Therapy effects on these factors.

Ricketts's determination of the facial growth pattern is based on four principles (17):

1. Chin position in space.
2. Face convexity.
3. Teeth relation with the face.
4. Profile evaluation.

The auther puts 6 measurements to determine the facial growth pattern (Figure 6) (17):

1. The facial angle N,Pg / FH:
   This angle is between the facial plane (Na,Pg) and Frankfort plane (Po,Or) and its value is 87± 3, this angle value increases in forward rotation cases and decreases in backward rotation cases.
2. The facial axis angle Na,Ba / Pt,Gn:
   It is the inferior posterior angle between the facial axis (Pt,Gn) and the cranial base plane (Na,Ba) that shows chin direction growth, its value is 90°, decreasing of this value refers to a retracted mandible and the tendency of the long face while increasing value refers to a short face.
3. Mandibular plane angle Go,Me / FH:
   It is the angle between the mandibular plane (Go,Me) and Frankfort plane (Po,Or) that benefit to diagnose anterior open bites, its average is 26°.
4. The lower facial height angle Xi,Pm / Xi,ANS:
   Its normal value is 46°, increases in backward rotation cases and decreases in forward rotation cases.
5. Curvature of the mandible Xi,Pm / Xi,Dc:
   It is the posterior angle between the mandible body axis (Xi-Pm) and the ramus axis (Xi,Dc), its average is 26°, increases in backward rotations and decreases in forward rotations.
6. Full facial height Xi,Pm / Na,Ba:

It is the angle between cranial base plane (Na,Ba) and (Xi,Pm) plane, its average is 60°, increases in backward rotations and decreases in forward rotations of the mandible (13, 17).

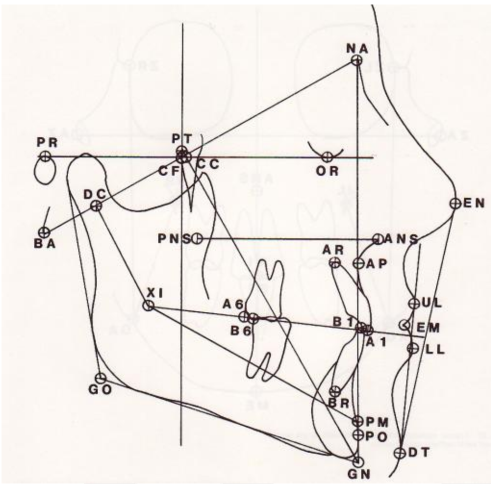

Figure 6. Ricketts measurements

Jarabak concept:

Josef Jarabak (18) has classified facial heights on the basis of three diverse types defined by Jarabak quotient or Facial Height Ratio (FHR). This quotient is the ratio of posterior facial height (S-Go) to the anterior facial height (N-Me) as the following:

1. Long face: with the FHR < 59% and the face rotates with clockwise with growth. This type is correlated with short ramus altitude and with large gonial angle.
2. Normal face: the FHR is between 59% - 63% it is the most common and the growth direction occurs posteriorly and anteriorly at the same amount.
3. Short face: the FHR > 63% the growth direction is with anti-clockwise. This type is associated with long ramus altitude and with small gonial (18).

2.3 The skeletal and soft tissues relationship:

Present principles in diagnosis and treatment planning of orthodontics concentrate on the balance and harmony of the different facial features (2, 19).

The essential consideration among orthodontists was limited to the relationship which must be achieved in the position of teeth and their surrounding bones. But after the refinement of cephalometric roentgenography by Carrea, the soft tissues became clear and visible in cephalometric images. Therefore, soft tissue analyses began to take place in orthodontics studies (20).

After releasing of cephalometric radiography many orthodontists introduced different analyses to understand the facial structures and to help them in treatment planning but almost all measurements were on skeletal components, teeth positions, and their relationships. Intermittent efforts were made to introduce a soft tissue profile estimation, such as Ricketts esthetic plane, Holdaway line, and Burstone's soft tissue analysis. But these weren’t enough references to establish harmony of facial profiles (20).

The interrelations between the soft tissues morphology and the underlying bony structures became an interesting subject for the researchers in the orthodontic field because the prediction of outer peripheries of soft tissues which are affected by the skeletal structures is a very important issue in orthodontics. However, the facial soft tissue analysis is considered as an essential factor of diagnosis and making a perfect treatment plan in orthodontics (19).

In 1957, Riedel confirmed that the soft tissue profile has a strong relationship with the dental and skeletal tissue which are covering. And the relation of maxillary and mandibular bases in the sagittal dimension, and the relation anterior teeth with face have important effects in the soft tissue thickness (20, 21).

In 1958, Burstone mentioned that the malocclusion doesn’t only express the poor relation between teeth but also reflects facial disproportion that could be a result of different soft tissues thickness overlying the facial bones, and sometimes the different soft tissues thickness hides the facial bones disproportions (22).

In 1959, Subtelny suggested that the soft tissues profile doesn't follow all underlying skeletal structures directly because of the position of soft tissue overlying the upper jaws except the dental area doesn't reflect the skeletal structures position but in contrast, the soft tissue which overlies the symphysis depends directly on the position of chin and as well upper and lower lips which cover the dental area are dependent on the underlying bony structures. And he mentioned the overlying soft tissues don't continue with the consistency of underlying hard tissues and this indicates the difference of overlying soft tissues thickness depends on underlying hard tissues position as the soft tissue which covers the maxilla is thicker than the soft tissue which covers the mandibular symphysis and the forehead and that leads to more convex facial profile but also leads to preventing relatively the anterior part of maxilla to continue in growing and the bony chin to grow as to be a slight compensation. Also, he mentioned that the chin has a tendency to grow more forward relative to the forehead from birth until puberty so will affect the soft tissue as well and males show more mandibular prognathism than females due to the development of mandibular continue after puberty in men, unlike women which show lesser growth of mandible after puberty. However, the bony structures resort to become straighter with age while the soft tissue maintains somewhat its convexity (23).

In 1964, Hambleton elucidated that achieving a harmonic facial profile with the covered soft tissues is very difficult issue because the difference soft tissues' thickness which accompanies with varied malocclusions, this difference may be resulted from individual differences in the soft tissues (thickness, height, and activity) or resulted from disproportions of underlying skeletal structures (24).

In 1966, Merrifield clarified that the soft tissue of the lower face is a very important point to the orthodontists due to orthodontics therapy affects this area and the chin thickness has a major concern in profile assessment. Also, he found some differences in soft tissue thickness between women and men where the women have equal chin thickness to upper lip thickness while the men have thicker upper lip thickness than chin thickness (25).

In another study in 1967, Burstone mentioned that there isn’t a direct relationship between the soft tissues profile and skeletal and dental structures because of the difference of soft tissues' thickness which covering the facial hard structures (26).

In 1986, Park and Burstone concluded that the facial skeletal standards doubtful to get a desired facial harmony after an orthodontic therapy and they mentioned the importance of individual soft tissues thickness in diagnosis and treatment planning because they found a huge variation in soft tissue thickness between individuals (27).

In 1993, Czarnecki et al. suggested that the purposes of orthodontic therapy should achieve harmonic and consistency of facial countenances more than to be connected with the normal values of dental and skeletal standards. And he also confirmed that the treatment plan must consider the facial soft tissues thickness (20).

In 1999, Arnett et al. contrived new cephalometric analyses of soft tissues for diagnosis and treatment planning, and these analyses corroborated a presence between the bony structures and soft tissues which affects the facial balance and harmony. The auther confirmed that the dentoskeletal factors have a huge effect in the facial profile so, how precisely the orthodontist treats those dentoskeletal parts highly affect the resulting profile. Also, the thickness of the lips and the soft tissue chin greatly rule the balance and harmony of the lower facial part and the balanced values depend on the position of each point in the facial profile relative to other points which must be a certain ratio between these points. Four areas were determinded to examine intramandibular balance, interjaw balance, orbits to jaw balance, and the balance of total face (28).

