TURKISH REPUBLIC OF NORTHERN CYPRUS

NEAR EAST UNIVERSITY FACULTY OF DENTISTRY

GRADUATE SCHOOL OF HEALTH SCIENCES

COMPARISON OF PALATAL ARCH FORM MORPHOLOGY AND TOOTH INCLINATION IN EXTRACTION AND NON-EXTRACTION ORTHODONTIC TREATMENT BY USING CONE BEAM COMPUTED TOMOGRAPHY

YAMEN TALJABINI

PhD THESIS

DEPARTMENT OF ORTHODONTICS

Supervisor:

Assoc. Prof. Dr. ULAŞ ÖZ

2020 NICOSIA

TURKISH REPUBLIC OF NORTHERN CYPRUS

NEAR EAST UNIVERSITY FACULTY OF DENTISTRY

GRADUATE SCHOOL OF HEALTH SCIENCES

COMPARISON OF PALATAL ARCH FORM MORPHOLOGY AND TOOTH INCLINATION IN EXTRACTION AND NON-EXTRACTION ORTHODONTIC TREATMENT BY USING CONE BEAM COMPUTED TOMOGRAPHY

YAMEN TALJABINI

PhD THESIS

DEPARTMENT OF ORTHODONTICS

Supervisor:

Assoc. Prof. Dr. ULAŞ ÖZ

2020 NICOSIA

NEAR EAST UNIVERSITY

THESIS APPROVAL

Directorate of Institute of Health Sciences

This study was accepted by our jury as a doctoral thesis in the orthodontics program.

Head of Jury:	Prof. Dr. Zahir Altuğ Ankara University
Advisor:	Assoc. Prof. Dr. Ulaş Öz Near East University
Jury Member:	Prof. Dr. Mehmet Okan Akçam Ankara University
Jury Member:	Asst. Prof. Levent Vahdettin Near East University
Jury Member:	Asst. Prof. Beste Kamiloğlu Near East University

This thesis was approved by the above jury members in accordance with the relevant articles of the Near East University Graduate Education and Examination Regulations and accepted by the Board of Directors of the Institute.

Prof. Dr. Hüsnü Can BAŞER

Director of Institute of Health Sciences

NEAR EAST UNIVERSITY GRADUATE SCHOOL OF HEALTH SCIENCES, NICOSIA 2020

Signed Plagiarism Form

Student’s Name & Surname: Dr. Yamen Taljabini
Student’s Number: 20153724

Programme:
□ Master’s without Thesis □ Master’s with Thesis ● Doctorate

I hereby declare that I have fully cited and referenced all material that are not original to this work as required by these rules and conduct. I also declare that any violation of the academic rules and the ethical conduct concerned will be regarded as plagiarism and will lead to disciplinary investigation which may result in expulsion from the university and which will also require other legal proceedings.

....
(Signature)

ACKNOWLEDGEMENTS

Foremost, I would like to express my sincere gratitude to my advisor Assoc. Prof. Dr. Ulaş Öz for the continuous support of my Ph.D. study and research, for his patience, motivation, enthusiasm, and immense knowledge. His guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better advisor and mentor for my Ph.D. study.

Besides my advisor, I would like to thank the rest of my thesis committee: Prof. Dr. Zahir Altuğ Prof. Dr. Mehmet Okan Akçam Asst. Prof. Levent Vahdettin Asst. Prof. Beste Kamiloğlu for their encouragement, insightful comments, and hard questions.

I would like to thank my family: my parents Nasser Taljabini and Roula Ghazal, for giving birth to me at the first place and supporting me spiritually throughout my life. Also, thanks to my brothers for their support, advice and assistance to me.

Last but not the least, I would like to thank all my friends who have always been beside me and helped me and support me in carrying out this work.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

°	Degree
3D	Three dimensional
2D	Two dimensional
AAOMR	American Institute of Oral and Maxillofacial Radiology
CBCT	Cone Beam Computed Tomography
Cm	Centimeter
GFs	Growth Factors
FVD	Facial Vertical Dimension
IBM	International Business Machines
LLLT	Low-level laser therapy
MSv	Micro Sievert
Mm	Millimeters
MPR	Multiplanar transformation
PAOO	Periodontal Accelerated Osteogenic Orthodontics
PV	Palatal Volume
PA	Palatal Area
PDL	periodontal ligament
PTH	parathyroid hormone
RME	Rapid Maxillary Expansion
SPSS	Statistical Package for the Social Sciences
STA	Soft Tissues Analysis
STL	Stereolithography
TMG	Temporal Mandibular Joint
YDU	Yakın Dogu University

Comparison Of Palatal Arch Form Morphology and Tooth Inclination in Extraction and Non-Extraction Orthodontic Treatment by Using Cone Beam Computed Tomography

Name of the student: Yamen Taljabını

Supervisor: Assoc. Prof. Dr. ULAŞ ÖZ

Department: Department of Orthodontıcs

ABSTRACT

Purpose: The purpose of this study was to investigate changes in the palatal form in patients treated with and without premolar extractions.

Material and Method: A total of 40 patients who had undergone orthodontic treatment (extraction and non-extraction) were divided into two groups coequally. Retrospective records were collected at pretreatment and at bracket removal. Stone casts were scanned by cone-beam tomography; linear and angular measurements on the three-dimensional model were then performed for both the sagittal direction and the transverse direction. The data obtained from this study were analyzed using IBM SPSS Statistics 22.0 (demo version) software. Since all the variables used in the study were quantitative (continuous) variables, they are presented as mean ± standard deviation (x ± ss). Due to the insufficient number of subjects (fewer than 50 subjects), the quantitative data were evaluated using the Shaphiro-Wilks test. When comparing quantitative data between the groups, t-tests for independent samples were used. When the data did not comply with the regular distribution, the Mann-Whitney U test was used. Finally, when comparing quantitative data within the groups, t-tests for dependent samples were used. The level of error (= α) was taken as 0.05, and P values ($P \leq 0.05$) were considered statistically significant. All P values above this value ($P > 0.05$) were considered statistically insignificant.

Statistics also showed that the accuracy of the results is 95%.

Arithmetic mean, standard deviation standard error and 95% confidence intervals related to the data presented in the table.

Results: The sagittal palatal form increased in the non-extraction group, whereas it decreased in the extraction group. There was a decrement in the transversal palatal form in both groups. There were no differences or changes in molar or canine crown angulation in the non-extraction group. Conversely, distal tipping of the upper right first molar and distal tipping and lingual movement of both left and right upper canines were observed in the extraction group.

Conclusions: This study investigated the transverse and sagittal changes in the palatal form and angular changes in the molars and canines in patients treated with and without premolar extractions. The results were as follows:

- In the extraction group, the sagittal and transverse palatal form is decreased.
- In the non-extraction group, the sagittal palatal form decrease in the left canine length, left pre molar length and left molar length. And increased in the right canine length and right lateral length.
- In the extraction group with mesiodistal and buccolingual molar angulation results especially in the extraction group we observed statistically significant distal tipping in the right molar.
- In the extraction group with mesiodistal and buccolingual canine angulation results especially in the extraction group we observed statistically significant lingual tipping in the right and left canine.
- In the non-extraction group, with mesiodistal and buccolingual molar and canine angulation, the rest of the measurements showed no statistical significant differences in the mesiodistal and buccolingual molar and canine angulation with non- extraction group.

Keywords: Model analysis, arch width changes, crown angulation, dental crowding, axial angulation, tooth extraction, orthodontic planning.

Koni Işınlı Bilgisayarlı Tomografi Kullanılarak Ekstraksiyon ve Ekstraksiyon Dışı Ortodontik Tedavide Palatal Ark Formu Morfolojisi ve Diş Eğiminin Karşılaştırılması

Öğrencinin adı: Yamen Taljabını

Danışman: Doç. Dr. Ulaş ÖZ

Bölüm: Ortodonti Anabilim Dalı

ÖZ

Amaç: Bu çalışmanın amacı premolar ekstraksiyonu olan ve olmayan hastalarda palatal formdaki değişiklikleri araştırmaktı.

Gereç ve Yöntem: Ortodontik tedavi uygulanan (ekstraksiyon ve ekstraksiyon olmayan) toplam 40 hasta birlikte iki gruba ayrıldı. Retrospektif kayıtlar, tedavi öncesi ve braket çıkarılmasında toplandı. Taş dökümler koni ışınlı tomografi ile tarandı; daha sonra hem sagital yön hem de enine yön için üç boyutlu model üzerinde doğrusal ve açısal ölçümler yapılmıştır. Bu çalışmadan elde edilen veriler IBM SPSS Statistics 22.0 (demo versiyonu) yazılımı kullanılarak analiz edilmiştir. Araştırmada kullanılan tüm değişkenler kantitatif (sürekli) değişkenler olduğu için ortalama ± standart sapma (x ± ss) olarak sunulmuştur. Yetersiz denek sayısı nedeniyle (50 den az denek) nicel veriler Shaphiro-Wilks testi kullanılarak değerlendirildi. Gruplar arasında kantitatif veriler karşılaştırılırken bağımsız örnekler için t-testi kullanıldı. Veriler düzenli dağılıma uymadığında Mann-Whitney U testi kullanıldı. Son olarak, gruplar içindeki kantitatif veriler karşılaştırılırken, bağımlı numuneler için t-testleri kullanıldı. Hata düzeyi (= α) 0,05 olarak alındı ve P değerleri (P = 0,05) istatistiksel olarak anlamlı kabul edildi. Bu değerin üzerindeki tüm P değerleri (P> 0.05) istatistiksel olarak önemsiz kabul edildi.

İstatistikler ayrıca sonuçların doğruluğunun% 95 olduğunu göstermiştir.

Tabloda sunulan verilerle ilgili aritmetik ortalama, standart sapma standart hatası ve% 95 güven aralıkları.

Bulgular: Sagital palatal form ekstraksiyon dışı grupta artmış, ekstraksiyon grubunda azalmıştır. Her iki grupta da enine palatal formda bir azalma vardı. Ekstraksiyon olmayan grupta molar veya köpek kemiği açılanmasında hiçbir fark veya değişiklik yoktu. Tersine, ekstraksiyon grubunda sağ üst birinci molar distal devrilme, hem sol hem de sağ üst köpeklerin distal devrilme ve lingual hareketi gözlendi.

Sonuç: Bu çalışmada premolar ekstraksiyon ile tedavi edilen ve olmayan hastalarda palatal formdaki enine ve sagital değişiklikler ile azı ve köpek dişlerinde açısal değişiklikler araştırıldı. Sonuçlar aşağıdaki gibidir:

- Ekstraksiyon grubunda sagital ve enine palatal form azalır.
- Ekstraksiyon olmayan grupta sagital palatal form sol köpek uzunluğunda, sol ön molar uzunlukta ve sol molar uzunlukta azalır. Ve sağ köpek uzunluğunda ve sağ yan uzunluğunda artmıştır.
- Özellikle ekstraksiyon grubunda meziyodistal ve bukkal dilli molar angulasyon sonuçları olan ekstraksiyon grubunda sağ molarda istatistiksel olarak anlamlı distal devrilme gözlemledik.
- Özellikle ekstraksiyon grubunda meziodistal ve bukkal dilli köpeklerin açılanması olan ekstraksiyon grubunda sağ ve sol köpeklerde istatistiksel olarak anlamlı lingual devrilme gözlemledik.
- Ekstraksiyon olmayan grupta, meziodistal ve buklölingel molar ve köpek angulasyonu ile, ölçümlerin geri kalanında, ekstraksiyon dışı grup ile meziodistal ve bukklil molar ve köpek angulasyonunda istatistiksel olarak anlamlı bir fark görülmemiştir.

Anahtar Kelimeler: Model analizi, kemer genişliği değişiklikleri, kuron açılanması, dental kalabalık, eksenel açılanma, diş çekimi, ortodontik planlama.

1. INTRODUCTION

Orthodontic treatment aims to straighten up teeth, provide a proper occlusal relationship between teeth, and maintain healthy orofacial functions. (Roberts et al., 1988). Crowding of dental arches occurs as a result of arch size discrepancies, tooth size discrepancies, and sometimes transverse arch discrepancies (Proffit, 2006). Several methods can be used to relieve crowded arches and correct malocclusion.

Permanent teeth can be extracted or the dental arches can be expanded to provide enough space for teeth to align properly (Proffit, 2006).

There are many orthodontic treatment plans that containing tooth extraction to provide the necessary spaces for the jaw (Kouvelis et al., 2018). Studies have shown that there are many changes that occur in the treatment that contain extraction (Kouvelis et al., 2018). In the context of orthodontic treatment, dental extraction is sometimes indicated to gain space for straightening crowded teeth as well as for camouflaging mild skeletal malocclusion (Williams et al., 2004).

For many years, posterior tooth extractions have been suggested, especially in long-face patients to control the vertical dimension (Schudy et al., 1968).

Extracting permanent teeth may correct an open bite or reduce the vertical dimension of the face by counterclockwise rotation of the mandible, through the forward movement of the posterior teeth: the wedge-type effect (Isaacson et al., 1971).

Facial profile is an important factor in orthodontic diagnosis and treatment planning as it is determined by the base of the upper lip and the chin position; extreme forward or backward position of these points makes the profile unattractive for both patients and orthodontists (Al Taki et al., 2014).

In the mid1940s, Grieve significantly turned around the considering American orthodontists. Extraction in the changeless dentition turned into the most well-known action policy for revising Class I and Class II malocclusions (Grieve ., 1941).

Since the 1960s, with the improvement of orthodontic gadgets, the parity has started to shift back. Today, most orthodontists get themselves some place in the inside, treating a couple of patients with extractions and some without (Ruellas et al., 2010).

One of Point's main adversaries was Case, 1964, who stated that pushed orthodontic action with extraction now and again. He attested that dental extractions ought to not at all attempted so as to encourage orthodontic mechanics yet somewhat to give the most ideal treatment to the patient (Case., 1964).

This polarity stays right up until the present time. The diagnosis of certain malocclusions can be ambiguous as far as the requirement for extractions. As indicated by (Dewel et al., 1955), the test of orthodontic determination is not in those cases that apparently need extractions or individuals that obviously don't, yet in an enormous gathering known as marginal cases.

Williams declared that all marginal cases patients display a suitable and worthy skeletal example and sufficient delicate a situation that is regularly shown for extraction-in 5% to 87% of cases-by various experts (Williams., 1976).

Extractions in orthodontics have always been a controversial issue (Graber et al., 2005). This treatment approach contradicts the philosophy of Edward Angle, who believed that arch expansion could provide sufficient space for ideal positioning of the teeth (Graber et al., 2005).

Changes in teeth position and angulation should lead to changes in tongue placed, palate shape, volume, and height (Heiser et al., 2004). Moreover, the success of orthodontic therapy is evaluated in terms of the long-term stability of the orthodontic treatment results, which is achieved by maintaining proper teeth angulation, proper teeth occlusion, and a well-balanced stomatognathic system (Heiser et al., 2004).

Therefore, this study aimed to evaluate the transversal and sagittal palatal form changes in crown angulation on 3-dimensional models taken before and after treatment of patients treated with their premolars extraction and without extraction.

The study aimed to provide data that might prove valuable to clinicians deciding whether to extract teeth based on changes to the palate form that might occur, affecting the long-term stability of the orthodontic treatment.

2. GENERAL INFORMATION

2.1 History

Toward the start of the twentieth century, Edward Angel (1855-1930) founded the first orthodontic school, first orthodontic society and first orthodontic journal (Takada et al., 2009). He was the most influential figure in orthodontics and is considered as "the dad of present day orthodontics". He created a dental grouping of malocclusion which is still the most generally utilized order around the world today. His vision of orthodontic treatment was based on the possibility for any given patient to align the 32 teeth in perfect Class I occlusion: He strongly advocated a non-extraction approach stating that jaws and bones would grow accordingly and the adjacent tissues would adapt to their new position (Takada et al., 2009, Ruellas et al., 2010).

Ideal occlusion is “nature’s intended ideal form (Connor et al., 1993). His philosophy was that "the best parity, the most excellent concordance, the best extents of the mouth in its connection to different highlights need that there will be a full supplement of teeth, and that every tooth will be complete to involve its ordinary position—i.e., typical impediment.

Case (1964), defended extractions as a treatment to correct facial deformities in one of his articles and instigated the “Great Extraction Debate” in 1911 with Edward Angle (Case, 1964).

One of Angle’s disciples, Charles Tweed, followed his teacher’s approach and realized later in his career that many of his patients experienced relapse after the end of their non-extraction treatment, especially when the lower incisors were overly proclaimed. Non-extraction arch-expansion, originally proposed by Edward Angle, was found to be unstable after treatment (Proffit., 2006, Ruellas et al., 2010).

Tweed (1966) re-treated a number of his patients with the extraction of four premolars and obtained a satisfactory result. Other orthodontists like Raymond Begg followed his footsteps and advocated premolar extraction as a valid way to treat patients. Technological advances also played a major role in that direction (Tweed., 1966). As an example, the possibility to bond to enamel gave the clinician better control over the tooth movements.