In the same year, Bergman put a comprehensive entrance of cephalometric soft tissue analyses and he also mentioned the importance of these analyses in reinforcing the treatment planning by the preservation of balanced facial proportions and correction of unbalanced facial structures by the therapy (11).

In 1996, Phillips and Aulsebrook confirmed that the soft tissue thickness changes according to the racial and ethnically various. They found that African American people have a thicker soft issue of face than the biracial individuals in both sexes. Also, the biracial people have different soft tissue thickness when compared to White American people (29, 30).

In 2003, a study was published by Hashim and AlBarakati from kingdom of Saudi Arabia to compare the soft tissue analysis between Americans and Saudis. The result showed differences between these different ethnics which affect the diagnosis and treatment plan in orthodontic therapy and orthognathic surgery (31).

Mergen et al. in 2004, mentioned the determination of soft tissue profile and its relationship with the facial bones is a serious issue in treatment planning and in results assessment. The authers stressed that the main goal of orthodontic therapy is the achievement of harmonic facial appearance with balanced skeletal structures and an ideal occlusion (32).

In 2005 Ioi et al. indicated that the facial soft tissue convex expresses the underlying bones profile (33).

In 2012, ALBarakati et al. applied the Holdaway soft tissue cephalometric norms on a sample which contained Saudi adults x-ray images and compared them to the Anatolian Turkish and Japanese people. It was confirmed that Saudi norms were different from the other racial groups norms. Also, there were some differences between Saudi males and females which are required to consider norms related to race in diagnosis and treatment planning (34).

2.4 The cephalometric analyses which investigate lips and soft tissue of chin:

When cephalometric radiograph had been invented in 1931, many researchers and orthodontists worked to use this new technology in orthodontics and started to analyze these images to understand the facial structures more than before. So, they studied the relations between various cranial structures and their soft tissues because the final appearance of the face is the outcome of cranial structures, dental occlusion, and facial soft tissues relationships (35).

Burstone analysis:

Burstone (22), put some standards for soft tissue analysis which contact between nose, lips, and chin. They were all measured by the nasolabial angle and mentolabial angle (Figure 7).

The nasolabial angle: is formed from the intersection of the line between CO and SN points and the line between UL and SN points, and its value is 103 ° ± 8.

The mentolabial angle (mentolabial sulcus depth): is formed from the intersection of the line between LL and B' points and the line between B' and Pg' points, and its value is 122 ° ±11.

Figure 7. The Nasolabial and Mentolabial angles according to Burstone

Ricketts and Steiner analysis:

Ricketts (17) is one of the first orthodontists who discuss the golden ratio in the maxillofacial structure's relationships. He realized the importance of balance between chin, lips, and nose at the harmonic face and confirmed to consider this balance in treatment planning. In 1957 he clarified the relation between facial soft tissues by aesthetic plane (E line) which is the line passing the nose tip and the most prominence point of covering soft tissue of chin (Pg') (Figure 8) and explained to achieve the harmonic balance between chin, lips, and nose, and the face becomes harmonious, the lower lip must be 2mm posterior to E line in adolescents and the upper lip must be 4 mm posterior to it (17).

In 1960, Steiner studied the soft tissues of the face and found another aesthetic line and called it S line. S line passes from ala of the nose to Pg' (Figure 8). He mentioned that the upper and lower lips must touch this line in a normal case (36).

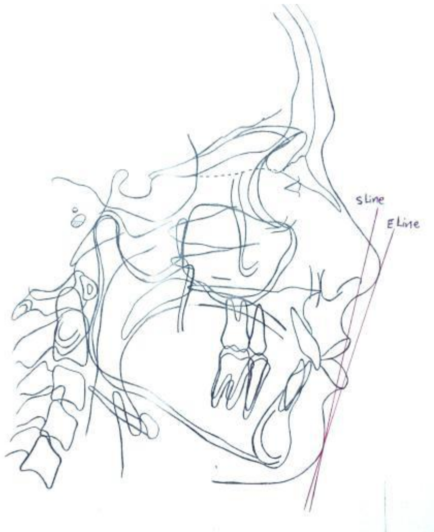

Figure 8. E Line and S Line

Merrifield studies:

In 1966, Merrifield (25) measured the thickness of upper lip from the junction of contour of the maxillary incisor and the pre-maxilla to the most prominent point in the lip contour. Merrifield measured the soft tissue thickness of chin from point Pg to Pg' (total chin) with the Na-B line, where the value of this distance relates to:

1. Growth of chin region.
2. Soft tissue thickness of chin.
3. Facial growth pattern.

The auther mentiond that in the normal situation, the upper lip thickness equal to the soft tissue thickness of chin and suggested that the vertical dimension of the face may change the all facial harmony (25).

Holdaway analysis:

In 1983, Holdaway (2) established analysis for a facial profile that consists of a combination of standards when these standards are achieved, a balanced and harmonic face can be achieved.

Holdaway analysis standards are as the following:

1. The relation between lower lip and the H line: is the distance between the most promenint point in the lower lip Li and H line (which is the harmony line of Holdaway analysis that passes from soft tissue Pg' to the most prominent point in the upper lip Ls).
2. The soft tissue thickness of chin: which is measured from Pg to Pg'.
3. The soft tissue facial angle: it is the angle between Na'-Pg' line and Frankfort plane. This chin landmark was chosen due to the stability of bone in this area during growth. In addition, in some cases that have hypermentalis activity that results in an irregular distribution of the soft tissue that covers this point. So, it is more factual to measure the prominence of the chin (2).

2.5 The previous studies which are relevant to this study:

In 1992, Walvoord made a study to determine the changes of skeletal and soft tissue profile during growth with different facial types (long, normal and short) at the University of Michigan. The samples were 60 patients aged from 6 to 18 years, 30 boys and 30 girls which were equally distributed over the three facial types. The results showed no significant difference at angular measurements between boys and girls and between different facial types while linear measurements increased in boy's group significantly. This study showed that the soft tissue thickness at Pg landmark increased in long face patients comparing with the short face patients (37).

In another study by Mark et al. in 1996, with subjects between 7 – 17 years of age, found statistically significant differences between different facial types and the soft tissue profile where the soft tissues thickness was thicker in hyperdivergent individuals comparing with hypodivergent individuals. They explained these differences as compensation mechanics which soft tissues attempt in long faces to give the face more natural appearance and cover the extremely skeletal growth while the thinner soft tissue drape in short faces attempt to mask the strong appearance of facial bones (38).

In 1997, Virgilio et al. made a research about the gender, age, and occlusion classification effects on the facial soft tissue profile. The findings showed the soft tissue thickness is significantly affected by gender and age but slightly with skeletal malocclusion (39).

In 2002, Maciej and Ellie studied the soft tissue thicknesses of the human face in different facial morphologies. The study was on white Australian adults (17 males and 23 females) with mean age of 78 years. The results showed significant relationship between the facial soft tissue thicknesses and the underlying skeletal structure dimensions. The findings indicated that the soft tissue thicknesses were thicker in male adults than female adults (40).

In 2007, Demetrios et al. made a cephalometric study that purposed to determine the formality changes of soft tissues of the face relative to gender and age. The sample comprised 170 cephalometric images of 82 males and 88 females with age range between 7 and 17 years. The results showed shape variability of soft tissue profile especially a concerned protrusion of the nose and chin relative to the convexity of the face and the relative protrusion of chin and nose increases with age for both sexes. However, gender differences in shape were diminutive and the age differences were more significant (41).