As of today, the philosophic evolution in orthodontic treatment lies on three principles: occlusion, stability, and soft tissue balance. Derived from these principles, it has been accepted by the orthodontic community that some patients will need extractions and other will not. However, in practicality, the question remains as to which patients should benefit from these extractions and how the clinician should make that decision (Proffit, 2006).

2.2 Hard Palate

2.2.1 Anatomy

The hard plate is that comprehends taste of the mouth. It makes the foremost 66% of the highest point of the oral hole (Proffit, 2006).

The hard plate is made of two facial bones: palatine procedure of the maxilla and combined palatine bones. It contains a few milestones, for example, the sharp foramen and more noteworthy also, lesser palatine foramina. They fill in as entry path for the neurovascular structures planned for the stockpile of the oral depression structures (Proffit., 2006).

2.2.2 Border

The foremost part of the hard plate is flanked anteriorly and along the side by the maxillary teeth. Superiorly it is secured by the respiratory epithelium of the nasal hole and poorly by the masticatory epithelium of the oral hole. Posteriorly, the hard plate is associated with the delicate sense of taste, which is an absolutely strong structure and is bound by a thick tendinous aponeurosis of the tensor veli palatine muscles on the different sides, which is known as the aponeurotic plate (Proffit., 2006, Norton et al., 2011, Methathrathip et al., 2005).

2.2.3 Function

The goal of the hard plate is together nourishing and discourse. Previous to current medical procedures were created, newborn children with inadequate palates couldn't suckle (Norton et al., 2011). It is utilized to make a vacuum which powers the fluid into the mouth with the goal that it tends to be ingested. It is additionally basic, alongside the tongue, to make certain phonetic sounds. At the point when an individual has a congenital fissure for instance, they are also incapable to articulate these sounds or they do however with an unmistakable nasal vibration which makes their word usage exceptionally vague (Proffit., 2006, Norton et al., 2011, Methathrathip et al., 2005).

The hard plate isolates the oral and nasal depressions, flanking the oral pit superiorly and shaping the top of the mouth, and the nasal cavity poorly, confining its floor. It's hard structure is contained three cranial bones, the maxilla and the joined palatine bones (Proffit., 2006, Norton et al., 2011, Methathrathip et al., 2005).

Anteriorly, the palatine procedure of the maxilla is arranged, covering the district between the different sides of the maxillary dental curve until posteriorly it meets the two level palatine procedures, which are intertwined down the midline, as the two beginning time palatine racks of the maxilla (Proffit., 2006, Norton et al., 2011, Methathrathip et al., 2005).

In the front midline, the sharp foramen can be discovered, which sits just beneath the sharp papilla that is a beefy convexity on the palatal mucosa. This foramen transmits the terminal parts of the nasopalatine nerve and the sphenopalatine supply routes and veins. It is arranged roughly one centimeter behind the average maxillary incisors (Proffit., 2006, Norton et al., 2011, Methathrathip et al., 2005).

Posterolateral, one centimeter average from the second maxillary molar, the more noteworthy furthermore, lesser palatine foramina can be found. The more noteworthy foramina are situated only foremost to the lesser one. They transmit the more noteworthy what's more, lesser palatine nerves and vessels individually (Proffit., 2006, Norton et al., 2011, Methathrathip et al., 2005).

The hard plate melded on either side during early stage advancement, only back to the sharp papilla there is a thick palatine raphe which proceeds posteriorly along the midline as a leftover, with transverse rugae which are parallel transverse edges of the mucosa transmitting outwards. This plica is increasingly clear anteriorly. Somewhere down in the palatal mucosa are several mucous discharging salivary organs (Proffit., 2006, Norton et al., 2011, Methathrathip et al., 2005).

2.3 Advantages of Tooth Extraction in Orthodontics

Even though most dentists will at first attempt against a tooth extraction there are definite cases in which tooth extraction may be taken advantage of non-extraction ones (Hupp et al., 2008).

There are a few patients that normally have relatively small mouths and greater teeth or there are such a large number of them. Sometimes, it attempts to take a solitary tooth out and that route there can be sufficient space for the remainder of the teeth without impaction. Unnatural ejections, for example, uncommonly high canines are additional reasons for tooth extraction (Hupp et al., 2008).

Lehman (1979) said that the second premolar extractions offer some advantages in the treatment of certain types of malocclusion, including reduction of the appliance complexity and treatment duration.

2.4 Contraindication of Extraction in Orthodontics

There are a few risks for undergoing a tooth extraction in orthodontic treatment especially in the cases that are associated with the deep bite or cases that contain distances between the teeth and also in cases where the tooth is used as a space maintainers in children where it is preferred not to remove the tooth to maintain the distance (Hupp et al., 2008).

Also among the factors that prevent tooth extraction, there are psychological factors for patients who request orthodontic treatment without tooth extraction, and here the patient’s request must be taken into account and look for other alternatives in orthodontic treatments (Hupp et al., 2008).

2.5 Acceleration of Tooth Movement during Orthodontic Treatment

There is a lot of development in modern orthodontic treatments, especially in the treatment plan. Although there are modern technologies like modification of wires and brackets as a result of the biomechanical efficiencies in orthodontics has greatly improved. There is a need to develop these techniques and use other methods to influence the movement of the teeth during orthodontic treatment (Nimeri et al., 2013).

Reducing the duration of orthodontic treatment considered a challenge in orthodontic treatment, because the increase in the duration of orthodontic treatment leads to an increase the risks of caries, gingival recession, and root resorption. (Nimeri et al., 2013).

The teeth movement is caused by remodeling of the alveolar bone and periodontal ligament (PDL). And the force applied to the teeth leads to changes in the microenvironment around the PDL due to alterations of blood flow then after that the movement of the teeth occurs (Davidovitch et al., 1991).

Relaxin is a hormone that helps during childbirth by widening of the pubic ligaments in females and is suggested to be present in cranial suture and PDL (Nicozisis et al., 2000). The role of relaxin is known in the remodeling of soft tissue rather than remodeling of bone. It has been shown that it increases collagen in the tension site and decreases it in compression site during orthodontic movement (Bumann et al., 1997).

Effect of Vitamin D3 on tooth movement Vitamin D3 has also attracted the attention of some scientist to its role in the acceleration of tooth movement; 1, 25 dihydroxycholecalciferol is a hormonal form of vitamin D and plays an important role in calcium homeostasis with calcitonin and parathyroid hormone (PTH) (Collins et al., 1988)

Low-level laser therapy is one of the most promising approaches today, It has been found that laser light stimulates the proliferation of osteoclast, osteoblast, and fibroblasts, and thereby affects bone remodeling and accelerates tooth movement (Fujita et al., 2008)

Cyclical force device effect on tooth movement: this device using the cyclical force device with patients and achieved 2 to 3 mm/month of tooth movement. The vibration rate was 20 to 30 Hz and used for 20 min/day (Kau., 2011). Further results needed to be investigated to clearly identify the range of Hertz that can be used in these experiments to get the maximum desired results.

The surgical technique has been documented in many case reports. It is a clinically effective technique used for adult patients, where duration of orthodontic treatment may be critical in selected groups of patients. The PDL and alveolar bone remodeling are the important parameters in tooth movement, and bone turnover is known to increase after bone grafting, fracture, and osteotomy. Several surgical approaches that have been tried in order to accelerate tooth movement were interseptal alveolar surgery, osteotomy, corticotomy, and Piezocision technique (Nimeri et al., 2013).

The advantage of these methods can be used in cases treated by extraction and accelerate orthodontic tooth movement. In another word, hypothetically there need to be questioned if there is an effect on alveolar bone level and palate morphology with the accelerated tooth movement techniques.

2.6 Retention

One of the biggest challenges of orthodontic treatment is to maintain the achieved treatment result (Proffit., 2006).

Retention is the holding of points into an excellent artistic furthermore purposeful location at the end of orthodontic treatment.

Proffit (2006) retention is necessary after orthodontic treatment to avoid backslide of the last occlusal result. Backslide can happen because of powers from the periodontal strands around the teeth which will in general force the teeth back towards their pre-treatment positions, and furthermore from avoiding occlusal contacts if the last impediment is not exactly perfect. Age changes, through continuous dentofacial development, just as changes in the encompassing delicate tissues, can likewise influence the soundness of the orthodontic result. It is along these lines fundamental that orthodontists, patients and their universal dental specialists comprehend the significance of wearing retainers behind orthodontic treatment (Proffit., 2006, Sadowsky et al., 1994, Johnston and Littlewood., 2015).

Therefore, in cases that were treated with tooth extraction, we need a more stability and retention duration of cases than those treated without extraction. The mechanism used in the orthodontic treatment has greatly effecting to the stability and the retention of the end of the orthodontic treatment with or without extraction (Proffit., 2006, Sadowsky et al., 1994, Johnston and Littlewood., 2015).

2.7 Benefits of Using CBCT Scans in Orthodontics

Cone-beam computed tomography (CBCT) frameworks should be intended for imagery solid series of the maxillofacial areas. CBCT is equipped for giving sub-millimeter resolution in pictures of great indicative features, with little examining occasions (10–70 seconds) including emission measurements apparently exhausted to multiple points lesser than the of customary CT filters (Bamgbose et al., 2008).

Expanding accessibility from this innovation gives the dental clinician an imaging methodology fit for giving a 3-dimensional portrayal of the maxillofacial skeleton including insignificant twisting. (Bamgbose et al., 2005).

2.7.1 Advantages of CBCT

CBCT is appropriate for imagery of the craniofacial territory. It gives free pictures of profoundly differentiated constructions also is incredibly valuable for assessing ossein (Sukovic et al., 2003). Despite the fact that constraints as of now are in the utilization of this innovation for delicate tissue imaging, endeavors are being coordinated toward the development of strategies and programming calculations to improve signal-to-commotion proportion and increment differentiate. The utilization of CBCT innovation in the clinical application gives a representation of possible focal points to maxillofacial imagery contrasted and traditional CT: (Sukovic et al., 2003).

2.7.2 Dose Reduction

Distributed reports demonstrate that the effective portion of radiation (normal range 36.9–50.3 microsievert [μSv] is fundamentally decreased by up to98% contrasted and "regular" fan-beam CT systems (average extend for andible 1,320–3,324 μSv; normal range for maxilla 1,031–1,420 μSv). This diminishes the effective patient portion to around that of a film-based periapical overview of the dentition a full mouth (13–100 μSv)18–20 or4–multiple times that of a solitary all-encompassing radiograph (2.9–11 μSv) (Cohnen et al., 2002).

3. MATERIALS AND METHODS

In the present study, 40 patients were treated for the orthodontic treatment of decomposition. The experiment was carried out in two groups Group (A) and Group (B).

The Group (A) 20 of patients was treated with conventional fixed orthodontic appliances and without extraction, and the Group (B) 20 of patients was treated with conventional fixed orthodontic appliances and with extraction of pre molars.

Inclusion criterion was orthodontically treated patients with malocclusion types only Class I, and II cases with spaces, crowding, deep- bite and over- jet were also included in the cohort.

Samples containing extracted teeth, congenital missing tooth, Class III cases, cleft lip and palate, open-bite and cross-bite or episodes syndromes, were excluded.

We analyzed digitally scanned orthodontic dental casts before and after orthodontic treatment for the plate morphology in the sagittal and transversal dimensions, also canine and molar angulations. A total of 80 digital dental casts were examined.

The maxillary casts were retreated from the archive of treated cases, which underwent treatment in the outpatient Clinic of Orthodontics at the Near East University, Dental School in Turkish Republic of Northern Cyprus. From the document pre and post treatment maxillary plaster dental casts were taken and afterward copied as digital analog by using cone beam computed tomography (CBCT). Newtom CCD (3G), (Quantitative Radiology S.R.L., Verona, Italy).

The Invivo Anatomage (Version 5, Anatomage, San Jose, CA, USA) software program has been used to measure changes in the dimensions of sagittal and transversal of palate. For the dental canine and molar angulation changes the Maxillim® version 2.3.0. (Medicim, Sint-Niklass, Belgium) was used.

Ethical approval was obtained from the Near East University Scientific Research Ethics Committee (IRB approval number YDÜ/2018/62-652). The examiner only examined digital dental casts and was blinded to all other patient data in the dental cast examination procedure.

3.1. Sagittal Palatal Form

In order to calculate the changes that occurred in the sagittal palatal form throughout the action of extraction and non-extraction cases anatomical points were identified and adopted in the sagittal measurement such as maxillary tuberosity right and left.

A straight line was generated between maxillary tuberosity right and maxillary tuberosity left, and then we calculated the length of the distance between the tuberosity right and left.

A new point was then identified, in the midpoint between the maxillary tuberosity right and left line. This point was the starting point of measuring the length of the sagittal palatal form towards the entire medial lingual gingival border of incisive papilla; lateral incisor left, and right; canine left, and right; first and second premolar left, and right (i.e. with the cases of tooth extraction the measurement applied for only remaining premolar); first molar left, and right as shown in Figure 1 and 2.

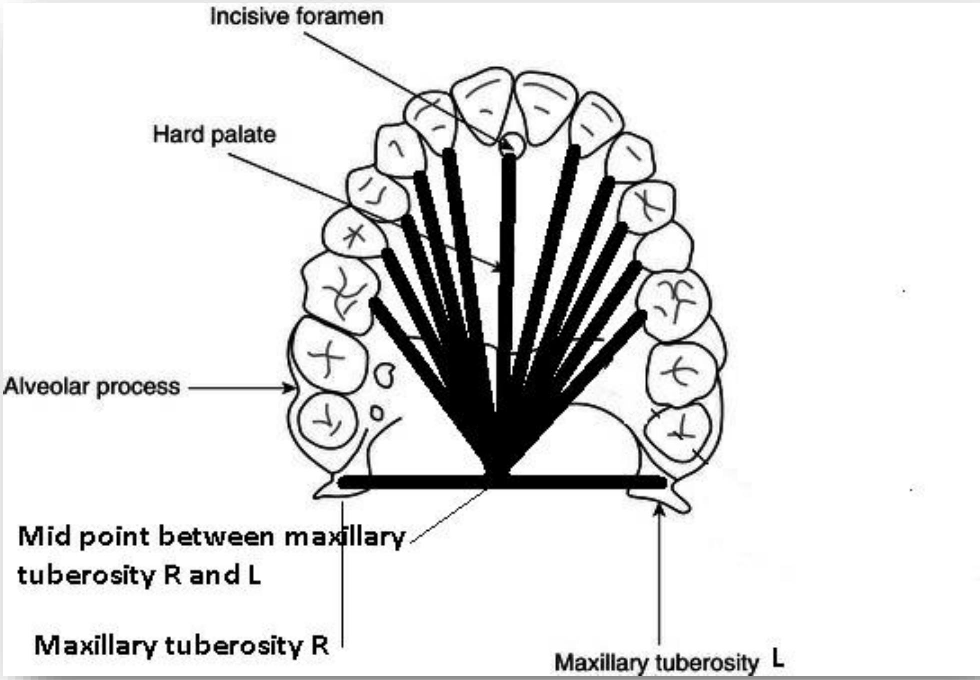

Figure 1. Individual sagittal linear measurements were created from the tuberosity line midpoint to the every single tooth and incisive papilla except central incisors.

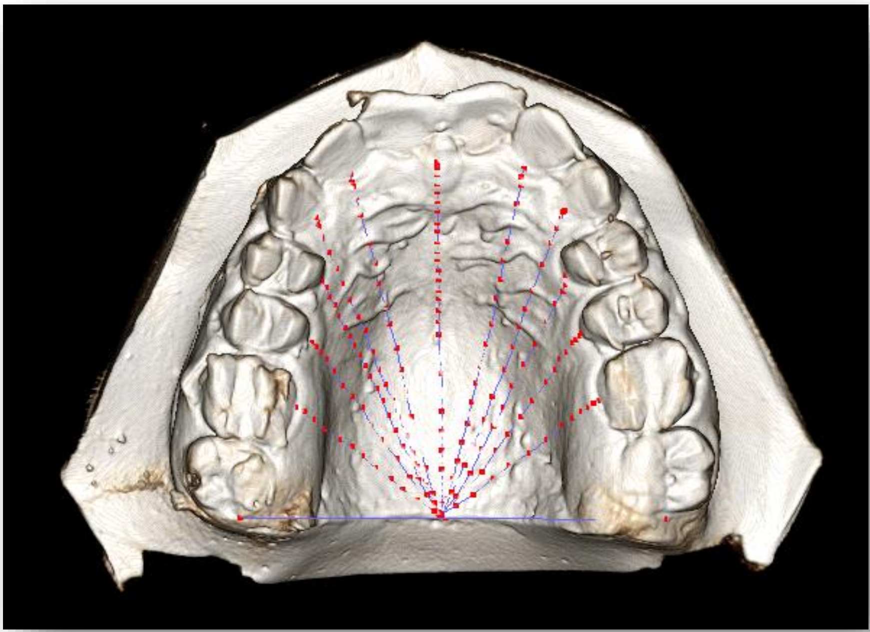

Figure 2. Individual sagittal linear measurements were shown in the Anatomage InVivo software. The red dots in the figure can be put on as much as necessity in order to collect true anatomic distance following palate shape.