In another study by Demetrios et al. in 2007, was shown in Greek subjects a strong relationship between facial soft tissue shape and the underlying skeletal structures shape (42).

In 2005, Kamak and Çelikoğlu studied facial soft tissue thickness among different skeletal malocclusion. The study was made on 180 cephalometric images (90 males and 90 females). The results of this study showed significant differences in soft tissue thicknesses among skeletal malocclusions and the differences were greater in men than women. The authers indicated that the upper lip thickness was higher in Class III patients while the lower lip thickness was higher in Class II patients (43).

In 2010, Murilo et al. made a study that compares soft tissue size between different facial patterns in Brazil. The study was comprised 90 cephalometric radiograph images of growing patients of both sexes, with age between 12 and 16 years. The sample was divided into three groups according to facial patterns (mesofacials, dolichofacials, and brachyfacials). The study compared the thickness of lips and soft tissue of chin. The results showed no differences between lips thickness and soft tissue chin thickness in all groups but the soft tissue thickness was thinner in dolichofacials groups than brachyfacials groups. There was no significant effect of gender on the soft tissue thickness of all groups (44).

Another study published in 2011, by Nada Al–Sayagh et al. from University of Mosul, about facial soft tissue morphology in different vertical dimensions has done at the. The sample was included 120 lateral cephalometric images of Iraqi Adults (60 males and 60 females), aged between 20 and 30 years and they were divided according to the vertical dimension into three groups as short, average and long faces. The results showed that the facial soft tissue profile is affected by the vertical dimension of the face and the long face group has thicker lower lip thickness than other groups while the males have thicker lip thickness than females (45).

In 2012, Hiba et al. determined the variation of facial soft tissue thickness in Iraqi adult patients with different skeletal malocclusions. The study used 60 lateral cephalometric radiographs with normal vertical dimension (SN-MP angle between 28-36 degree) with the patients were aged 18-30 years and divided into three groups according to skeletal sagittal relationship (ANB). The results showed significant increase in facial soft tissue thickness in males than females (46).

In 2013, Cha studied the thickness of soft tissue in Korean adults with normal face height and the study sample consisted of 40 CBCT images of adult patients aged between 20-27 years old (18 females and 22 males). The result showed that the males have thicker soft tissue thickness than females at certain areas of the face as the supraglabella, nasion, while other areas as lateral orbit, inferior malar, and gonion landmarks the females have thicker soft tissue thickness. The auther confirmed that the thickness of soft tissue in different facial points alters according to gender and also mentioned that sexual hormones contribute in growth and development of human body, the testosterone plays a role in muscles development in males and makes the muscles stronger and bigger than females, gives the skin thicker appearance because sharing in collagen synthesis. In contrast, the estrogen hormone in females contributes in fat distribution and smaller muscles than males and causes a lack in collagen in women skin giveing thinner skin appearance than men (47).

In 2014 Macari and Hanna (3) studied the relationship between the soft tissue thickness of chin (STC) and facial height according to the mandibular plane rotation. The sample was consisted of 190 lateral cephalometric images of white adult patients who seek orthodontic treatment (77 males and 113 females), aged between 18-53 years. The material was divided into four groups based on the mandibular plane inclination in relation to anterior cranial base (low face, medium-low face, medium-high face, and high face). A Pg, Me and Gn were used landmarks to measure chin thickness, which was different from the other landmarks used in the previous studies. The results showed that:

1. All the STC measurements were greater in men than in women.
2. The STC measurements were smaller in hyperdivergent patients compared with normal and hypodivergent patients.
3. Patients with hyperdivergent mandible showed thinner STC at Gn and Me in comparison to hypodivergent patients.

Also, Macari mentioned that the vertical growth of skeletal structures involves more strain on the soft tissue of the lower section of the face, especially in hyperdivergence pattern patients (3).

In 2014, Prasad Chitra et al. studied soft tissue chin thicknesses in Indian adults who have Class II malocclusion. The sample was included eighty cephalometric x-ray images of nongrowing Indian individuals (40 men and 40 women) who are seeking orthodontics therapy and was divided into four groups according to the divergence of the mandibular plane to the cranial base. The result showed the lowest facial height patients have thickest STC thickness and gradually decreased across the groups (48).

In 2017, Somaiah et al. compared soft tissue chin thickness in non-growing patients with different mandibular divergence in Kodava population in India. They studied 80 cephalometric images of 80 subjects (37 men and 43 women) aged between 18 and 35 years, divided into four groups according to the mandibular divergence as Macari study. The study results showed that the STC thickness at Pg‑Pg’ and Gn-Gn’ was the highest in medium-low angle group followed by medium-high, low, and was least at high angle group. At Me-Me', the STC thickness was the highest in the medium-low group followed by the low group, medium-high, and was least at high angle group. And the authers concluded that the STC thickness was greater in men of Kodava than women of Kodava in all groups except the high angle group. Also, STC thickness values were lesser in hyperdivergent individuals except at the level of Pg compared betweent normal and hypodivergent individuals (4).

In 2015, Mevlut et al. made a study to evaluate the soft tissue thickness of anterior lower face in nongrowing patients with various skeletal vertical patterns using a cone-beam computed tomography (CBCT). The research sample consisted of 105 adult patients (54 women and 51 men) who were skeletal class I and were divided into three groups according to the vertical growth pattern (low-angle, high-angle and normal-angle). The results showed that the values of soft tissue thickness were the lowest at the high-angle group for women and men, all soft tissue measurements were greater in men than in women in all groups and the soft tissue thickness at Pg point, upper and lower lips were thinner in the high-angle group than the normal-angle group (49).

In 2016, Rasoola et al. compared the thickness of soft tissue chin in different facial heights in in Pakistani patients. The study sample was comprised 95 pre-treatment cephalometric x-rays of nongrowing individuals (56 women and 39 men) with age range of 18-53 years and was divided into four groups according to the facial height (low group, medium-low group, medium-high group and high group). The result showed the STC thickness measurements were the greatest at the low group. The lowest measurements were at the high group with a statistically significant difference at Gn-Gn' level in males compared between low and high groups. The authers concluded that all measurements were higher in males than females (50).

In 2017, Cezayirli discussed the soft tissue thickness of face among various vertical patterns. The study materials were 90 cephalometric images of 36 men and 54 women aged between 20-26 years was divided into three groups (low-angle normal-angle and high angle) based on SN/GoGn angle. Holdaway soft-tissue analysis was used to determine the soft tissue thickness. The results showed significant differences in soft tissue thickness in the Gnation and Menton for both genders, and values were thinner in the high-angle group (51).

In 2016, Subramaniam compared between soft tissue chin prominence in different vertical dimensions of Tamil Nadu population in India. The study sample was consisted of 90 cephalograms (38 men and 52 women) of adult patients who seek orthodontics therapy and the mean age was 25 years. The results were as follows:

1. STC thickness values were greater in the short face group than normal and long face groups.
2. All STC values were greater in males than in females (52).

3. Materials and Methods

3.1 Sample size and research design:

In the sum, 142 digital cephalometric radiographs selected randomly to represent soft tissue chin prominence in various mandibular divergence patterns. The target population of the research was Saudi Arabian adults age above 18 years, participants are males and females – comprising 42.95% males of the sample population. The gathered data apropos the requirement for measuring the possibility to vertically grow hard tissues impinging on the inferior soft-tissue envelope in patients with severe hyperdivergence and to plan for genioplasty in such patients when more advancement of the chin might be needed to compensate for the increased vertical height.

3.2 Power analysis calculation:

Power Analysis (G*Power, 2014) calculation was used. Calculation of sample size revealed that at least 142 patients for each group (separate two subgroups 71 and 71) should be included to Gn-Gn' variable effect size 0,42 with statistical power (1-β value) of 80% allowing for a type I (α) error of 0.05. (Comparison of soft tissue chin prominence in various mandibular divergence patterns of Tamil Nadu population Sharmilaa Subramaniam, M. Karthi, K. P. Senthil Kumar, S. Raja) (52).

3.3 Research approval:

The research approval was given by the Ethics Committee of İstanbul Yeni Yüzyıl University and Al-Rabwah Dental Center Riyadh Kingdom of Saudi Arabia.

Inclusion criteria:

When choosing the samples, the following criteria were followed (Figure 9):

1. Good pre-treatment x-ray quality without images of artifacts especially in lips and chin area.
2. Saudi Arabian citizens.
3. The age is above 18 years.
4. The patient hasn't had any orthodontics or surgical treatment in the face before.

5. The patient who has not to have any facial syndrome.

Exclusion criteria:

1. Have passed through any kind of orthodontic treatment or facial surgery.
2. Not originally Saudi Arabian.
3. Subjects younger than 18 years of age.
4. Patients who have any type of a facial syndrome.
5. The image showed gross asymmetry or that the patient was not properly positioned as shown by ear rod markers.
6. The landmarks on the images could not be identified because of motion, resolution or lack of contrast.
7. The image showed craniofacial deformity or excess soft tissue that interfere with anatomical points.
8. Subjects with unclosed lips.

Figure 9. An example of x-ray images which are used in this study

All the digital cephalometric images have been printed at the original size and have been divided into two groups based on their mandibular divergence pattern.

Group A consists hyperdivergent patients (27 males and 44 female).

Group B consists of normal divergence patients (34 males and 37 females).

3.4 X-ray machine:

The lateral cephalometric images were taken in Al-Rabwah Dental Center by using an x-ray device from Vatech company. They were taken by the conventional standards of orthodontics which the patient's head is in horizontal position and Frankfort plane is parallel to the floor (Figure 10,11).

Figure 10. X-ray machine 1

Figure 11. X-ray machine 2

The tracing was made manually (hand tracing) by a pencil 0.7 mm HB at the library of the dental hospital of İstanbul Yeni Yuzil University Faculty of Dentistry (Figure 12).

Figure 12. Tracing materials

3.5 The landmarks that were used in this study:

The hard tissue points (Table 1) (Figure 13):

S point	Sella turcica a saddle-shaped depression in the body of the sphenoid bone.
N point	Nasion the midline bony depression between eyes where the frontal and two nasal bones meet, just below the glabella.
Go point	Gonion the most outward point on the angle of the mandible formed by the junction of the ramus and the body of the mandible.
Pg point	Pogonion the most forward-projecting point on the anterior surface of the chin.
Gn point	Gnathion the midpoint between the Me and Pg on the contour of the chin on the mid-sagittal plane.

Me point	Menton is the most inferior midpoint of the chin on the outline of the mandibular symphysis.
ANS point	Anterior nasal spine is the most anterior point of the tip of the anterior nasal spine in the midsagittal plane.
PNS point	Posterior nasal spine is the tip of the posterior spine of the palatine bone of the hard palate.
a	The junction of the contour of the maxillary incisor and the pre-maxilla.
b	The junction of the contour of the lower incisor and the anterior contour of the chin.

Table 1. The hard tissue landmarks

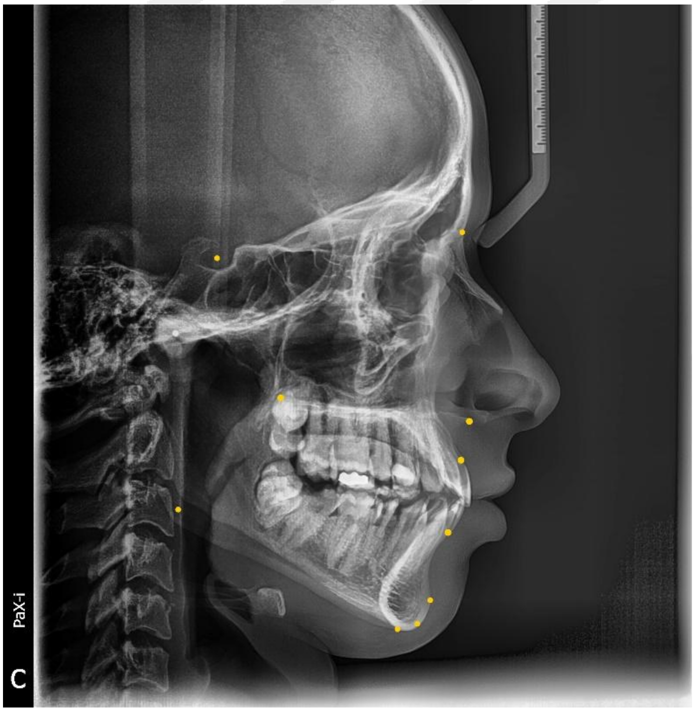

Figure 13. The hard tissue landmarks

The soft tissue points (Table 2) (Figure 14):

Pg' point	Vertical projection on the soft tissue of hard tissue Pogonion
Gn' point	Vertical projection on the soft tissue of hard tissue Gnation
Me' point	Vertical projection on the soft tissue of hard tissue Menton
Ls	Labrale superius is the most prominent point of mucocutaneous border of the upper lip.
Li	Labrale inferius is the most prominent point of mucocutaneous border of the lower lip.

Table 2. The soft tissue landmarks

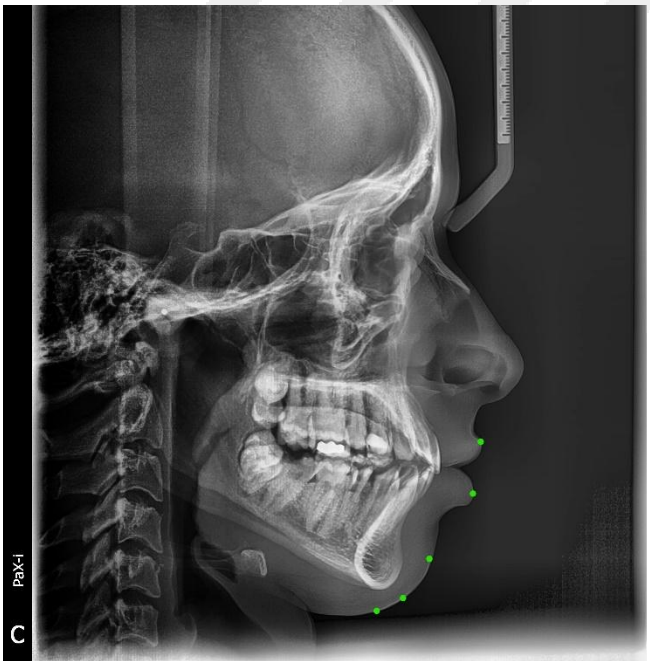

Figure 14. The soft tissue landmarks

The planes are used in this study (Table 3) (Figure 15):

SN	Anterior cranial base from nasion to sella
MP	Mandibular plane from menton to gonion
NL	Nasal plane from ANS to PNS