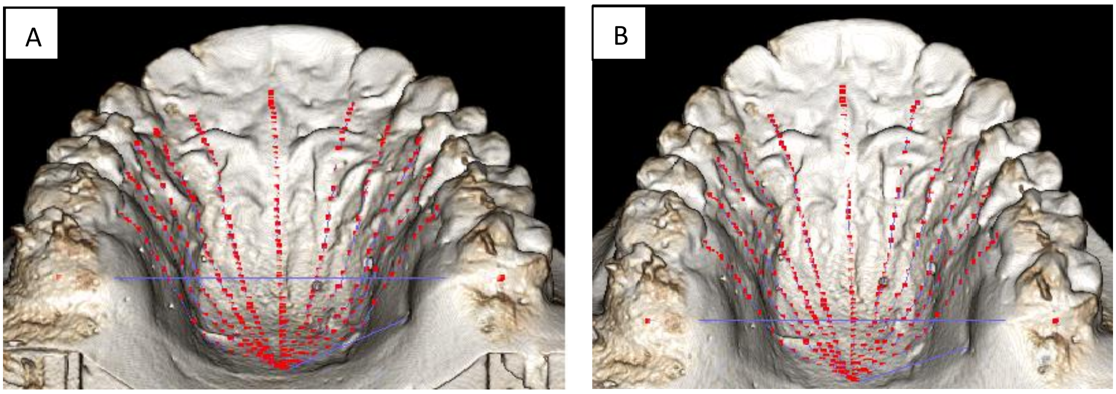

Figure 3.A. Individual sagittal linear measurements were shown in the Anatomage InVivo software. The red dots in the figure can be put on as much as necessity in order to collect true anatomic distance following palate shape. **3.B.** Individual sagittal linear measurements were shown in the Anatomage InVivo software. The red dots in the figure can be put on as much as necessity in order to collect true anatomic distance following palate shape.

3.2 Transversal Palatal Form:

In order to calculate the changes that occurred in to the transversal palatal form during the treatment of extraction and non-extraction cases, four measurements were used as follows:

1. Distance between central grove of maxillary first molar right and left.
2. Distance between tip of the cusp of the second pre molar right and left.
3. Distance between tip of the cusp of the first pre molar right and left.
4. Distance between tip of the cusp of the canine right and left as shown in Figure 4 and 5.

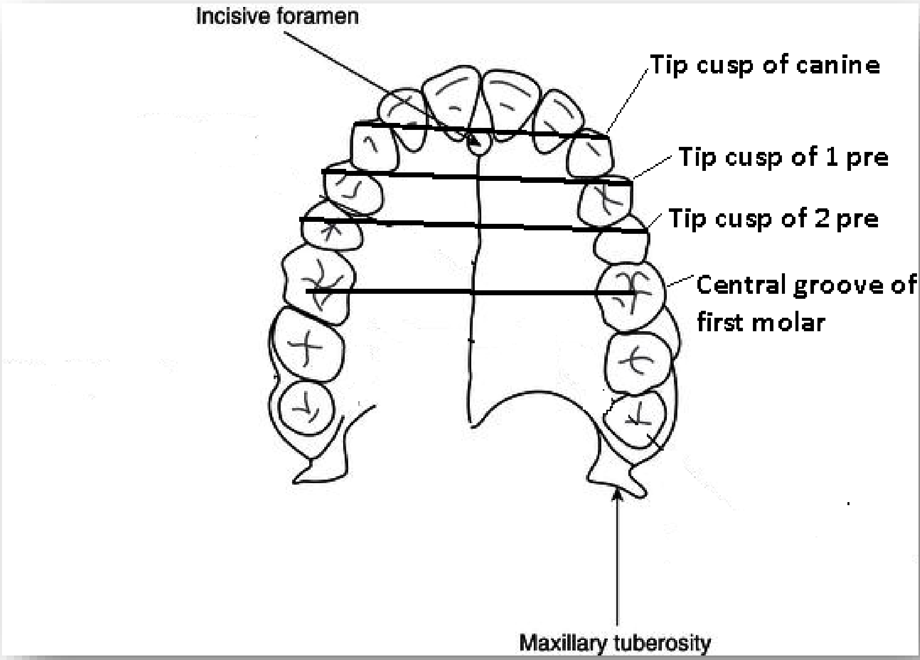

Figure 4. Transversal linear measurements were collected direct lines of first molars, first and second premolars (with the extraction cases post-treatment models only remaining premolar transversal distance was calculated), and canines left and right sides.

Figure 5. Transversal linear measurements in CBCT were shown in the Anatomage InVivo software.

3.4. Measurements of Crown Angulation:

For the crown angulations, we calculated the angulation of maxillary first right and left molars, and maxillary right and left canines in buccolingual and mesiodistal directions.

In order to calculate the crown angulation, two new planes were defined as the sagittal and horizontal.

The sagittal plane was adopted to calculate mesiodistal crown angulation by using the landmarks of incisive papilla point, midpoint of first palatal ruga, and midpoint of second palatal ruga (Figure 6)

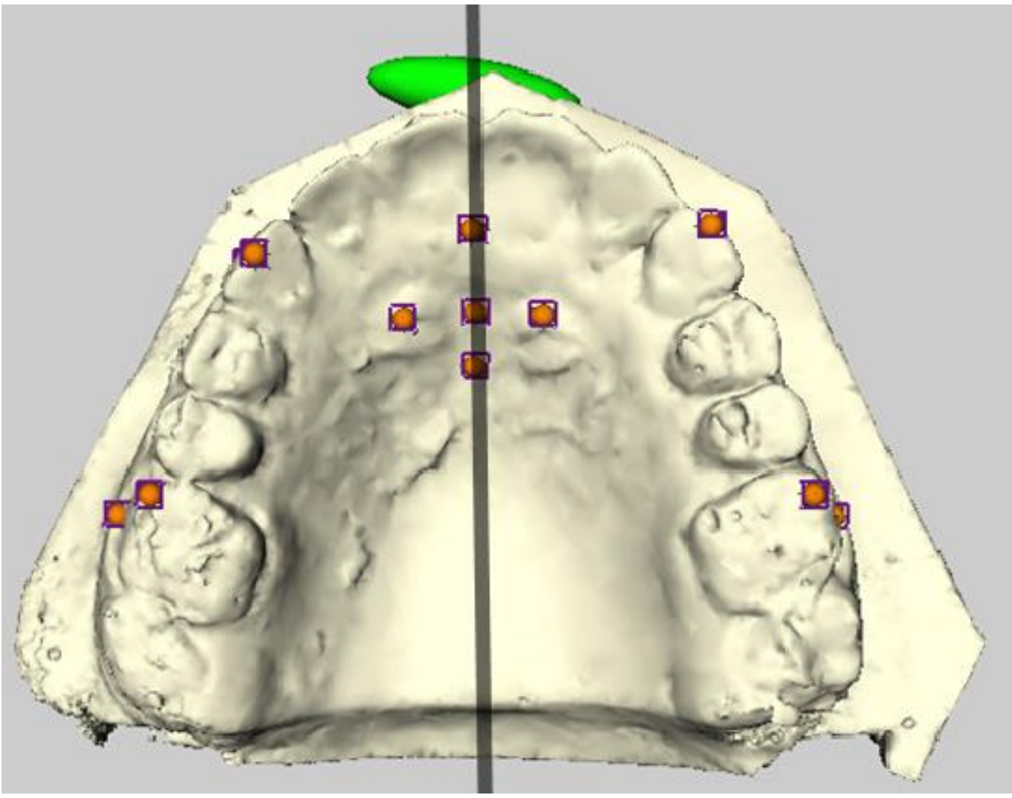

Figure 6. Measurements of crown angulation. The black plane shows the sagittal line.

The horizontal plane was also adopted to calculate buccolingual crown angulation by using of anatomical landmarks of right and left middle point of the first palatal ruga, and midpoint of first palatal ruga (Figure 7). and midpoint of first palatal ruga (Figure 7).

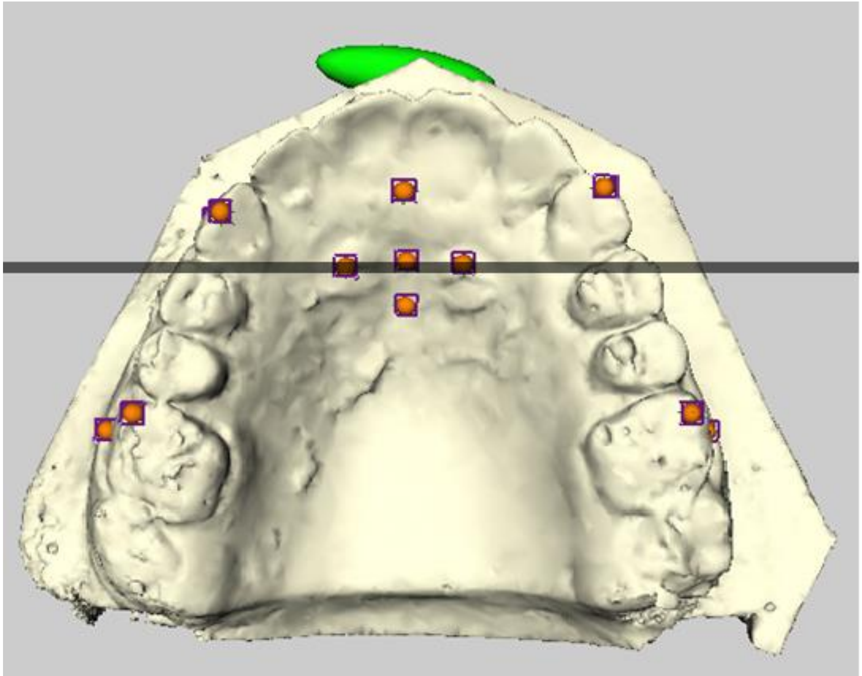

Figure 7. Measurements of crown angulation. The black plane shows the horizontal line.

For the molar angulation, The first axial line formed from mesiobuccal cusp of first molar and to the projection point of central groove on the buccal gingival midpoint of the molar. For the canine angulation similarly another new axial second line was drawn starting from cusp of canine trough buccal gingival midpoint as shown in Figure 8 and 9.

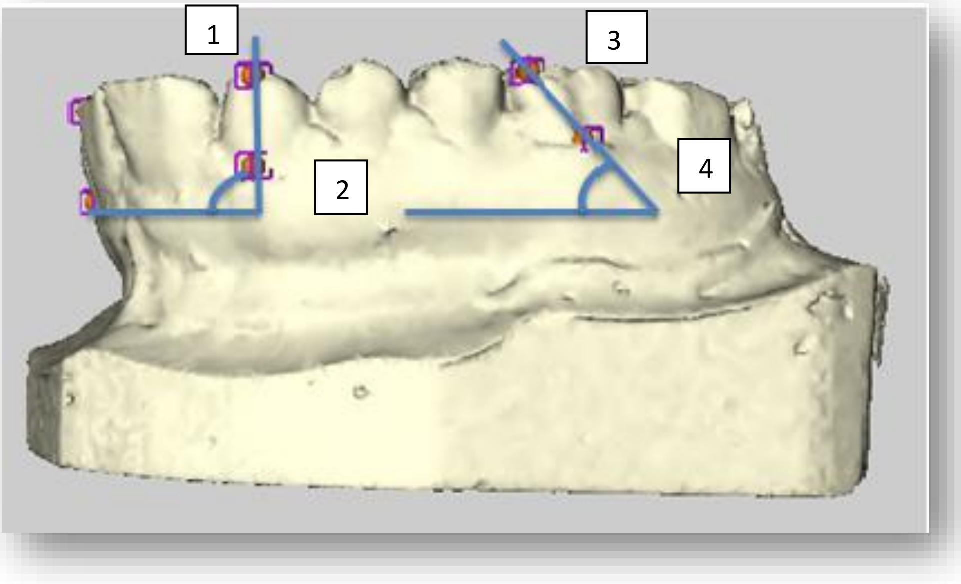

Figure 8. Measurements of crown angulation. The black plane shows the sagittal line and the line represents the molar and the canine axial lines. 1. Canine cusp tip; 2. Canine buccal ginigival midpoint; 3. Molar mesiobucacal cusp; and 4. Molar buccal gingival midpoint

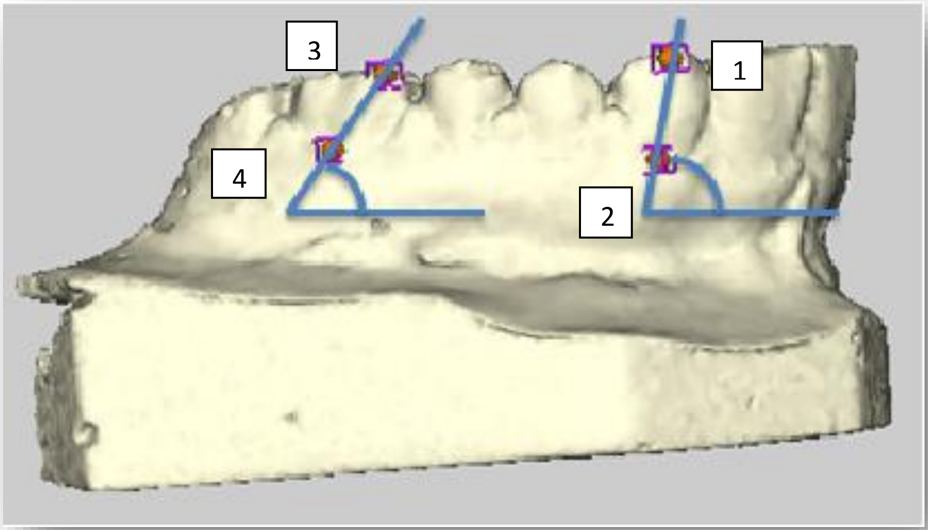

Figure 9. Measurements of crown angulation. The black plane shows the sagittal line and the line represents the molar and the canine axial lines. 1. Canine cusp tip; 2. Canine buccal ginigival midpoint; 3. Molar mesiobucacal cusp; and 4. Molar buccal gingival midpoint.

For the bucculingual angulation, the angle between the molar axial line and the horizontal plane for the molar was used. For the canine buccolingual angulation the angle between the canine axial line and the horizontal plane was used (Figure 10, 11 and 12).

For the mesiodistal angulation, the angle between the molar axial line and the sagittal plane for the molar was used. For the canine mesiodistal angulation the angle between the canine axial line and the sagittal plane was used (Figure 13, 14 and 15).

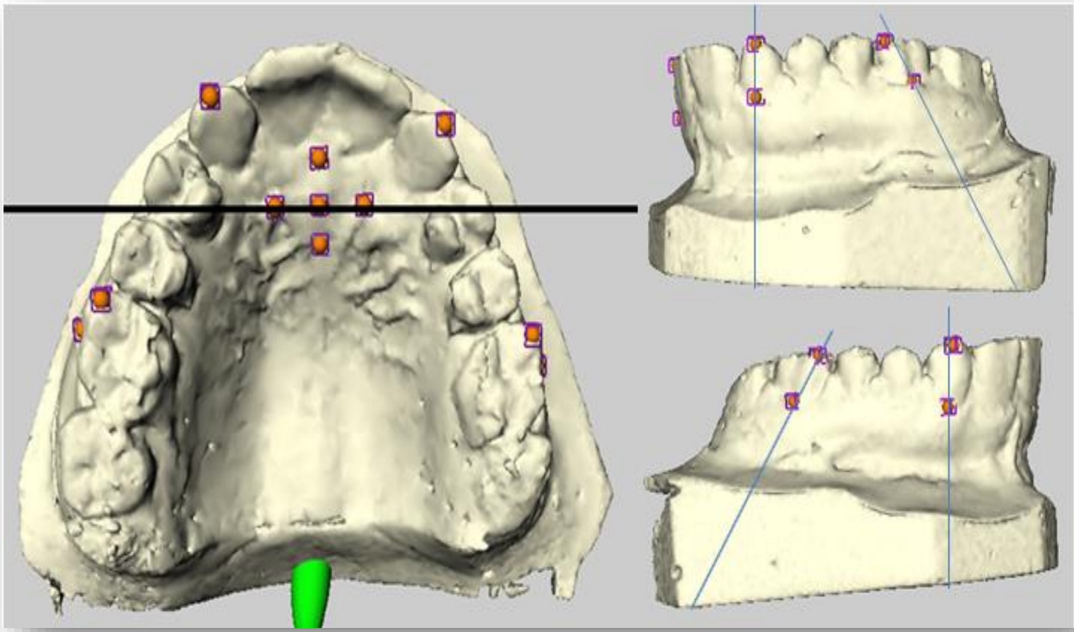

Figure 10. Bucculingual angulation in the angle between the molar axial line and the horizontal plane.