Table 3. The planes which are used in this study

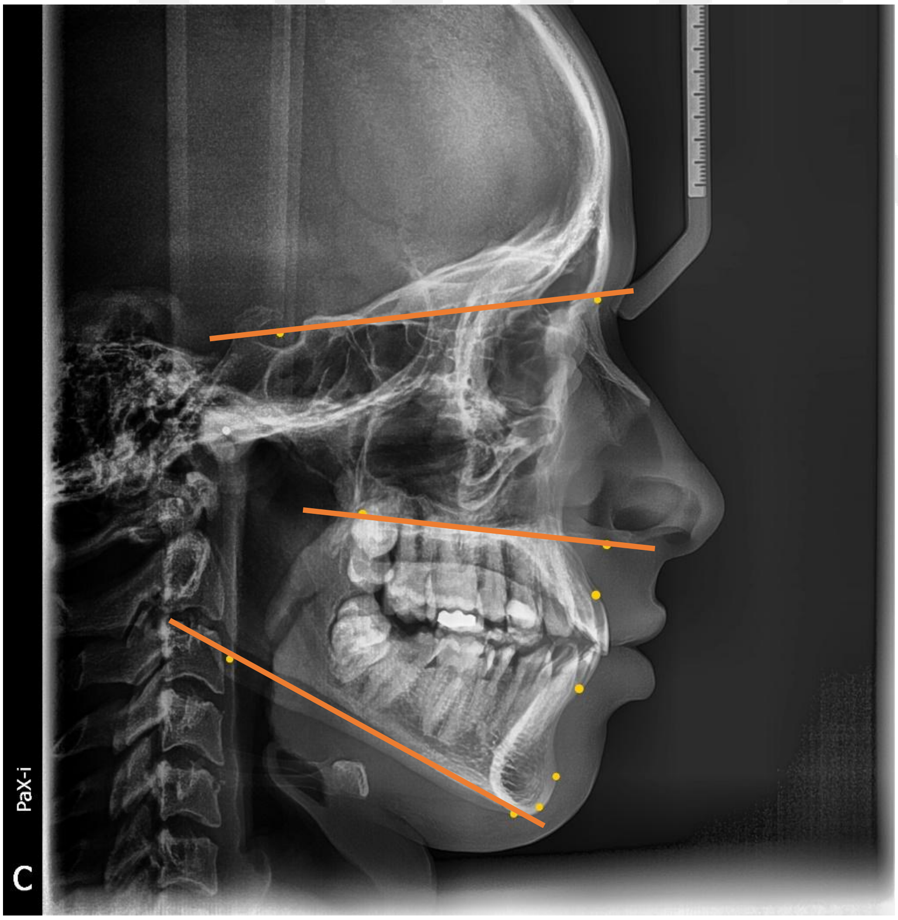

Figure 15. The planes

The linears which are used to measure the lips and the STC thickness:

1. a-Ls.
2. b-Li.
3. Pg-Pg'.
4. Gn-Gn'.
5. Me-Me'.

And all measurements are written in this schedule (Figure 16):

No.	Patient Number	Patient Gender	Patient Age	MP/SN	MP/NL	SN/NL	U. lip	L. lip	Pg-Pg'	Gn-Gn'	Me-Me'

Figure 16. The table of measurements

4. Results

4.1 Method Error

Group	Variable	1st Measure		2nd Measure		ICC	95% CL	
		Mean	Sd.	Mean	Sd.		Lower	Upper
Long Face Male	Upper Lip	17.92	3.18	17.37	3.17	.970	.885	.992
	Lower Lip	19.81	3.92	14.04	2.45	.991	.962	.998
	Pg-Pg'	13.10	5.43	16.81	2.17	.996	.984	.999
	Gn-Gn'	10.75	5.07	15.91	4.15	.995	.980	.999
	Me-Me'	8.50	2.49	19.75	3.92	.983	.934	.996
Long Face Female	Upper Lip	14.04	2.71	17.04	2.30	.982	.930	.996
	Lower Lip	17.09	2.26	18.33	1.71	.980	.922	.995
	Pg-Pg'	12.44	2.11	17.99	4.01	.964	.862	.991
	Gn-Gn'	8.31	2.23	13.30	5.20	.969	.882	.992
	Me-Me'	6.65	1.63	12.74	2.01	.948	.806	.987
Normal Face Male	Upper Lip	16.54	2.37	12.65	2.91	.940	.778	.985
	Lower Lip	18.18	1.73	12.31	2.28	.968	.879	.992
	Pg-Pg'	12.40	3.07	10.48	4.97	.986	.945	.996
	Gn-Gn'	9.78	2.52	8.62	2.24	.970	.883	.992
	Me-Me'	8.00	1.23	9.73	2.53	.886	.608	.970
Normal Face Female	Upper Lip	15.93	4.22	9.56	2.90	.993	.971	.998
	Lower Lip	17.87	3.88	8.66	2.26	.983	.933	.996
	Pg-Pg'	12.22	2.54	7.01	1.42	.964	.861	.991
	Gn-Gn'	9.45	2.96	8.00	1.45	.980	.922	.995
	Me-Me'	7.55	2.81	7.72	2.79	.984	.937	.996

Table 4 Method Error

10 samples from each group were re-measured after 1 month from the first measure, ICC estimates and their 95% confident intervals were calculated and showed excellent reliability as ICC estimates ranged from 0.886 and 0.996 (Table 4).

4.2 Descriptive Statistics

Group	Gender	N.	Age Mean	Standard Deviation	Minimum	Maximum
Long Face	Male	27	25.04	5.63	18.00	36.00
	Female	44	26.52	6.11	18.00	40.00
	Total	71	25.96	5.94	18.00	40.00
Normal Face	Male	34	25.12	7.63	18.00	49.00
	Female	37	23.59	7.04	18.00	48.00
	Total	71	24.32	7.31	18.00	49.00
Total		142	25.14	6.69	18.00	49.00

Table 5 Mean age and standard deviation

The table shows the data of the patients included in the groups (Table 5) (Figure 17) (Figure 18).

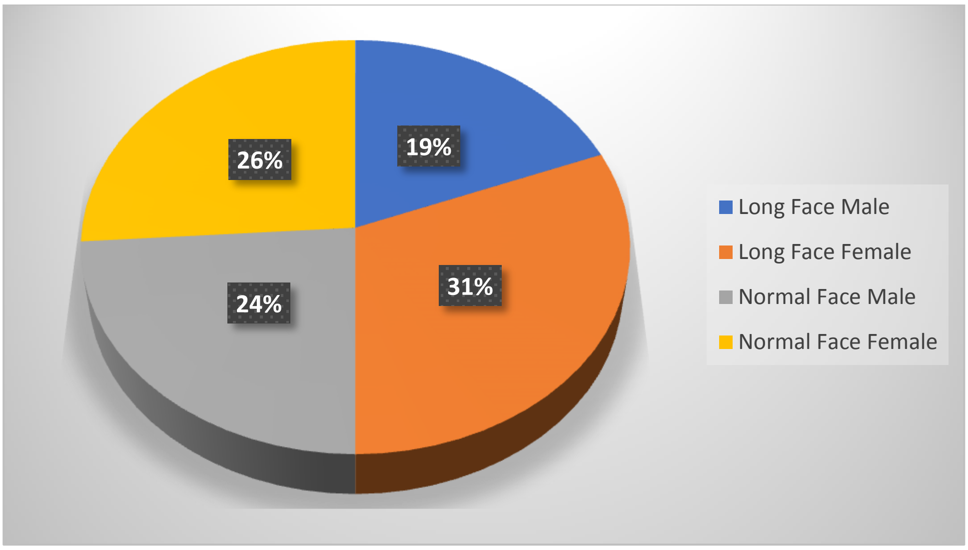

Figure 17. The percentage of men and women in groups

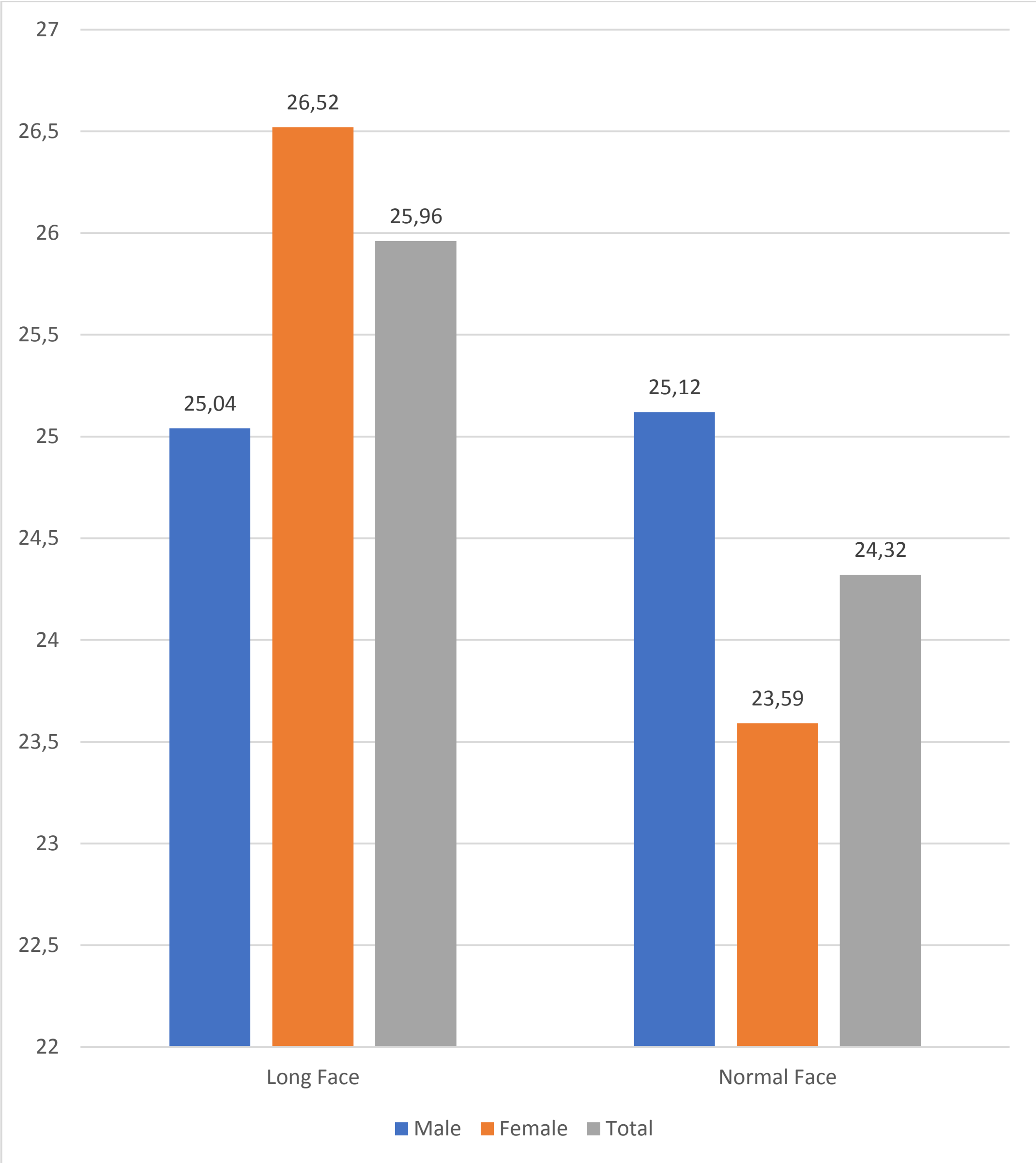

Figure 18. Age distribution of the study samples

4.3 Soft tissues thickness

Group	Gender	Measure	Mean	Standard Deviation	95.0% Lower CL for Mean	95.0% Upper CL for Mean
Long Face	Male	Upper Lip	18.65	3.77	17.15	20.14
		Lower Lip	21.01	3.90	19.47	22.56
		Pg-Pg'	14.76	4.50	12.98	16.54
		Gn-Gn'	10.90	3.87	9.37	12.43
		Me-Me'	9.23	2.71	8.15	10.30
	Female	Upper Lip	14.62	2.58	13.83	15.40
		Lower Lip	17.44	3.01	16.52	18.35
		Pg-Pg'	12.66	2.64	11.86	13.46
		Gn-Gn'	8.70	2.54	7.92	9.47
		Me-Me'	6.90	2.39	6.17	7.63
	Total	Upper Lip	16.15	3.64	15.29	17.01
		Lower Lip	18.80	3.78	17.90	19.69
		Pg-Pg'	13.46	3.59	12.61	14.31
		Gn-Gn'	9.53	3.27	8.76	10.31
		Me-Me'	7.79	2.74	7.14	8.43

Table 6. Mean standard deviation values of lips and STC thickness in the long face group

Group	Gender	Measure	Mean	Standard Deviation	95.0% Lower CL for Mean	95.0% Upper CL for Mean
Normal Face	Male	Upper Lip	17.36	3.62	16.09	18.62
		Lower Lip	18.50	2.86	17.50	19.50
		Pg-Pg'	12.98	2.82	11.99	13.96
		Gn-Gn'	10.01	2.86	9.01	11.01
		Me-Me'	8.69	2.65	7.77	9.62
	Female	Upper Lip	16.01	3.22	14.94	17.09
		Lower Lip	17.95	3.40	16.82	19.08
		Pg-Pg'	12.65	2.69	11.75	13.54
		Gn-Gn'	10.24	3.04	9.22	11.25
		Me-Me'	8.06	2.40	7.26	8.86
	Total	Upper Lip	16.65	3.46	15.84	17.47
		Lower Lip	18.22	3.14	17.47	18.96
		Pg-Pg'	12.80	2.74	12.16	13.45
		Gn-Gn'	10.13	2.94	9.43	10.82
		Me-Me'	8.36	2.52	7.77	8.96

Table 7. Mean standard deviation values of lips and STC thickness in the normal face group

Descriptive statistics for long face and normal groups are shown in the Tables 6 and 7 respectively.

4.4 Difference between Long and Normal Face

Tests of Normality				
Group		Shapiro-Wilk		
		Statistic	df	Sig.
Upper Lip	Long Face	.937	71	.002
	Normal Face	.962	71	.029
Lower Lip	Long Face	.947	71	.005
	Normal Face	.957	71	.016
Pg-Pg'	Long Face	.987	71	.690
	Normal Face	.967	71	.058
Gn-Gn'	Long Face	.961	71	.026
	Normal Face	.958	71	.019
Me-Me'	Long Face	.945	71	.004
	Normal Face	.938	71	.002

Table 8. Test of normality between groups

An independent samples t-test will be used to compare the differences of (Pg-Pg') between Normal and Long faces groups as data were normally distributed. Independent Samples Mann-Whitney U tests will be used to compare the differences of the remaining variables as data were not normally distributed (Table 8).

	t	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Pg-Pg'	1.223	0.224	0.65	-0.40	1.71

Table 9. Mean difference of Pg between groups

Data are mean ± standard deviation unless otherwise stated. There were 71 Long faces and 71 Normal Faces patients. An independent-samples t-test was run to determine if there were differences in Pg-Pg' measures between the two mentioned groups. Patients with Long faces have higher Pg-Pg' measures (13.46 ± 3.59 mm) than patients with Normal faces (12.80 ± 2.74 mm), however, the mean difference of 0.65 mm was not statistically significant, t = 1.223, p = .224 (Table 9).