.

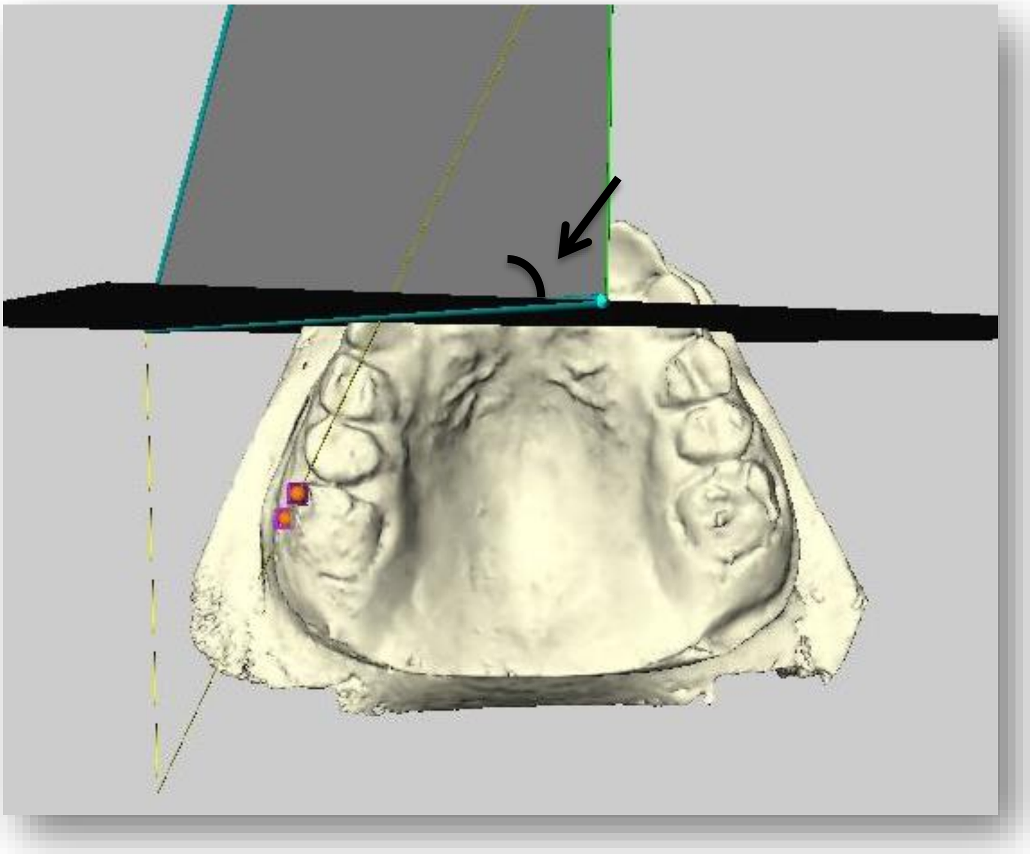

Figure 11. Bucculingual angulation in the angle between the molar axial line and the horizontal plane.

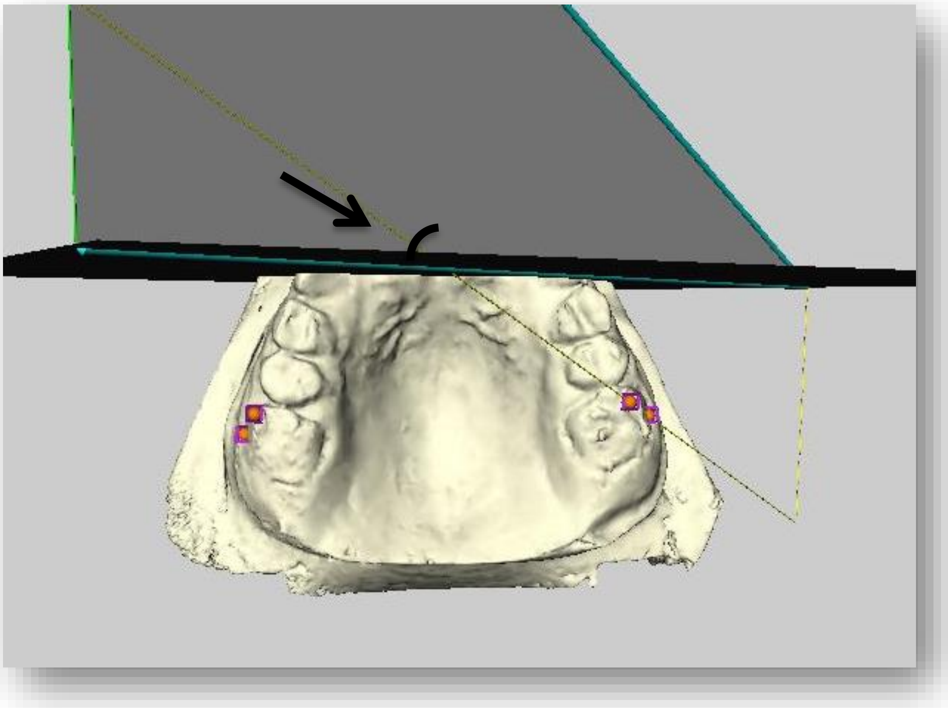

Figure 12. Bucculingual angulation in the angle between the molar axial line and the horizontal plane.

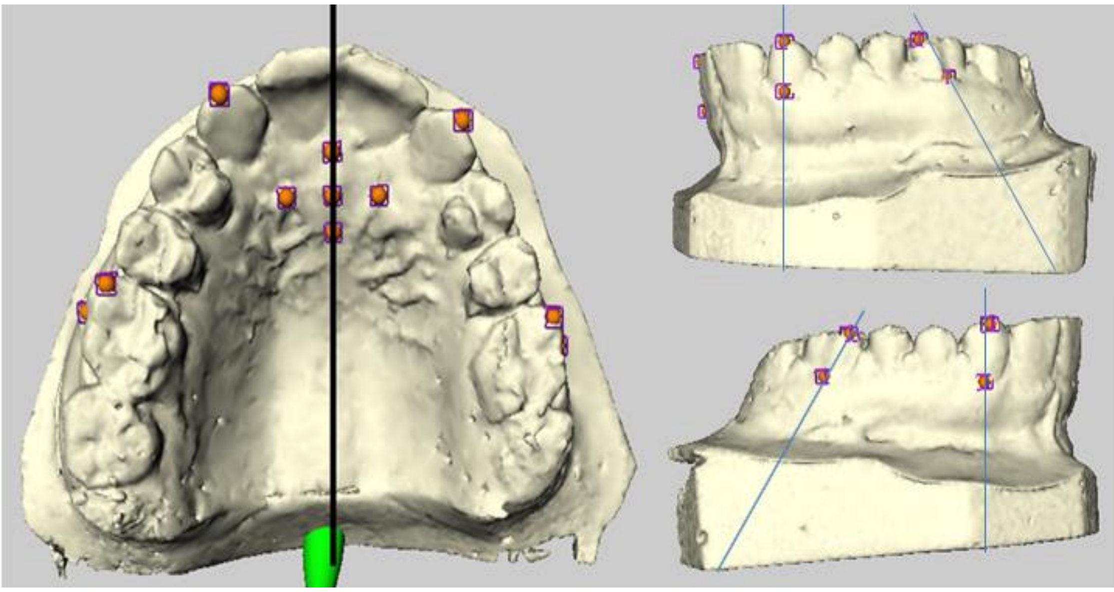

Figure 13. Mesiodistal angulation, the angle between the molar axial line and the sagittal plane.

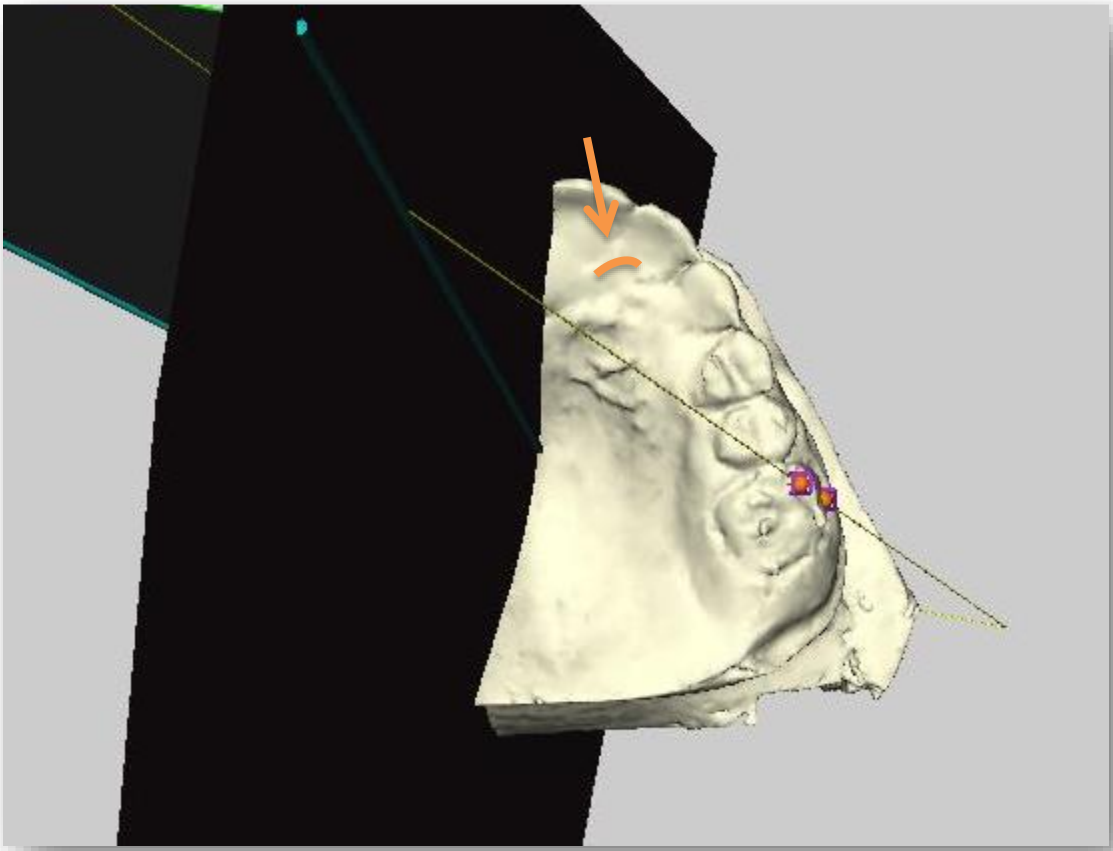

Figure 14. Mesiodistal angulation, the angle between the molar axial line and the sagittal plane.

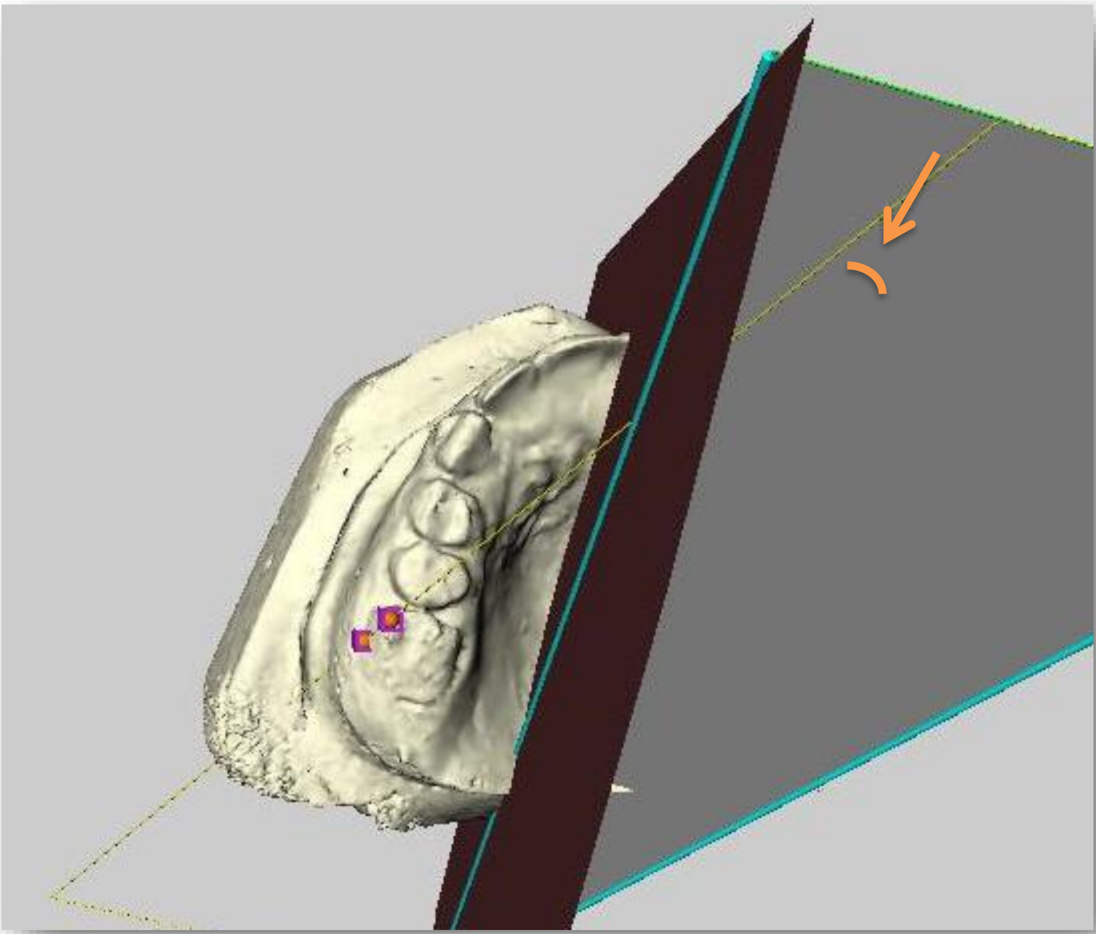

Figure 15. Mesiodistal angulation, the angle between the molar axial line and the sagittal plane.

4. RESULTS

In the current study we analyzed of the 40 digital dental casts before and after orthodontic treatment without extraction and 40 digital dental casts before and after orthodontic treatment with premolar extraction both sides. A total of 8o digital dental casts measurement collected. In order to compare the results IBM SPSS Statistics 22.0 (Demo version) software was used.

4.1 Statistical Analysis

The data obtained from this study were analyzed using IBM SPSS Statistics 22.0 (demo version) software. Since all the variables used in the study were quantitative (continuous) variables, they are presented as mean ± standard deviation (x ± ss). Due to the insufficient number of subjects (fewer than 50 subjects), the quantitative data were evaluated using the Shaphiro-Wilks test. When comparing quantitative data between the groups, t-tests for independent samples were used. When the data did not comply with the regular distribution, the Mann-Whitney U test was used. Finally, when comparing quantitative data within the groups, t-tests for dependent samples were used. The level of error (= α) was taken as 0.05, and P values ($P \leq 0.05$) were considered statistically significant. All P values above this value ($P > 0.05$) were considered statistically insignificant.

Statistics also showed that the accuracy of the results is 95%.

Arithmetic mean, standard deviation standard error and 95% confidence intervals related to the data presented in the table.

4.2 Evaluation of Palatal Form in the Transversal and Sagittal Dimension before and after Extraction in Orthodontic Cases.

With sagittal palatal form results especially in the extraction group we observed statistically significant decrease in the incisive papilla length, left canine length, left pre molar length and left molar length ($p \leq 0.05$). The rest of the measurements showed no statistical significant differences in the sagittal palatal form with extraction group (Table 1).

Table 1. Result of measurements of sagittal palatal form in extraction group.

Variables		Arithmetic mean	N	Std. Deviation	Std. Error	t	p
Pair 1	Sagittal Before B1	46,1240	20	4,44732	,99445	2.983	0.008
	Sagittal After C1	42,8635	20	5,61802	1,25623		*s
Pair 2	Sagittal Before B2	27,6430	20	4,26546	,95379	1.193	0.248
	Sagittal After C2	29,3830	20	4,97099	1,11155		
Pair 3	Sagittal Before B3	32,1425	20	4,67252	1,04481	1.459	0.161
	Sagittal AfterC3	33,5380	20	3,55310	,79450		
Pair 4	Sagittal Before B4	37,3055	20	5,55800	1,24281	1.047	0.308
	Sagittal After C4	38,3655	20	3,58154	,80086		
Pair 5	Sagittal Before B5	42,9885	20	4,23378	,94670	1.240	0.230
	Sagittal After C5	42,0950	20	2,83733	,63445		
Pair 6	Sagittal Before B6	44,2155	20	4,36279	,97555	1.772	0.092
	Sagittal After C6	42,6820	20	4,33460	,96925		
Pair 7	Sagittal Before B7	44,6500	20	4,63671	1,03680	6.145	0.0001*s
	Sagittal After C7	39,2175	20	4,09043	,91465		
Pair 8	Sagittal Before B8	42,9800	20	5,04712	1,12857	12.882	0.0001*s
	Sagittal After C8	33,9480	20	4,25571	,95161		
Pair 9	Sagittal Before B9	37,6475	20	4,97682	1,11285	12.550	0.0001*s
	Sagittal After C9	27,7550	20	4,15773	,92970		

*p<0.05

With transversal palatal form results especially in the extraction group we observed statistically significant decrease in the molar transversal length and canine transversal length ($p \leq 0.05$).The rest of the measurements showed no statistical significant differences in the transversal palatal form with extraction group (Table 2).

Table 2. Result of measurements of transversal palatal form in extraction group.

Variables		Arithmetic mean	N	Std. Deviation	Std. Error	t	p
Pair 1	Transversal Before D1	43,6035	20	3,43808	,76878	3.9	0.001*s
	Transversal After E1	41,7540	20	2,15743	,48242	84	
Pair 2	Transversal Before D2	43,8835	20	4,06951	,90997	1.9	0.073
	Transversal After E2	42,4115	20	2,15855	,48267	01	
Pair 3	Transversal Before D3	39,8445	20	2,79967	,62603	11.	0.0001*s
	Transversal After E3	34,0345	20	1,75615	,39269	993	

*p<0.05

To understand the results, the following symbols should be explained:

B1: Measurement of the distance between incisive papilla and the midpoint of the maxillary tuberosity right and left (Before extraction).

C1: Measurement of the distance between incisive papilla and the midpoint of the maxillary tuberosity right and left (After extraction).

B2: Measurement of the distance between right first molar lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).

C2: Measurement of the distance between right first molar lingual border and midpoint of the maxillary tuberosity right and left (After extraction).

B3: Measurement of the distance between right 2premolar lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).

C3: Measurement of the distance between right 2premolar lingual border and midpoint of the maxillary tuberosity right and left (After extraction).

B4: Measurement of the distance between right canine lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).

C4: Measurement of the distance between right canine lingual border and midpoint of the maxillary tuberosity right and left (After extraction).

B5: Measurement of the distance between right lateral lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).

C5: Measurement of the distance between right lateral lingual border and midpoint of the maxillary tuberosity right and left (After extraction).

B6: Measurement of the distance between left lateral lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).

C6: Measurement of the distance between left lateral lingual border and midpoint of the maxillary tuberosity right and left (After extraction).
B7: Measurement of the distance between left canine lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).
C7: Measurement of the distance between left canine lingual border and midpoint of the maxillary tuberosity right and left (After extraction).
B8: Measurement of the distance between left 2pre molar lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).
C8: Measurement of the distance between left 2pre molar lingual border and midpoint of the maxillary tuberosity right and left (After extraction).
B9: Measurement of the distance between left first molar lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).
C9: Measurement of the distance between left first molar lingual border and midpoint of the maxillary tuberosity right and left (After extraction).
D1: Distance between central grove of maxillary first molar right and left (Before extraction).
E1: Distance between central grove of maxillary first molar right and left (After extraction).
D2: Distance between tip of the cusp of the second pre molar right and left (Before extraction).
E2: Distance between tip of the cusp of the second pre molar right and left (After extraction).
D3: Distance between tip of the cusp of the canine right and left (Before extraction).
E3: Distance between tip of the cusp of the canine right and left (After extraction).

The results that the sagittal palatal form was decrease in extraction group after orthodontic treatment especially is:
Sagittal before B1 and Sagittal after C1" was statistically significant ($p = 0.008$).
The difference between Sagittal before B7 and Sagittal after C7" was statistically significant ($p = 0.0001$).
The difference between Sagittal before B8 and Sagittal after C8" was statistically significant ($p = 0.0001$).

The difference between Sagittal before B9 and Sagittal after C9" was statistically significant ($p = 0.0001$).

The difference between the others is not significant ($p > 0.05$).

Also the transversal palatal form was decrease in extraction group after orthodontic treatment especially in:

Transversal before D1 and Transversal after E1" was statistically significant ($p = 0.001$).

Transversal before D3 and Transversal after E3 E was statistically significant ($p = 0.0001$). The difference between the other is not significant ($p > 0.05$).

4.3 Evaluation of Palatal Form in the Transversal and Sagittal Dimension before and After Non-Extraction in Orthodontic Cases.

With sagittal palatal form results especially in the non- extraction group we observed statistically significant decrease in the left canine length, left pre molar length and left molar length. On the other hand, there was an increase in the right canine length and right lateral length ($p \leq 0.05$). The rest of the measurements showed no statistical significant differences in the sagittal palatal form with non- extraction group (Table 3).

Table 3. Result of measurements of sagittal palatal form in non-extraction group.

Variables		Arithmetic mean	N	Std. Deviation	Std. Error	t	p
Pair 1	Sagittal Before B1	46,1750	20	4,64725	1,03916	1.427	0.170
	Sagittal After C1	44,7620	20	3,09797	,69273		
Pair 2	Sagittal Before B2	28,7645	20	3,77429	,84396	0.444	0.662
	Sagittal After C2	29,0740	20	3,57436	,79925		
Pair 3	Sagittal Before B3	33,7140	20	3,45813	,77326	0.927	0.366
	Sagittal After C3	33,1780	20	2,85972	,63945		
Pair 4	Sagittal Before B4	37,3175	20	3,11115	,69567	6.0.19	0.0001*s
	Sagittal After C4	40,8860	20	2,67953	,59916		
Pair 5	Sagittal Before B5	42,0630	20	3,68609	,82424	3.365	0.003*s
	Sagittal After C5	44,5325	20	2,59003	,57915		
Pair 6	Sagittal Before B6	45,8385	20	3,81817	,85377	1.844	0.081
	Sagittal After C6	44,4160	20	2,74624	,61408		
Pair 7	Sagittal Before B7	44,1520	20	4,49389	1,00486	4.071	0.001*s
	Sagittal After C7	40,7375	20	2,94592	,65873		
Pair 8	Sagittal Before B8	42,1485	20	3,73997	,83628	14.212	0.0001*s
	Sagittal After C8	31,4565	20	2,32869	,52071		
Pair 9	Sagittal Before B9	36,9350	20	4,14434	,92670	10.023	0.0001*s
	Sagittal After C9	27,5685	20	2,32471	,51982		

*p<0.05

With transversal palatal form results especially in the non- extraction group we observed statistically significant decrease in the canine transversal length ($p \leq 0.05$). The rest of the measurements showed no statistical significant differences in the transversal palatal form with extraction group (Table 4).

Table 4. Results of measurements of transversal palatal form in non-extraction group.

Variables		Arithmetic mean	N	Std. Deviation	Std. Error	t	p
Pair 1	Transversal Before D1	45,9070	20	3,04145	,68009	0.023	0.982
	Transversal After E1	45,8960	20	2,98461	,66738		
Pair 2	Transversal Before D2	47,1285	20	3,77363	,84381	1.980	0.062
	Transversal After E2	48,2720	20	2,59284	,57978		
Pair 3	Transversal Before D3	41,9195	20	2,94943	,65951	13.268	0.0001*s
	Transversal After E3	34,6140	20	1,89075	,42278		

*p<0.05

To understand the results, the following symbols should be explained:

B1: Measurement of the distance between incisive papilla and midpoint of the maxillary tuberosity right and left (Before extraction).

C1: Measurement of the distance between incisive papilla and midpoint of the maxillary tuberosity right and left (After extraction).

B2: Measurement of the distance between right first molar lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).

C2: Measurement of the distance between right first molar lingual border and midpoint of the maxillary tuberosity right and left (After extraction).

B3: Measurement of the distance between right 2premolar lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).

C3: Measurement of the distance between right 2premolar lingual border and midpoint of the maxillary tuberosity right and left (After extraction).

B4: Measurement of the distance between right canine lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).

C4: Measurement of the distance between right canine lingual border and midpoint of the maxillary tuberosity right and left (After extraction).

B5: Measurement of the distance between right lateral lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).

C5: Measurement of the distance between right lateral lingual border and midpoint of the maxillary tuberosity right and left (After extraction).

B6: Measurement of the distance between left lateral lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).

C6: Measurement of the distance between left lateral lingual border and midpoint of the maxillary tuberosity right and left (After extraction).

B7: Measurement of the distance between left canine lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).

C7: Measurement of the distance between left canine lingual border and midpoint of the maxillary tuberosity right and left (After extraction).

B8: Measurement of the distance between left 2pre molar lingual border and midpoint of the maxillary tuberosity right and left (Before extraction).

C8: Measurement of the distance between left 2pre molar lingual border and midpoint of the maxillary tuberosity right and left (After extraction).

B9: Measurement of the distance between the left first molar lingual border and midpoint from the maxillary tuberosity right and left (Before extraction).

C9: Measurement of the distance between left first molar lingual border and midpoint of the maxillary tuberosity right and left (After extraction).

D1: Distance between central groves of maxillary first molar right furthermore left (Ere descent).

E1: Distance between central groves of maxillary initial molar right furthermore left (subsequent descent).

D2: Distance between tip of the cusp of the second pre molar right and left (Before extraction).

E2: Distance between tip of the cusp of the second pre molar right and left (After extraction).

D3: Distance between tip of the cusp of the canine right furthermore left (Before extraction).

E3: Distance between tip of the cusp of the canine right furthermore left (After extraction).

As it is evident from the results, sagittal palatal form was increase in non-extraction group after orthodontic treatment especially in (b4c4 – b5c5) and decrease in (b7c7 – b8c8 – b9c9).

Sagittal before B4 and Sagittal after C4 statistical was statistically notable (p = 0.0001).

Sagittal before B5 and Sagittal after C5" was statistically notable (p = 0.003).

Sagittal before B7 and Sagittal after C7" was statistically notable (p = 0.001).

Sagittal before B8 and Sagittal after C8" was statistically notable (p = 0.0001).

Sagittal before B9 and Sagittal after C9" was statistically notable (p = 0.0001).

The distinction among the others is not notable (p> 0.05).

Also the transversal palatal form was decrease in non-extraction group after orthodontic treatment especially in: (d1e1 – d3e3) and increase in (d2e2).

Transversal before D3 and Transversal after E3 was statistically significant (p = 0.0001).

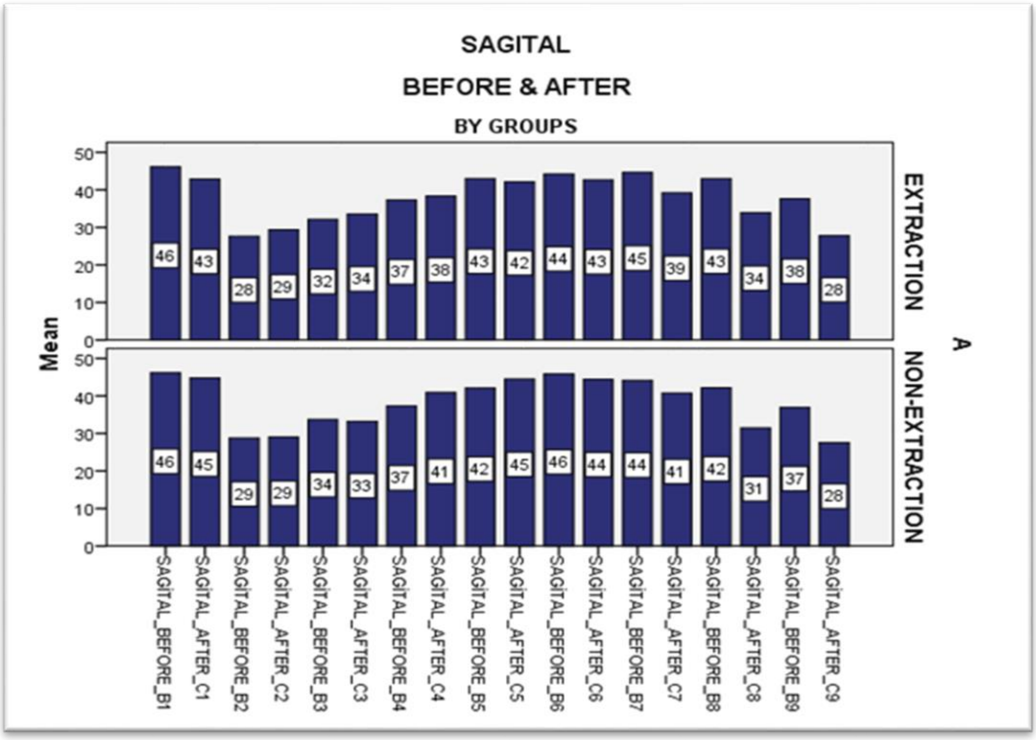

Figure 16. Sagittal palatal form before and after orthodontic treatment in extraction and non-extraction group.

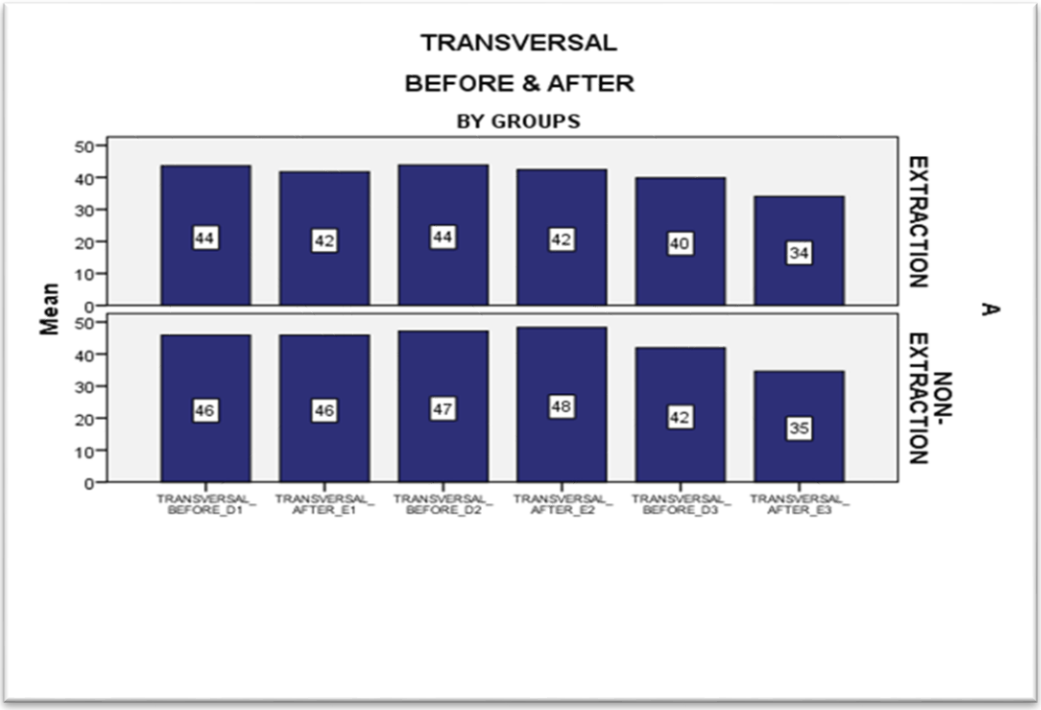

Figure 17. Transversal palatal form before and after orthodontic treatment in extraction and non-extraction group

4.4 Evaluation of Upper First Molars Angulation Before and After Orthodontic Treatment in Extraction and Non-Extraction Cases

With mesiodistal and buccolingual molar angulation results especially in the extraction group we observed statistically significant distal tipping in the right molar ($p \leq 0.05$). The rest of the measurements showed no statistical significant differences in the mesiodistal and buccolingual molar angulation with extraction group (Table 5).

Table 5. Result of measurements of molar angulation in extraction group.

Variables		Arithmetic mean	N	Std. Deviation	Std. Error	t	p
Pair 1	Molar1 F1	26,810	20	8,7070	1,9469	2.5	0.019*s
	Molar2 G1	31,0600	20	6,07319	1,35801	58	
Pair 2	Molar1 F2	31,260	20	7,9864	1,7858	0.7	0.483
	Molar2 G2	29,845	20	7,8778	1,7615	15	
Pair 3	Molar1 F3	36,0750	20	12,76128	2,85351	0.5	0.617
	Molar2 G3	37,2900	20	6,76593	1,51291	09	
Pair 4	Molar1 F4	40,230	20	10,4549	2,3378	1.0	0.323
	Molar2 G4	37,685	20	11,4222	2,5541	15	

*p<0.05

With mesiodistal and buccolingual molar angulation the rest of the measurements showed no statistical significant differences in the mesiodistal and buccolingual molar angulation with non- extraction group (Table 6).