Measure	Group	Mean Rank	Sig.
Upper Lip	Long Face	67.85	.290
	Normal Face	75.15	
Lower Lip	Long Face	74.68	.357
	Normal Face	68.32	
Gn-Gn'	Long Face	68.03	.314
	Normal Face	74.97	
Me-Me'	Long Face	66.44	.142
	Normal Face	76.56	

Table 10. Mean differences of other points between groups

Mann-Whitney U tests were run to determine if there were differences in Upper Lip, Lower Lip, Gn-Gn' and Me-Me' measures between Long and Normal Faces Patients. Upper Lip measures for Long Faces (mean rank = 67.85) and Normal Faces (mean rank = 75.15) were not statistically significantly different, p = .290. Lower Lip measures for Long Faces (mean rank = 74.68) and Normal Faces (mean rank = 68.32) were not statistically significantly different, p = .357. Gn-Gn' measures for Long Faces (mean rank = 68.03) and Normal Faces (mean rank = 74.97) were not statistically significantly different, p = .314. Me-Me' measures for Long Faces (mean rank = 66.44) and Normal Faces (mean rank = 76.56) were not statistically significantly different, p = .142 (Table 10).

4.5 Difference between Male and Female in Long face patients

Tests of Normality				
Group		Shapiro-Wilk		
		Statistic	df	Sig.
Upper Lip	Long Face	.914	27	.029
	Normal Face	.969	44	.283
Lower Lip	Long Face	.927	27	.058
	Normal Face	.965	44	.200
Pg-Pg'	Long Face	.964	27	.450
	Normal Face	.982	44	.702
Gn-Gn'	Long Face	.970	27	.598
	Normal Face	.948	44	.045
Me-Me'	Long Face	.971	27	.626
	Normal Face	.910	44	.002

Table 11. Test of normality in long face group

An independent samples t-test will be used to compare the differences of (Lower Lip and Pg-Pg' measures) between Long Face Males and Females patients as data were normally distributed. Independent Samples Mann-Whitney U tests will be used to compare the differences of the remaining variables as data were not normally distributed (Table 11).

	t	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Lower Lip	4.336	0.000	3.58	1.93	5.22
Pg-Pg'	2.206	0.034	2.10	0.17	4.04

Table 12. Mean differences of lower lip and Pg in long face group

Data are mean ± standard deviation unless otherwise stated. There were 27 Males and 44 Females Long Faces patients. An independent-samples t-test was run to determine if there were differences in Lower Lip and Pg-Pg' measures between the two mentioned groups. Male patients have higher Lower Lip measures (21.01 ± 3.90 mm) than Female patients (17.44 ± 3.01 mm), a statistically significant difference of 3.58 mm (95% CI, 1.93 to 5.22), $t = 4.336$, $p < 0.0005$. Male patients have higher Pg-Pg' measures (14.76 ± 4.50 mm) than Female patients (12.66 ± 2.64 mm), a statistically significant difference of 2.10 mm (95% CI, 0.17 to 4.04), $t = 2.206$, $p = 0.034$ (Table 12).

Measure	Group	Mean Rank	Sig.
Upper Lip	Male	50.11	.000
	Female	27.34	
Gn-Gn'	Male	44.31	.008
	Female	30.90	
Me-Me'	Male	46.91	.000
	Female	29.31	

Table 13. Mean differences of other points in long face group

Mann-Whitney U tests were run to determine if there were differences in Upper Lip, Gn-Gn' and Me-Me' measures between Long Face Male and Female Patients. Upper Lip measures for males (mean rank = 50.11) were statistically significantly higher than for females (mean rank = 27.34), $p < 0.0005$. Gn-Gn' measures for males (mean rank = 44.31) were statistically significantly higher than for females (mean rank = 30.90), $p = 0.008$. Me-Me' measures for males (mean rank = 46.91) were statistically significantly higher than for females (mean rank = 29.31), $p < 0.0005$ (Table 13).

4.6 Difference between Male and Female in Normal face patients

Tests of Normality				
Group		Shapiro-Wilk		
		Statistic	df	Sig.
Upper Lip	Long Face	.932	34	.035
	Normal Face	.978	37	.646
Lower Lip	Long Face	.981	34	.816
	Normal Face	.910	37	.006
Pg-Pg'	Long Face	.968	34	.407
	Normal Face	.944	37	.062
Gn-Gn'	Long Face	.969	34	.441
	Normal Face	.941	37	.048
Me-Me'	Long Face	.936	34	.048
	Normal Face	.911	37	.006

Table 14. Test of normality in normal face group

An independent samples t-test will be used to compare the differences of (Pg-Pg' measures) between Normal Face Males and Females patients as data were normally distributed. Independent Samples Mann-Whitney U tests will be used to compare the differences of the remaining variables as data were not normally distributed (Table 14).

	t	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Pg-Pg'	0.908	0.504	0.616	0.33	-0.98

Table 15. Mean difference of Pg in normal face group

Data are mean ± standard deviation unless otherwise stated. There were 34 Males and 37 Females Normal Faces patients. An independent-samples t-test was run to determine if there were differences in Pg-Pg' measures between the two mentioned groups. Male patients have higher Pg-Pg' measures (12.98 ± 2.82 mm) than Female patients (12.65 ± 2.69 mm), however, the mean difference of 0.616 mm was not statistically significant, t = 0.908, p = .504 (Table 15).

Measure	Group	Mean Rank	Sig.
Upper Lip	Male	39.94	.123
	Female	32.38	
Lower Lip	Male	39.18	.214
	Female	33.08	
Gn-Gn'	Male	35.69	.904
	Female	36.28	
Me-Me'	Male	39.38	.185
	Female	32.89	

Table 16. Mean differences of other points in normal face group

Mann-Whitney U tests were run to determine if there were differences in Upper Lip, Lower Lip, Gn-Gn' and Me-Me' measures between Long Face Male and Female Patients. Upper Lip measures for males (mean rank = 39.94) and females (mean rank = 32.38) were not statistically significantly different, p = .123. Lower Lip measures for males (mean rank = 39.18) and females (mean rank = 33.08) were not statistically significantly different, p = .214. Gn-Gn' measures for males (mean rank = 35.69) and females (mean rank = 36.28) were not statistically significantly different, p = .904. Me-Me' measures for males (mean rank = 39.38) and females (mean rank = 32.89) were not statistically significantly different, p = .185 (Table 16).

5. Discussion

Numbers of adults who seek orthodontic treatment has increased recently in all world and most of them focus on esthetics details so, the primary goal of orthodontic treatment for these patients is achieving the balanced and harmonic facial profile with concerning all small details of soft and hard tissues. Therefore, the current studies emphasize on the assessment of soft tissue variables and the chin is an essential prominent anatomical area of the lower third of the face and takes part in soft tissue profile characteristics. All these studies try to improve our understanding of the relationship between soft and hard tissues of the face and to enhance treatment planning of orthodontic in future (53, 54).

The bony structures of the skull give some information about the facial features of the individual, these features wouldn’t be clear if they weren’t supported by those bony structures, so the facial balance and harmony are determined by the internal skeleton and the overlying soft tissues together. Therefore, the evaluation of skeletal relations from the external appearance of soft tissues has an intimate relationship to orthodontics (53).

Many studies have explained that facial soft tissue doesn’t follow the underlying bony tissues in the same ratio at all points. Subtelny (23) concluded that the soft tissue of the face doesn’t grow in the same amount, the covering soft tissue of the middle third if the face is thicker than the covering soft tissue of upper and lower thirds and that tends to convex profile. Also, Park and Burstone concluded that the facial skeletal norms doubtful to get a required facial harmony after an orthodontic treatment and they confirmed the importance of individual soft tissues' thickness in diagnosis and treatment planning (27).