Table 6. Result of measurements of molar angulation in non-extraction group.

Variables		Arithmetic mean	N	Std. Deviation	Std. Error	t	p
Pair 1	Molar1 F1	21,620	20	7,4435	1,6644	1.609	0.124
	Molar2 G1	25,6750	20	10,89055	2,43520		
Pair 2	Molar1 F2	32,210	20	9,3792	2,0973	1.443	0.165
	Molar2 G2	28,700	20	8,1564	1,8238		
Pair 3	Molar1 F3	39,7350	20	9,07439	2,02909	1.640	0.117
	Molar2 G3	35,4900	20	11,51287	2,57436		
Pair 4	Molar1 F4	38,215	20	10,1479	2,2691	0.742	0.467
	Molar2 G4	36,405	20	10,7416	2,4019		

To understand the results, the following symbols should be explained:

F1: Mesiodistal angulation of upper first molar right before extraction.

G1: Mesiodistal angulation of upper first molar right after extraction.

F2: Mesiodistal angulation of upper first molar left before extraction.

G2: Mesiodistal angulation of upper first molar left after extraction.

F3: Buccolingual angulation of upper first molar right before extraction.

G3: Buccolingual angulation of upper first molar right after extraction.

F4: Buccolingual angulation of upper first molar left before extraction.

G4: Buccolingual angulation of upper first molar left after extraction.

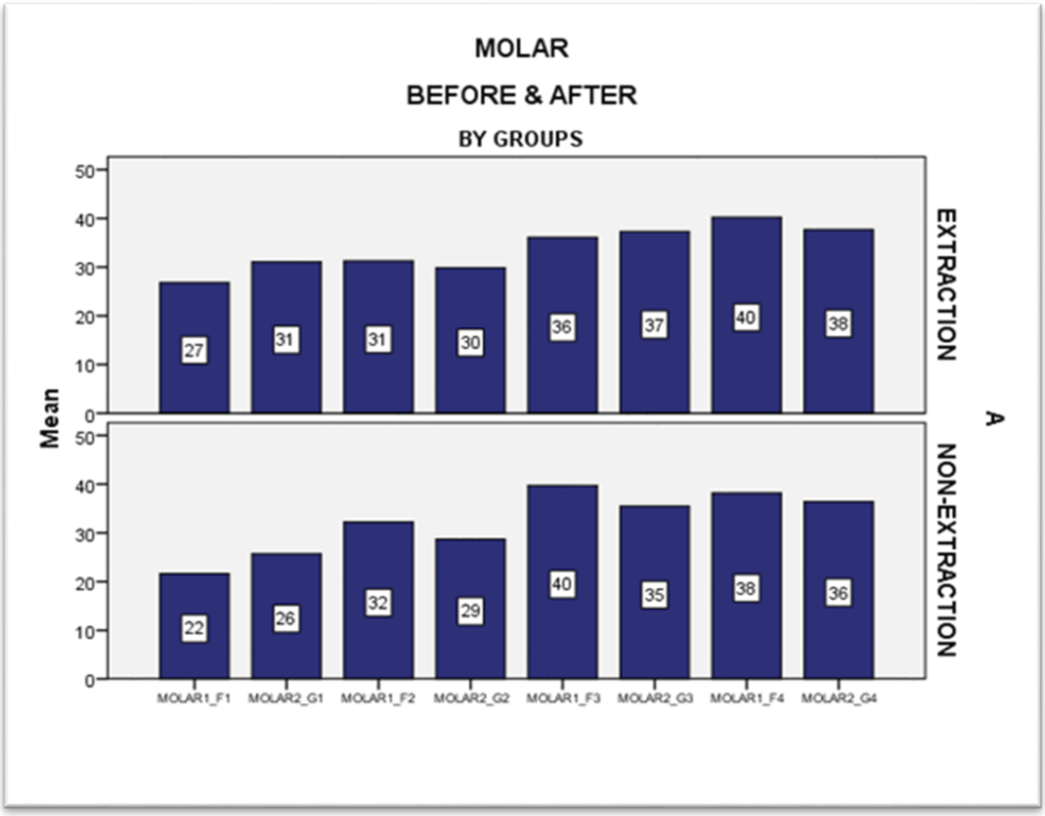

Figure 18. Molar angulation before and after orthodontic treatment in extraction and non-extraction treatment.

4.5 Evaluation of Upper Firs Canine Angulation Before and After Orthodontic Treatment in Extraction and Non-Extraction Cases

With mesiodistal and buccolingual canine angulation results especially in the extraction group we observed statistically significant lingual tipping in the right and left canine ($p \leq 0.05$). The rest of the measurements showed no statistical significant differences in the mesiodistal and buccolingual canine angulation with extraction group (Table 7).

Table 7. Result of measurements of canine angulation in extraction group.

Variables		Arithmetic mean	N	Std. Deviation	Std. Error	t	p
Pair 1	Canine1 H1	12,0500	20	10,80572	2,41623	0.2	0.774
	Canine2 I1	12,9750	20	7,62785	1,70564	92	
Pair 2	Canine1 H2	12,335	20	11,8835	2,6572	0.6	0.533
	Canine2 I2	13,970	20	5,7753	1,2914	34	
Pair 3	Canine1 H3	19,0750	20	15,71623	3,51426	3.9	0.001*s
	Canine2 I3	9,0350	20	7,37301	1,64866	75	
Pair 4	Canine1 H4	17,700	20	14,2779	3,1926	3.0	0.007*s
	Canine2 I4	9,925	20	6,2073	1,3880	45	

*p<0.05

With mesiodistal and buccolingual canine angulation the rest of the measurements showed no statistical significant differences in the mesiodistal and buccolingual canine angulation with non- extraction group (Table 8).

Table 8. Result of measurements of canine angulation in extraction group.

Variables		Arithmetic mean	N	Std. Deviation	Std. Error	t	p
Pair 1	Canine1 H1	14,5800	20	13,08441	2,92576	0.306	0.763
	Canine2 I1	13,7200	20	10,78716	2,41208		
Pair 2	Canine1 H2	16,905	20	14,7454	3,2972	1.136	0.270
	Canine2 I2	12,325	20	10,5705	2,3636		
Pair 3	Canine1 H3	13,5300	20	11,29290	2,52517	0.798	0.435
	Canine2 I3	17,3900	20	18,78148	4,19967		
Pair 4	Canine1 H4	17,360	20	13,2699	2,9672	0.381	0.707
	Canine2 I4	19,020	20	19,1473	4,2815		

To understand the results, the following symbols should be explained:

H1: Mesiodistal angulation of upper first canine right before extraction.

I1: Mesiodistal angulation of upper first canine right after extraction.

H2: Mesiodistal angulation of upper first canine left before extraction.

I2: Mesiodistal angulation of upper first canine left after extraction.

H3: Buccolingual angulation of upper first canine right before extraction.

I3: Buccolingual angulation of upper first canine right after extraction.

H4: Buccolingual angulation of upper first canine left before extraction.

I4: Buccolingual angulation of upper first canine left after extraction.

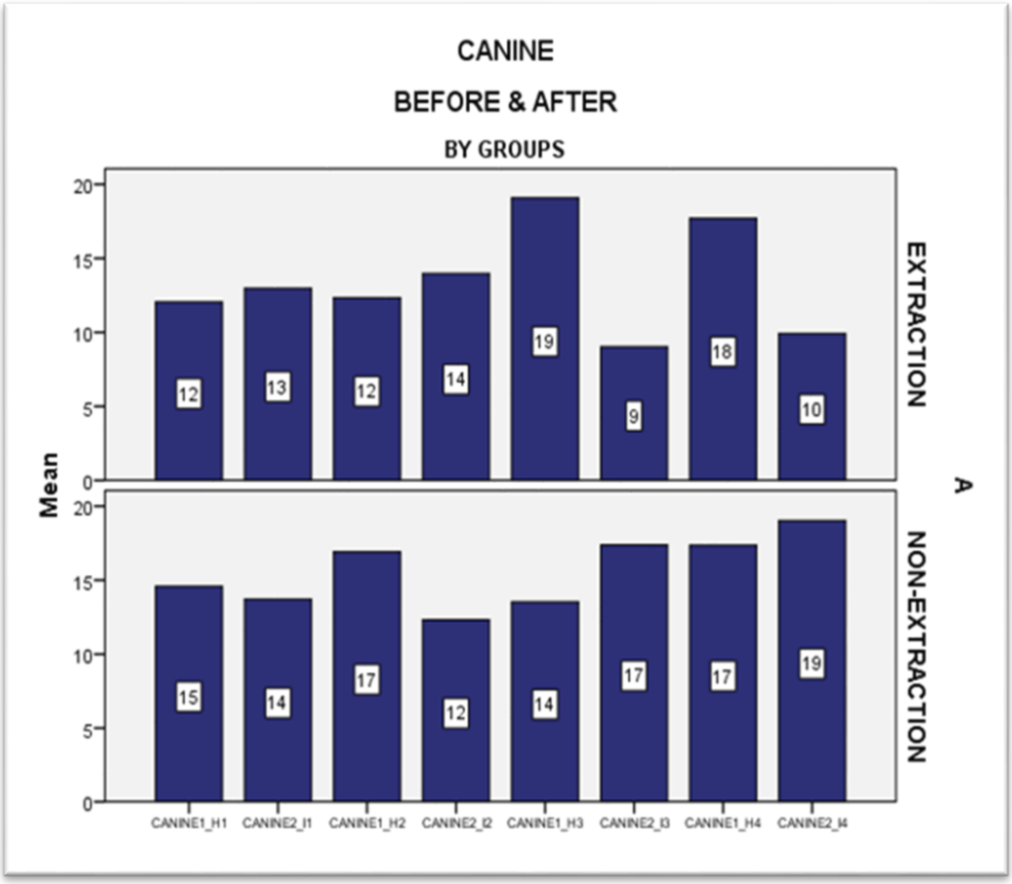

Figure 19. Canine angulation before and after orthodontic treatment in extraction and non-extraction treatment.

5. DISCUSSION

This study aimed to establish a specific mechanism to measure the sagittal axis and transversal of the jaw by using several sagittal and transversal lines in addition to fixed anatomical points to obtain accurate results. This study helped to identify the real changes that took place and to get accurate results.

Sagittal changes of the upper jaw were measured by conducting a unique method, in which 11 longitudinal linear measurements were performed on each dental model. This helped determine the specific location of where the increase or decrease of the sagittal dimensions had occurred. Furthermore, four cross-lines were drawn to determine the location of the increase and decrease and to obtain accurate results of the changes that occurred in the width of the upper jaw.

3D measurement technology, which is considered more accurate than manual measurements, was implemented in order to obtain more accurate results. Random samples were taken from the archives of the Faculty of Dentistry Department of Orthodontics at the Near East University. Orthodontic cases were selected and the ones that had undergone premolar extraction procedures were compared to cases that had not undergone this procedure. The degree of crowding was not taken into consideration either.

However, plaster molds of all patients who had undergone orthodontic treatment in the past 5 years were unavailable the archive due to the irregularities in their 6th month interval follow-up appointments. (RIAN et al., 2018) carried out a study aimed at analyzing the changes in soft tissue profile after Orthodontic treatment by using Electronic databases (CENTRAL–Cochrane Register of Controlled Trials, PubMed, Embase, EBESCOhost, LILACS, and Google Scholar). The result of the study showed that a significant retraction of the lips and an increase in the nasolabial angle are associated with extraction protocols. This result corresponds to the present study, as there was a decrease in the length and width of the jaw in the group treated with teeth extraction. This helps explain the retraction of the lips, the increase in the buccal corridor and the increase in the size of black triangles.

Research into the examination of the changes that occurred in the vertical dimension of the face after comparing cases which involved 4 premolar extractions with cases where the orthodontic treatment did not involve extractions was conducted by Kouvelis et al. (2018). Electronic database searches (MEDLINE, EMBASE, Cochrane Oral Health Group's Trials Register, and CENTRAL) were utilized to carry out the analysis. The results indicated that orthodontic treatment which involved the extraction of 4 premolar teeth had no specific effect on the skeletal vertical dimension. That is, this study indicated that premolar teeth extraction (Ex) and nonextraction (Nonex) had no effect on the vertical dimension of the face. Therefore, the decision to start a treatment by extracting the premolars or not has become easier.

(Morays et al., 2018) conducted a study which assessed the changes in the maxillary buccal alveolar bone during alignment without extractions. The study also evaluated the changes in arch dimensions and buccolingual inclinations of teeth and identified risk factors for bone loss. Twenty-two adolescents with crowded permanent dentitions were treated without extractions with Damon 3MX brackets. Cone beam computed tomographic scans were taken before treatment (T0) and after alignment (T1). Bone thickness (BT) and height from the cementoenamel junction to the alveolar crest (BH) were evaluated at the maxillary central incisors, second premolars, and buccal roots of first molars. The results showed that self-ligating brackets led to arch expansion associated with tipping of teeth. Expansion related to alignment resulted in horizontal and vertical bone loss at the incisors and mesiobuccal root of the first molars and increased the risk for buccal bone loss. These results of this study (Morays et al., 2018) support the results of the present study, which also found that there were no significant changes to the dental inclination (buccolingual inclinations) in cases that were treated without extraction of the teeth. These findings support the outcome of this study which found that the patients who underwent treatment without premolar extraction did not suffer any horizontal or vertical bone loss.

A study which compared the skeletal, dental, and soft-tissue treatment effects of nonextraction therapy using the modified C-palatal plate (MCPP) to those of premolar extraction (PE) treatment in adult patients with Class II malocclusion was carried out by (Youn Jo et al., 2017). The pretreatment and post treatment lateral cephalographs of 40 adult patients with Class II malocclusion were retrospectively analyzed. The result of the study showed that the MCPP was an effective distalization appliance in the maxillary arch. The amount of incisor retraction, however, was significantly higher in the PE group. Therefore, four PE may be recommended when greater improvement of incisor position and soft-tissue profile is required. This result suggests that the decision to extract the teeth could be taken in cases that require greater improvement of incisor position and soft-tissue profile is required. This result suggests that the decision to extract the teeth could be taken in cases that require greater improvement of incisor position and in cases where soft-tissue profile is required as major changes occur at two levels of soft tissue and incisor position.

The results of treatments carried out with the extraction method yielded that there were significant changes in the level of the lips and retraction of the incisors. This explains the reason for the decrease in the length and width of the maxilla in extraction grope, and also proves that the results of this study are accurate and logical.

(Vaden et al., 2018) carried out research on three clinical cases. It aimed at determining whether treatments which involved tooth extraction yielded better results than those which did not. This clinical case study conceded that each patient's individual needs were the factors that determined the course of treatment that the dentist should agree upon and concluded that the clinician must decide what approach is in the best interest of each patient. That is, the decision should be made after the clinician considers the face, skeletal pattern, and dentition of each patient in order to determine the available space required to reposition the teeth.

240 patients in which some of whom had extractions and others did not were subjects of the study conducted by (Oz et al., 2015). The study compared the arch width changes in patients who were treated with fixed orthodontic mechanics. Anterior, middle, and posterior distances were measured on pre‑ and post‑treatment molds. The results of this (Oz et al., 2015) study were completely inconsistent with the results of the present study (Taljabini et al., 2019). The aforementioned study yielded that the anterior, middle and posterior arch widths increased significantly; however the findings of this study indicated that there was a decrease in the widths of the upper jaw. Literature supports the findings of this study; therefore, more research on this

subject is required in order to provide explanation for the inconsistency between the results of these two studies.

A simple random sampling technique from the data of 1500 orthodontic patients helped select 202 pre-treatment records of patients with Class I malocclusion. The research aim was to identify variables that could play a role in the treatment decision (Batool et al., 2017).The results showed that the variables of lower anterior facial height, E-plane to upper lip, and maxillary and mandibular incisor inclinations were significantly increased in the extraction group (P \0.05), whereas spacing in the mandibular arch and increased overbite were statistically significant in the non-extraction treatment group. These findings prove that the decision to extract teeth before beginning the treatment or to carry out the treatment without extractions considerably affect the outcomes.   Hence, the planning stage for any orthodontic patient requires skill and expertise with considerable practice variations. It is essential for a clinician to thoroughly evaluate each patient's dental, facial, and skeletal features to establish an effective treatment plan for the type of malocclusion. Vertical facial pattern, overbite, mandibular tooth size-arch length discrepancy, lip position, and maxillary and mandibular incisor inclinations are a few of the important variables that should not be overlooked when planning orthodontic treatment.

The most common extraction pattern is the extraction of four premolars, two on the upper arch and two on the lower arch. However, different extraction patterns can be followed depending on the type of malocclusion and all are successful if used in appropriate patients (Chang et al., 2011).

Occlusion, stability and esthetics are the three goals for a successful treatment plan, However, there is no a single definition of the decision for orthodontic treatment plan. A simple way to decide how to reach these three goals: The extraction decision is multi-factorial (Boley; et al., 2003). Therefore, one of the aims of this study was to find out the effects of orthodontic treatment that is carried out with extraction and to discover whether it is possible to determine these three goals.

This study investigated the changes in the sagittal palatal form and the transversal that occurred on patients whose treatments were carried out with a fixed edgewise orthodontic appliance. Accurate measurements were carried out to determine whether there were any significant discrepancies between the patients whose premolars were extracted and those whose were not. After reviewing the results, it was established that there were several changes in the upper jaw during the orthodontic treatment in both cases. This result points to the overall positive or negative changes orthodontic treatment has on teeth and jaws.

The results of Group B, which had received an orthodontic treatment with tooth extraction, yielded that there was a decrease in sagittal palatal form and transversal. The changes of palatal form such as the retrusion of the teeth toward the front and the lessening of the spacing in the teeth resulted it the decrease in the length and the width of the jaw. All of these affect the tongue's position in the mouth as the tongue will try regaining lost space when the incisors are retruded and this may lead to changes in the palatal dimension and form (Heiser; et al., 2004).

Therefore, the variations of the palate in Group B were probably due to the modification in the position of the tongue caused by anterior root withdrawal since theoretically the maxillary incisors retract and cause the anterior tongue functioning space to decrease thus creating more pressure on the sagittal palatal by the tongue.

This also explains why patients who undergo treatment with premolar extraction display similar decrease in arch diameter compared to those who are not subjected to extractions (Heiser; et al., 2004).

The study showed that both transversal and the sagittal palatal frame also decreased in Group A, which was comprised of the patients who underwent orthodontic treatment without extraction. This decrease has been attributed to the treatment which led to the correct articulation of the teeth, the decrease of space between the teeth and the natural positioning of their teeth.

The results from the measurements taken from Group B showed that the extraction of the premolars induced the angulation of upper molars to lean toward the mesial of the left molar in order to close the space that the extraction created. Moreover, the extraction of the premolars resulted in distal tipping of the right and left canines toward the space caused by the extraction.

The changing of angulation of left molars in buccolingual direction was decreased indicating lingual tipping and this explains the decrease in transversal palatal form. It was observed that the change of angulation of the left and right canines in the buccolingual direction decreased significantly in the group that had extractions. This is an indication of lingual tipping in the upper dental arch which explains the decrease in transversal palatal form.

The fundamental dilemma on whether to extract the premolars before commencing treatment or not still remains. Some clinicians are more inclined to extract teeth than to expand the arches; others would rather conserve the teeth if possible and try to expand the arches to relieve the crowding. In borderline cases, both treatments offer good stability and results (Guez; et al., 2015). The academically accepted practice of carrying out the treatment with extraction was adopted in this study, as it is considered faster than the process of enlarging the upper jaw and. Furthermore, fewer cases of relapses after treatments carried out with extractions have been documented.

A reliable criterion for extracting teeth remains elusive. Many researchers have tempted to find a way to help the decision of the clinician, like Takada, who created a mathematical model to guide the treatment plan decision and optimize orthodontic treatment outcome (Takada; et al., 2009).

His model used 25 morphologic characteristics with four significant classes (sagittal dento skeletal and delicate tissue relationship, vertical dentoskeletal relationship, transverse dental relationship and intra-curve conditions). The model’s success rate was 90.4 %; however, despite this success, Takada acknowledged the importance of the orthodontist’s elaborate process in reaching the final decision on how to proceed. The model would be tested on different ethnical groups, at different times and with different groups of orthodontists to be improved in the future (Janson; et al, 2014).

Based on previous studies (Takada et al., 2009, Taljabini et al., 2019) the inclination of the tooth extraction with the general orthodontic treatment had a broader approach to apply contemporary orthodontic treatment. However, in the present study we aimed to reveal which method was more widely implemented. Therefore, the currents results proved not to be in line with the findings of (Takada et al., 2009) and (Taljabini et al., 2019). On the other hand, there were some similarities with the results of a study carried out by (Taljabini et al. 2019). The inclination of the molars showed that there is always a mesiobuccal crown inclination with extraction cases. In addition, the present study found that the premolars had the same rotational inclinations as was observed in the molars.

The results of the present study and the results obtained from a study conducted by (Heiser et al., 2004) showed great similarities. In that study, the changes were measured in the sagittal palatal form; a line was traced in pencil, starting at the incisal contact point of the maxillary central incisors to the gingival border, then to the incisive papilla, and from there to the end of raphe. Transversal palatal form was measured by lines marking section borders.

The changes that occurred; such as the reduction in the length and width of the palate in patients that had been treated with extraction and the increase in the length and width of the palate in patients who did not undergo extraction, corresponded with each other in both studies.

(Heiser et al., 2004) concluded that the decrease that occurred in the group that received orthodontic treatment with extraction of pre molars was based on an increase in the depth of the palate and that the increase in the length and width of the upper jaw in the group that received orthodontic treatment without tooth extraction was accompanied by a decrease in the depth of the palate.

This study concluded that there was no change in the size of the upper jaw in both groups that received orthodontic treatment, whether it was associated with tooth extraction or without tooth extraction, because this increase or decrease moved to compensate elsewhere, which is the depth of the palate.(Heiser et al., 2004)

This study also found that in the group that underwent orthodontic treatment attached to premolars extraction, both canine and first molar were the direction of inclination moved towards the extraction area and this logically occurs in normal cases that the teeth always move toward voids (Janson et al., 2017).

(Masunaga et al., 2012) measured the changes of the width in the upper jaw of patients who had orthodontic treatment without extraction using the same measurement. After comparing the results, it was seen that there were inconsistencies and differences in the results. An increase in the width of the upper jaw of patients who underwent orthodontic treatment without tooth extraction was registered while the results of the present study showed a decrease in the width of the upper jaw. This discrepancy in the results of the two studies may be due to the presence of some molds which were taken of patients who initially had spacing between their teeth.

The results of crown angulation measured by the long axis of clinical crown and the occlusal plane of the study carried out by (Masunaga et al., 2012) was compared with the results of this study. The comparison showed that changes in the angulation of the teeth (distal tipping) of patients who had been treated without extraction were recorded in the study carried out by (Masunaga et al., 2012) whereas no significant changes in the angulation of the teeth were recorded in this study. This discrepancy can be explained by the difference in the methods of measuring of crown angulation between the two studies.

5.1 Limitation

This study is retrospective study. Retrospective studies can have certain limitations. Digital impressions were not taken directly from the patients. The alginate impressions were taken. However, it must be acknowledged that some changes in dimensions can occur during the process of taking the alginate impression due to the quality of the impressions.

In the next stage, three-dimensional digital scans of the impressions were taken by a CBCT device but since some of the molds did not have clear anatomical features it was difficult to identify some points. Thus a common decision was made to omit these samples from the cohort and this may have had an effect on the results.

The molds were measured only one time as the statistical results showed that the measurements were 95% accurate.The samples were randomly chosen, the age of the patient or the gender was not taken into consideration.

6. CONCLUSION

This study investigated the transverse and sagittal changes in the palatal form and angular changes in the molars and canines in patients treated with and without premolar extractions. The results were as follows:

- In the extraction group, the sagittal and transverse palatal form is decreased.
- In the non-extraction group, the sagittal palatal form decrease in the left canine length, left pre molar length and left molar length. And increased in the right canine length and right lateral length.
- In the extraction group with mesiodistal and buccolingual molar angulation results especially in the extraction group we observed statistically significant distal tipping in the right molar.
- In the extraction group with mesiodistal and buccolingual canine angulation results especially in the extraction group we observed statistically significant lingual tipping in the right and left canine.
- In the non-extraction group, with mesiodistal and buccolingual molar and canine angulation, the rest of the measurements showed no statistical significant differences in the mesiodistal and buccolingual molar and canine angulation with non- extraction group.

7. REFERENCES

Al Taki A, Guidoum A. Facial profile preferences, self-awareness and perception among groups of people in the United Arab Emirates. Journal of orthodontic science, 2014; 3, 55.

Ali B, Shaikh A, Fida M. Factors affecting treatment decisions for Class I malocclusions. American journal of orthodontics and dentofacial orthopedics, 2018; 154, 234-237.

Almurtadha RH, Alhammadi MS, Fayed MM, Abou-El-Ezz A, Halboub E. Changes in soft tissue profile after orthodontic treatment with and without extraction: A systematic review and meta-analysis. Journal of Evidence Based Dental Practice, 2018; 18, 193-202.

Anthopoulou C, Constantonis D, Makou M. Treatment outcomes after extraction and non-extraction treatment evaluated with the American Board of Orthodontics objective grading system. Am J Orthod Dentofacial Orthop. 2014; 146:717-723.

Antonio Nanci. Oral histology: development, structure, and function (7th ed.). St. Louis, Mo.: Mosby. 2007; ISBN 9780323045575.

Bamgbose BO, Adeyemo WL, Ladeinde AL, Ogunlewe MO. Conebeam computed tomography (CBCT): the new vista in oral and maxillofacial imaging. Nigerian quarterly journal of hospital medicine, 2008; 18, 32-35.

Baba R, Konno Y, Ueda K, Ikeda S. Comparison of flat-panel detector and image-intensifier detector for cone-beam CT. Comput Med Imaging Graph, 2002; 26:153–8.

Baba R, Ueda K, Okabe M. Using a flat-panel detector in high resolution cone beam CT for dental imaging. DentomaxillofacRadiol, 2004; 33:285–90.

Bailey E, Worthington HV, van Wijk A, Yates J M, Coulthard P, Afzal Z. Ibuprofen and/or paracetamol (acetaminophen) for pain relief after surgical removal of lower wisdom teeth. Cochrane Database of Systematic Reviews, (2013).

Bernstein L, Edward H. Angle versus Calvin S. Case: extraction versus non-extraction. Historical revisionism. Part II. Am JOrthod Dentofacial Orthop. 1992; 102:546-61.

Boley J, Jeffrey M, Sachdeva R, Buschang P. Long-term stability of Class I premolar extraction treatment. Am J Orthod Dentofacial Orthop. 2003; 124:277-87.

Bumann A, Carvalho RS, Schwarzer CL, Yen EH. Collagen synthesis from human PDL cells following orthodontic tooth movement. Eur J Orthod. 1997; 19:29–37.

Gualtieri CT. Brain injury and mental retardation: psychopharmacology and neuropsychiatry. Lippincott Williams & Wilkins, (2002).

Chang, Chan A, Henry W, Fields JR. Frank Michael Beck, Nathan C. Springer, Allen R. Firestone, Stephen Rosenstiel, and James C. Christensen. "Smile esthetics from patients’ perspectives for faces of varying attractiveness." American Journal of Orthodontics and Dentofacial Orthopedics 140, no. 4 (2011): e171-e180.

Christopherson, Elizabeth A, Dan Briskie, and Marita Rohr Inglehart. "Objective, Subjective, and Self-Assessment of Preadolescent Orthodontic Treatment Need–A Function of Age, Gender, and Ethnic/Racial Background?." Journal of public health dentistry 69, no. 1 (2009): 9-17.

Case CS. The question of extraction in orthodontia. American journal of orthodontics, 1964; 50, 660-691.

Cohnen M, Kemper J, Mobes O, Pawelzik J, Modder U. Radiation dose in dental radiology. EurRadiol, 2002; 12:634–7.

Connor BMP. Contemporary trends in orthodontic practice: A national survey. Am J Orthod Dentofacial Orthop. 1993; 103:163-170.

Collins MK, Sinclair PM. The local use of vitamin D to increase the rate of orthodontic tooth movement. Am J Orthod Dentofacial Orthop. 1988; 94:278–84.

Dewel BF. Second premolar extraction in orthodontics. Principles procedures and case analysis. Am J Orthod.1955; 41:107-20.

Davidovitch Z. Tooth movement. Crit Rev Oral Biol Med. 1991; 2:411–50.

Tavarez, Rudys Rodolfo De Jesus, Washigton Luís Machado Dos Reis, Adrycila Teixeira Rocha, Leily Macedo Firoozmand, Matheus Coêlho Bandéca, Mateus Rodrigues Tonetto, and Adriana Santos Malheiros. "Atraumatic extraction and immediate implant installation: The importance of maintaining the contour gingival tissues." Journal of international oral health: JIOH 5, no. 6 (2013): 113.

Fujita S, Yamaguchi M, Utsunomiya T, Yamamoto H, Kasai K. Low-energy laser stimulates tooth movement velocity via expression of RANK and RANKL. Orthod Craniofac Res. 2008; 11:143–55.

Fujiwara-kyo study. J Alzheimers Dis. 2014; 44:777-86

Gardner SD, Chaconas SJ. Post treatment and post retention hanges following orthodontic therapy. Angle Orthod, 1976; 46:151-161.

Gianelly AA, Cozzani M, Boffa J. Condylar position and maxillary first premolar extraction. Am J Orthod Dentofacial Orthop. 1991; 99:473–476.

Gianelly AA, Hughes HM, Wohlgemuth P, Gildea G. Condylar position and extraction treatment. Am J Orthod Dentofacial Orthop, 1988; 93:201–205.

Gibbs SJ. Effective dose equivalent and effective dose: comparison for common projections in oral and maxillofacial radiology. Oral Surg Oral MedOralPathol Oral RadiolEndod, 2000; 90:538–45.

Glenn G, Sinclair PM, Alexander RG. Non-extraction orthodontic therapy: post treatment dental and skeletal stability. Am J Orthod Dentofacial Orthop.1987; 92:321-8.

Graber TM, Vanarsdall RL, Vig KL, editors. Orthodontics: current principles and techniques. St Louis: Mosby; 2005; 90:538–45.

Grieve GW. Analysis of malocclusion based upon the forward translation theory. Am J Orthod Oral Surg, 1941; 27:323-8.

Grieve GW. Anatomical and clinical problems involved where extraction is indicated in orthodontic treatment. Am J OrthodOral Surg, 1944; 30:437-43.

Hasija N, Bala M, Goyal V. Estimation of Tooth Size Discrepancies among Different Malocclusion Groups. Int J ClinPediatr Dent. 2014; 7:82-85.

Heiser W, Niederwanger A, Bancher B, Bittermann G, Neunteufel N, Kulmer S. Three-dimensional dental arch and palatal form changes after extraction and nonextraction treatment. Part 3. Transversal and sagittal palatal form. American journal of orthodontics and dentofacial orthopedics, 2004; 126, 91-99.

Hollins C. Levison's textbook for dental nurses. John Wiley & Sons. (2019).

Hu, Hui, H. David He, W. Dennis Foley, and Stanley H. Fox. "Four multidetector-row helical CT: image quality and volume coverage speed." Radiology 215, no. 1 (2000): 55-62.

Hupp, James R. Contemporary Oral and Maxillofacial Surgery: Pageburst Retail. Elsevier Mosby, 2008.

Ioi H, Nakata S, Nakasima A, Counts AL. Anteroposterior lip positions of the most-favored Japanese facial profiles. American journal of orthodontics and dentofacial orthopedics, 2005; 128, 206-211.

Isaacson, John R., ROBERT J, ISAACSON T, MICHAEL SPEIDEL, FRANK W. WORMS. "Extreme variation in vertical facial growth and associated variation in skeletal and dental relations." The Angle Orthodontist 41, no. 3 (1971): 219-229.

Janson G, Araki J, Estelita S, Camardella L. Stability of class II subdivision malocclusion treatment with 3 or 4 premolars extractions. Progress in Orthodontics. 2014; 15:67.

Janson G, Maria FRT, Bombonatti R. Frequency evaluation of different extraction protocols in orthodontic treatment during 35 years. Progress in Orthodontics. 2014; 15:51.

Janson G, Valarelli FP, Beltrao RTS, Freitas MR, Henriques JFC. Stability of anterior open-bite extraction and nonextraction treatment in the permanent dentition. Am J Orthod Dentofacial Orthop. 2006; 129:768-774.

Jo Sung Youn, Mohamed Bayome, Justyn Park, Hee Jin Lim, Yoon-Ah Kook, Seong Ho Han. "Comparison of treatment effects between four premolar extraction and total arch distalization using the modified C-palatal plate." The korean journal of orthodontics 48, no. 4 (2018): 224-235.

Johnson KC. Cases six years post retention. Angle Orthod, 1977; 47:210-21.

Johnston CD, S. J. Littlewood. "Retention in orthodontics." British dental journal 218, no. 3 (2015): 119.

Kau CH. A radiographic analysis of tooth morphology following the use of a novel cyclical force device in orthodontics. Head & face medicine, 2011; 7(1), 14.

Keedy LR. Indications and contra indications for extraction in orthodontics treatment. Am J Orthod. 1975; 68:554-63.

Ker AJ, Chan R, Fields HW. Esthetic and smile characteristics from the layperson's perspective: a computer-based survey study. J Am Dent Assoc. 2008; 139:1318-1327.