Lateral cephalometric standards may be particular to an ethnic society and not able to be applied to other racial types. Holdaway (2), Subtelny (23), and Scheideman et al.(55), developed cephalometric analyses and their standards. However, these analyses standards were usually based on samples of Caucasian individuals only. They have confirmed that norms differ between Caucasians and other ethnic and racial groups. And to achieve a best orthodontic treatment should consider the facial and cephalometric characteristics of the ethnic background of patients (54-57).

Usually, adult patients with skeletal class II relative to retrognathic mandible need to a genioplasty surgery with orthodontic therapy to enhance the facial profile and correct the retracted chin. In Reddy PS. et al. (58), study showed the thickness of soft tissue displaces in a corresponding ratio 1:1 after genioplasty surgery but the findings of Macari and Hanna (3) impinges that information. Because they found that when the vertical dimension of facial bony structures increases, the soft tissue of the chin becomes thinner and mentioned women have thinner soft tissue thickness than men due to sex hormones because estrogen has some effects on women skin (3, 47, 58, 59).

In general, sexual hormones contribute in growth and development of human body, the testosterone plays a role in muscles development in males and makes the muscles stronger and bigger than females and give the skin thicker appearance because it shares in collagen synthesis. In contrast, the estrogen hormone in females contributes in fat distribution and smaller muscles than males and causes a lack in collagen in women skin so, that gives their skin thinner appearance than men (47).

5.1 The present study:

The main aim of this study was to evaluate the soft tissue chin and lips thickness of Saudi adult orthodontics seekers with hyperdivergent mandibular pattern and comparing them with normodivergent mandibular pattern.

In order to study the soft tissue overlying the chin, three specific points on the soft tissue which was connected to same points (corresponding points) on the bone by lines were chosen and then measured. The points were soft tissue Pogonion, Gnation and Menton (Pg', Gn', and Me' respectively) and bony Pogonion, Gnation and Menton (Pg, Gn, and Me respectively). To measure the lips thickness we chosed Labrale superius and Labrale inferius (Ls and Li respectively) on the soft tissues and the hard tissues points were on the junction of the contour of upper and lower incisors with the alveolar bone.

The sample size consisted of one hundred forty-two radiographs of sixty-one men and eighty-one women who are adults. By excluding who are younger than the 18 years old we surpassed the growth. The samples are divided into two groups (long face and normal face) according to the angle between mandibular plane and anterior cranial base plane which long face group angles >= 37° consists of twenty-seven males and forty-four females and normal face group angles >= 27° and < 37° consists of thirty-four males and thirty-seven females. Lateral cephalometric x-ray images are usually taken as standard diagnostic aid before the start of orthodontic therapy. The ethical approval was obtained from both the dental center providing documents containing cephalometrics and demographic data and the ethical community of İstanbul Yeni Yuzyil University. Because the participants are potential orthodontic receivers, a wide spectrum of craniofacial patterns in the sample is guaranteed. This study is done on two‐dimensional data, concentrating on the soft‐tissue profile outline with lateral cephalometric points.

5.2 Gender differences:

In this study according to the sex, STC and lips thicknesses are generally higher in men than women in the two groups with all the points except Gn in the normal face group. Statically significant differences where found in the long face group at all measurments but no significant differences found in the normal face group.

While in Somaiah et al. study which was obtained on Kodava population in India, his/her study samples were eighty cephalometric x-ray images of adult patients (aged between 18 and 35 years old) were divided into four groups according to mandibular divergence angle (high group, medium-high group, medium-low group, and low group), the women were 43 and men were 37, the males have thicker STC thickness than females in all three measurements in normal divergence group, but in the long group men have thinner STC thickness than women but without significant difference (4).

Macari et al. from Lebanon studied 190 cephalometric x-ray images of white adults who seek orthodontic treatment and were divided into four groups according to mandibular plane angle (high group, medium-high group, medium-low group, and low group). The women numbers were 113 and men numbers were 77 with mean age of 26.94 years, all chin measurements were greater with statistical significance in men than women in medium face group but no statically significant difference in long face group (3).

Rasoola et al. from Pakistan studied 95 pre-treatment cephalometric x-rays of adult individuals (56 women and 39 men) with age range of 18-53 years and were divided into four groups according to vertical growth pattern (low group, medium-low group, medium-high group, and high group) showed that all STC measurements were higher in males than females (50).

Subramaniam et al. from India studied on Tamil Nadu population and included 90 cephalometric x-ray images of nongrowing patients (38 males and 52 females) and they were divided into three groups according to facial height (long face group, normal face group, and short face group), females have thinner STC thickness than males in all groups and that was in Pg‐Pg' and Me‐Me' levels with significance (52).

Kamak and Çelikoğlu from Turkey studied facial soft tissue thickness among different skeletal malocclusion in a sample of 180 patients (90 women and 90 men) divided into 3 groups according to malocclusion type. The study findings were soft tissue thickness at all points was higher in males than females (43).

Another study was made by Nada Al–Sayagh et al. in Iraq in 2011, compared the facial soft tissue shape amoung different vertical dimensions in University of Mosul and the sample was 120 lateral cephalometric x-rays of Iraqi Adults (60 men and 60 women), aged between 20 to 30 years of age. The study sample was divided according to the vertical dimension into three groups short, average and long faces, showed that the men have thicker lips thickness than women at all groups (45).

Another study from Brazil was made by Murilo et al., in 2010 which studied the soft tissue size with different facial patterns has different findings. The study sample was 90 cephalometric radiograph images of growing patients of both sexes, with age between 12 and 16 years. The study sample was divided into three groups according to facial patterns (short face, normal face, and long face). The study findings showed no significant difference between girls and boys in soft tissue thickness of lips and chin (44).

Sundry studies assessing soft tissue cephalometric standards for diverse societies with different ages reported that facial soft tissue thickness values were greater in males than in females (26).

These differences between STC thickness measurements according to sex between these studies might be related to racial differences. In addition, in our study the differences between males and females may be due to the estrogen hormone in women which causes a lack in collagen synthesis while in contrast the testosterone hormone eases the collagen synthesis and causes a thicker skin in males. Some studies prove variations in the thickness of soft tissue among diverse ethnic and racial groups. Another possible explanation of these differences is the developmental differences among the two sexes (47, 60).

5.3 Lips and STC thickness between groups:

In this study patients of long face group have thinner soft tissue chin thickness and lip thickness except Pg-Pg', but there is no statically significant differences in the study findings when it is compared to the normal face group. In Macari et al. Subramaniam et al. Rasoola et al. (3, 4, 50) found statically significant difference at Gn while Somaiah et al. (52) found differences at all three points between long face and normal face groups.

Macari et al. explained this differences in results between soft tissue chin thickness by two points:

1. The presence of different growth ratio between the measured points in people with vertical growth pattern.
2. Adaptation of the soft tissue to the stretch exerted by long facial profile.

They also confirmed that their study was made in a limited geographic area and white caucasian subjects only and the ethic variations may affect the soft tissue thickness and give different results (3).

Murilo et al. study found no significant difference in thickness of both lips and soft tissue of chin between groups and that corresponds with this study (44).

The differences in this study comparing with the similar studies confirm the racial and ethical effects on the soft tissue and hard tissue shape.

6. Conclusion

1. There is no significant difference in lips and soft tissue chin thickness between the normal and long face groups.
2. There is a highly signigicant difference in lips and soft tissue chin thickness between women and men in the long face group.
3. Men have thicker soft tissue thickness than women in the long face group.

7. Recommendations

Further evaluation studies would be suggested which include hypodivergence mandibular pattern samples by using CBCT radiography technique and also considering body mass index.

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