Khiste, Sujeet Vinayak, Ritam Naik Tari. "Platelet-rich fibrin as a biofuel for tissue regeneration." ISRN Biomaterials 2013 (2013).

Kouvelis G, Dritsas K, Doulis I, Kloukos D, Gkantidis N. Effect of orthodontic treatment with 4 premolar extractions compared with nonextraction treatment on the vertical dimension of the face: A systematic review. American journal of orthodontics and dentofacial orthopedics, 2018; 154, 175-187.

Levy PH. Clinical implications of mandibular repositioning and the concept of an alterable centric relation. Int J Orthod. 1979; 17:6–25.

Lehman RA. consideration of the advantages of second pre molar extractions in orthodontics. The European Journal of Orthodontics, 1979; 1, 119-124.

Li Peilin, Deyu Kong, Tian Tang, Di Su, Pu Yang, Huixia Wang, Zhihe Zhao, Yang Liu. "orthodontic treatment planning based on Artificial Neural Networks." Scientific reports 9, no. 1 (2019): 1-9.

Luecke PE III, Johnston LE Jr. The effect of maxillary first premolar extraction and incisor retraction on mandibular position: testing the central dogma of ‘‘functional orthodontics.’’ Am J Orthod Dento facial Orthop. 1992; 101:4–12.

Luppanapornlap S, Johnston LE. The effects of premolar extraction: a long-term comparison of outcomes in “clear-cut” extraction and non-extraction Class II patients. Angle Orthod. 1993; 63:257-272.

McLaughlin RP, Bennett JC. The extraction–nonextraction dilemma as it relates to TMD. The Angle Orthodontist, 1995; 65, 175-186.

Morais JF, Melsen B, de Freitas KM, Castello Branco N, Garib DG, Cattaneo PM. Evaluation of maxillary buccal alveolar bone before and after orthodontic alignment without extractions: A cone beam computed tomographic study. The Angle Orthodontist, 2018; 88, 748-756.

Mozzo P, Procacci C, Tacconi A, Martini PT, Andreis IA. A new volumetric CT machine for dental imaging based on the cone-beam technique: preliminary results. EurRadiol 1998; 8:1558–64.

Methathrathip D, Apinhasmit W, Chompoopong S, Lertsirithong A, Ariyawatkul T, Sangvichien S. Anatomy of greater palatine foramen and canal and pterygopalatine fossa in Thais: considerations for maxillary nerve block. Surgical and Radiologic Anatomy, 2005; 27511-516.

Naini FB, Moss JP, Gill DS. The enigma of facial beauty: Esthetics, proportions, deformity, and controversy Am J Orthod Dentofacial Orthop. 2006; 130:277-282.

Neil S. Norton, Ph.D. Frank H. Netter, MD, Netter's Head and Neck Anatomy for Dentistry, Boundaries of the Oral Cavity, 2011; ISBN-**13**: 978-1437726633

Nicozisis JL, Nah-Cederquist HD, Tuncay OC. Relaxin affects the dentofacial sutural tissues. Clinical orthodontics and research, 2000; 3, 192-201.

Nimeri G, Kau CH, Abou-Kheir NS, Corona R. Acceleration of tooth movement during orthodontic treatment-a frontier in orthodontics. Progress in orthodontics, 2013; 14, 42.

O'Connor BMP. Contemporary trends in orthodontic practice: A national survey. Am J Orthod Dentofacial Orthop. 1993; 103:163-170.

Okamoto N, Morikawa M, Tomioka K, Yanagi M, Amano N, Kurumatani N. Association between Tooth Loss and the Development of Mild Memory Impairment in the Elderly,2000; 3:192–201.

Oz, A. A., A. Z. Oz, S. Yazicioğlu, N. Arici, M. Ozer, and S. Arici. "Comparison of arch width changes following orthodontic treatment with and without extraction using three-dimensional models." Nigerian journal of clinical practice 20, no. 5 (2017): 581-586.

Parekh S, Fields HJW, Rosenstiel S. Attractiveness of variations in the smile arc and buccal corridors space as judged by orthodontists and laymen. Angle Orthod. 2006; 76:612-618.

Peck S, Peck H. Frequency of tooth extraction in orthodontic treatment. Am J Orthod. 1979; 76:491-496.

Peck MT, Marnewick J, Stephen L. Alveolar ridge preservation using leukocyte and platelet-rich fibrin: a report of a case. Case reports in dentistry, 2011.

Proffit WR, Jackson TH, Turvey TA. Changes in the pattern of patients receiving surgical-orthodontic treatment. 2013; 143793-798.

Proffit WR. Forty-year review of extraction frequencies at a university orthodontic clinic. The Angle Orthodontist, 1994; 64, 407-414.

Proffit, W. R., Fields Jr, H. W., Sarver, D. M. Contemporary orthodontics. Elsevier Health Sciences (2006).

Ramos E, Santamaría J, Santamaría G, Barbier L, Arteagoitia I. Do systemic antibiotics prevent dry socket and infection after third molar extraction? A systematic review and meta-analysis. Oral surgery, oral medicine, oral pathology and oral radiology, 2016; 122, 403-425.

Reynders RM. Orthodontics and temporomandibular disorders: Is view of the literature. Am J Orthod Dento facial Orthop. 1990; 97:463–471.

Richmond S, Andrews M, Roberts C T. The provision of orthodontic care in the general dental services of England and Wales: extraction patterns, treatment duration, appliance types and standards. British Journal of Orthodontics, 1993; 20, 345-350.

Ruellas, Antônio Carlos de Oliveira, Ricardo Martins de Oliveira Ruellas, Fábio Lourenço Romano, Matheus Melo Pithon, Rogério Lacerda dos Santos. "Extrações dentárias em Ortodontia: avaliação de elementos de diagnóstico." Dental Press Journal of Orthodontics 15, no. 3 (2010): 134-157.

Roberts CA, Subtelny JD. Use of the face mask in treatment of maxillary skeletal retrusion. Am J Orthod Dentofacial Orthop.1988; 93:388-94.

Scaf G, Lurie AG, Mosier KM, Kantor ML, Ramsby GR, Freedman ML. Dosimetry and cost of imaging osseointegrated implants with film-based and computed tomography. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, 1997; 83, 41-48.

Schudy F. The control of vertical overbite in clinical orthodontics. Angle Orthod, 1968; 38:19-39.

Speers RD, Brands WG, Nuzzolese E, Smith D, Swiss P B, Van Woensel M, Welie JV. (Preventing dentists' involvement in torture: The developmental history of a new international declaration. The Journal of the American Dental Association, 2008; 139, 1667-1673.

Su, Shaochen, Tao Qi, Baoli Su, Huibin Gu, Jianlin Wang, Lan Yang. "Tooth loss inhibits neurogenesis in the dentate gyrus of adult mice." Neural regeneration research 9, no. 17 (2014): 1606.

Sukovic P, Brooks S, Perez L, Clinthorne N. Dento CAT a novel design of a cone-beam CT scanner for dentomaxillofacial imaging: introduction and preliminary results. In International Congress Series, 2001; 700-705.

Sukovic P. Cone beam computed tomography in craniofacial imaging. Orthodontics craniofacial research, 2003; 6, 31-36.

Sumanth, Kumbargere N, Prashanti, Eachempati, Aggarwal, Himanshi, Kumar, Pradeep, Lingappa, Ashok, Muthu, Murugan, Kiran Kumar Krishanappa, Salian. Am J Orthod Oral Surg1944; 30:405-28.

Sumanth, Kumbargere N, Eachempati Prashanti, Himanshi Aggarwal, Pradeep Kumar, Ashok Lingappa, Murugan S. Muthu, Salian Kiran Kumar Krishanappa. "Interventions for treating post-extraction bleeding." Cochrane Database of Systematic Reviews 6 (2016).

Sadowsky C, Schneider BJ, BeGole EA, Tahir E. Long-term stability after orthodontic treatment: nonextraction with prolonged retention. American Journal of Orthodontics and Dentofacial Orthopedics, 1994; 106, 243-249.

Takada K, Yagi M, Horiguchi E. Computational formulation of Orthodontic Tooth-Extraction Decision. Angle Orthod. 2009; 79:885-891.

Tulley WJ. The role of extractions in orthodontic treatment. BrDent J. 1959; 107:199–205.

Tweed CH. Indications for the extraction of teeth in orthodontic procedure. American journal of orthodontics and oral surgery, 1944; 30, 405-428.

Tweed CH. The application of the principles of the edgewise arch in the treatment of malocclusions. Parts I and II. Angle Orthod, 1941; 11:5-67.

Tweed CH. Clinical Orthodontics. 1966; Volume One pp. 1-54.

Vaden JL, Dale JG, Klontz HA. O aparelho tipo Edgewise de Tweed-Merrifield: filosofia, diagnóstico e tratamento. Graber TM, Vanarsdall RL. Ortodontia: princípios e técnicas atuais. Rio de Janeiro: Guanabara Koogan. (1996).

Vaden JL, Williams RA, Goforth RL. Class II correction: Extraction or nonextraction?. American Journal of Orthodontics and Dentofacial Orthopedics, 2018; 154, 860-876.

Vannier MW, Inamura K, Farman AG, Doi K,editors. Computer assisted radiology and surgery. Amsterdam: Elsevier Science; 2001; p. 659–64.

Weintraub JA., Vig PS, Brown C, Kowalski CJ. The prevalence of orthodontic extractions. American Journal of Orthodontics and Dentofacial Orthopedics, 1989; 96, 462-466.

White SC, Heslop EW, Hollender LG, Mosier KM, Ruprecht A, Shrout MK. Parameters of radiologic care: An official report of the American Academy of Oral and Maxillofacial Radiology. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, 2001; 91(5), 498-511.

Proffit WR., White RP, Sarver DM. Contemporary treatment of dentofacial deformity (Vol. 283). St. Louis: Mosby. (2002).

Williams R, Hosila FJ. The effect of different extraction sites upon incisor retraction. American Journal of Orthodontics and Dentofacial Orthopedics, 1976; 69, 388-410.

Williams P, Roberts-Harry D, Sandy J. Orthodontics. Fact and fantasy in orthodontics. Braz Dent J 2004; 196:143.

Witzig JW, Spahl TJ. The Clinical Management of Basic Maxillofacial Orthopedic Appliances. Littleton, MA: PSG Publishing; 1987:161–216.

Wyatt WE. Preventing adverse effects on the temporomandibular joint through orthodontic treatment. Am J Orthod Dentofacial Orthop. Bowbeer GR. The sixth key to facial beauty and TMJ health. FunctOrthod. 1987; 4:10–11,13–15,18.

Zadik Y, Levin L. Decision making of Hebrew University and Tel Aviv University Dental Schools graduates in every day dentistry--is there a difference?. Refu'at ha-peh veha-shinayim, 1993; 2, 19-23.

Zadik Y, Sandler V, Bechor R., Salehrabi R. Analysis of factors related to extraction of endodontically treated teeth. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, 2008; 106, e31-e35.

ATTACHMENTS

Annex 1.

Yamen Nasser Taljabini

E-mail : tag_yamen@hotmail.com Phone : 00966500602141
Address: Turkish Republic of Northern Cyprus. Nicosia

Education

Dentistry — 2008 september — 2014 february
University Of Kalamoon - Syria

Orthodontics — 2015 february — Present
Near East University - Cyprus

References

References available upon request.

Age

29 years old

Place and time of birth

Born in Saudi Arabia 3/28/1990

Languages

I speak Arabic, English and Turkish

Annex 2.

EK: 728-2018

YAKIN DOĞU ÜNİVERSİTESİ
BİLİMSEL ARAŞTIRMALAR DEĞERLENDİRME ETİK KURULU

ARAŞTIRMA PROJESİ DEĞERLENDİRME RAPORU

Toplantı Tarihi	:18.10.2018
Toplantı No	: 2018/62
Proje No	: 652

Yakın Doğu Üniversitesi Diş Hekimliği Fakültesi öğretim üyelerinden Prof. Dr. Hakan Gögen'in sorumlu araştırmacısı olduğu, YDU/2018/62-652 proje numaralı ve **"Computed Tomography Evaluationof Palatal Form İn The Transverse And Sagittal Dimension İnextraction And Non-Extraction Orthodontic Cases"** başlıklı proje önerisi kurulumuzca değerlendirilmiş olup, etik olarak uygun bulunmuştur.

1. Prof. Dr. Rüştü Onur (BAŞKAN)
2. Prof. Dr. Nerin Bahçeciler Önder (ÜYE)
3. Prof. Dr. Tamer Yılmaz (ÜYE)
4. Prof. Dr. Şahan Saygı (ÜYE)
5. Prof. Dr. Şanda Çalı (ÜYE)
6. Prof. Dr. Nedim Çakır (ÜYE) KATILMADI
7. Prof. Dr. Kaan Erler (ÜYE) KATILMADI
8. Doç. Dr. Ümran Dal Yılmaz (ÜYE)
9. Doç. Dr. Nilüfer Galip Çelik (ÜYE) KATILMADI
10. Doç.Dr. Emil Mammadov (ÜYE)

Annex 3.

YAKIN DOĞU ÜNİVERSİTESİ
Sağlık Bilimleri Enstitüsü
YÖNETİM KURULU KARARLARI

Toplantı Tarihi	Toplantı Sayısı	Karar Sayısı
07.01.2020	151	SBE /2019-151-28

Karar:28	**"Ortodonti"** Doktora programı Öğrencisi **Dt. Yamen TALJABIN (20153724)**'in tez izleme komitesi teklifi ve tez önerisi görüşüldü. **Dt. Yamen TALJABIN (20153724)**'in ***"Computed tomography evaluation of palatal form in the transverse and sagittal dimension inextraction and non-extraction orthodonic cases"*** konulu tezini Doç.Dr.Ulaş ÖZ danışmanlığında yürütmesine oybirliği ile karar verildi. Ayrıca tez izleme komitesinin de; aşağıdaki isimlerden oluşmasına oy birliği ile karar verildi. Doç.Dr. Ulaş ÖZ (YDÜ, Diş Hekimliği Fak. Ortodonti AD) Yrd.Doç.Dr. Levent VAHDETTİN (YDÜ, Diş Hekimliği Fak. Ortodonti AD) Prof.Dr. Zahir ALTUĞ (Ankara Üniversitesi, Diş Hekimliği Fak. Ortodonti AD)'dan oluşmasına (İlgi: Diş Hekimliği Fakültesi Dekanı Prof. Dr. M.Mutahhar ULUSOY'un DHF-S:073/2019 sayılı ve 20.12.2019 tarihli yazısı)

ASLI GİBİDİR

Prof. Dr. K. Hüsnü C. BAŞER (Md.)		Prof. Dr. Nazmi ÖZER (Üye)	
Doç.Dr. Kerem TERALI (Md.Yard.)		Prof. Dr. İhsan ÇALIŞ (Üye)	
Doç.Dr. Umut AKSOY (Md.Yard.)		Prof. Dr. Ümran DAL YILMAZ (Üye)	
Prof.Dr. Mehtap TİRYAKİOĞLU (Üye)		Prof.Dr. Adile ÖNİZ ÖZGÖREN (Üye)	
Doç. Dr. Beyza H. ULUSOY (Üye)			

Prof. Dr. K. Hüsnü Can BAŞER
Müdür
YDÜ Sağlık Bilimleri Enstitüsü

Annex 4.

Computed Tomography Evaluation of Palatal Form in The Transversal and Sagittal Fabrication Proc...

Publication:	Advanced Composites Letters	**Publisher:**	SAGE Publishing
Publication ID:	2633366X	**Author:**	Yamen Taljabini
Manuscript DOI:	10.1177/2633366X19896807	**ORCID® ID:**	0000-0002-9643-3374
Manuscript ID:	896807	**Institution:**	Near East University
Publication Date:		**Institution ID:**	RINGGOLD-52988
OA License(s):	CC BY-NC	**Co-Authors:**	Ulas Oz

Advanced Composites Letters - Decision on Manuscript ID ACM-19-0101.R1 Inbox

Advanced Composites Lett... Dec 3
to me

4 December 2019

Dear Dr. Taljabini:

It is a pleasure to accept your manuscript entitled "Computed Tomography Evaluation of Palatal Form in The Transversal and Sagittal Fabrication Process and the effect of First Molar and Canine Crown Angulations" in its current form for publication in Advanced Composites Letters. The comments of the reviewer(s) who reviewed your manuscript are included at the foot of this letter.

Thank you for your fine contribution. On behalf of the Editors of Advanced Composites Letters, we look forward to your continued contributions to the Journal.

Sincerely,
Professor Igor Guz
Advanced Composites Letters
acm@sagepub.com

Reviewer(s)' Comments to Author:

Reviewer: 2

Comments to the Author
The angulation of the maxillary right and left first molar and right and left canine in the buccolingual and mesiodistal direction was calculated. To calculate the buccolingual changes of angulation of the first molar and canines, 2 axes were adopted, and the angle between them was taken.