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Maxillary Expansion

A Project Submitted to

The College of Dentistry, University of Baghdad, department of Orthodontics in Partial Fulfillment for the Bachelor of Dental Surgery

By:

Sajjad Hussain Khalifa

Supervised by:

Assistant Lecturer

Dina Hamid Obaid

B.D.S., M.Sc. (Orthodontics)

Certification of the Supervisor

I certify that this project entitled "**maxillary expansion**" was prepared by **Sajjad Hussain Khalifa** under my Supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry

Supervisor's name

Assit.Lec.Dina Hamid Obaid

Dedication

I dedicate this work to my creator, for Allah, my strong pillar, my source of inspiration, wisdom. Mom & dad,

Thank you for teaching me to believe in myself, in God and in my dreams.

To my family members For raising me to believe that anything was possible.

To my best friends Whose make the world a better place, just by being in it.....

Acknowledgment

First and foremost, praises and thanks to **Allah** Almighty for helping me fulfill

my dream, for his blessings throughout my work to complete it successfully. I would like to extend my deepest respect and gratitude to the Dean of College

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List of Abbreviations

Subject	Abbreviation
RME	Rapid Maxillary Expansion
MARPE	Miniscrew Assisted Rapid Maxillary Expansion
FEM	Finite Element Method
MSE	Maxillary Skeletal Expansion
MPS	Maxillary Palatal Suture

Introduction

Under normal circumstances the maxillary arch overlaps the mandibular arch both labially and buccally. But when the mandibular teeth, single tooth or a segment of teeth, overlap the opposing maxillary teeth labially or buccally, depending upon their location in the arch, a cross bite is said to exist, then, it need maxillary expansion to correct it **(Singh, 2015).**

Arch expansion is one of the methods of gaining space in orthodontics. The concept of arch expansion was explained for the first time by Emerson C Angel. Hence, he is considered as the father of expansion appliances. Correction of the transverse discrepancy usually requires expansion of the palate by a combination of orthopedic and orthodontic tooth movements. Three expansion treatment modalities are used today: rapid maxillary expansion (RME), slow maxillary expansion (SME) and surgically assisted maxillary expansion **(phulari, 2011).**

Chapter one
Review of literacture

1.1 What is orthodontics?

Orthodontics is the area of dentistry concerned with study of the craniofacial growth, development of the dentition and occlusion, and with the diagnosis, interception, and treatment of dentofacial anomalies **(Yew, 2011).**

1.2 Types Of Malocclussion

1.2.1 Anterioposterior Discrepancies

1.2.1.1 Class II malocclusion

Occlusions is a major reason that patients seek orthodontic treatment. Combinations of dental and skeletal factors ranging from mild to severe provide the multiple characters of this discrep-ancy **(Baccetti *et al*., 2009)** Among other factors, the treatment protocol scan widely vary according to professional ability ,malocclusion severity, and patient compliance **(Bishara *et al*., 1997).**

1.2.1.2 Class III malocclusion

Has long been considered a complicated maxillofacial disorder that is characterised by a concave profile, which may exhibit mandibular protrusion, maxillary retrusion or a combination of both **(Chang *et al*., 2006)** as well as possible anatomic heterogeneity of this malocclusion.

1.2.2 Vertical Discrepancies

1.2.2.1 Openbite (Benjamin, 2010)

A. **Anterior open bite (AOB):** there is no vertical overlap of the incisors when the buccal segment teeth are in occlusion **(Figure 1).**
B. **Posterior open bite (POB):** when the teeth are in occlusion there is a space between the posterior teeth **(Figure 2).** This can sometimes be referred to as a lateral open bite (LOB**).**
C. **Incomplete overbite:** the lower incisors do not occlude with the opposing upper incisors or the palatal mucosa when the buc- cal segment teeth are in occlusion **(Figure 3).** The overbite may be decreased or increased**.**

Figure 1: Anterior open bite**(Benjamin, 2010)**

Figure 2: Posterior open bite
(Benjamin, 2010)

Figure 3: Incomplete overbite
(Benjamin, 2010)

1.2.2.2 Deepbite

Deepbite is one of the commonly encountered vertical discrepancy. When there is an excessive overbite, the patient is said to have andeepbite. As with many of the orthodontic problems, deepbite can also be skeletal or dental. It is important for us to diagnose a deep bite case properly and plan treatment accordingly (**Alhammadi *et al*., 2018)**.

1.2.3 Transverse Discrepancies

1.2.3.1 Scissorbite

Is a rare form of malocclusion that is often accompanied by varying degrees of facial asymmetry. Transverse discrepancies in adults are very difficult to treat, especially in cases that also exhibit vertical overlapping of the posterior teeth, dental and functional problems associated with scissors bite **(Jung *et al*., 2011).**

1.2.3.2 Crossbite

Cross bites are a deviation of the normal bucco-lingual relationship of the teeth of one arch with those of the opposing arch. Graber defined cross bites as a condition where one or more teeth may be malposed abnormally, buccally or lingually or labially with reference to the opposing tooth or teeth **(Adkins, 1990).**

Under normal circumstances the maxillary arch overlaps the mandibular arch both labially and buccally. But when the mandibular teeth, single tooth or a segment of of teeth, overlap the opposing maxillary teeth labially or buccally, depending upon their location in the arch, a cross bite is said to exist **(Adkins, 1990).**

1.2.3.2.1 Classification of crossbites (Mitchel, 2013)

Cross bites can be classified according to their location in the arch as

A. Anterior cross bites is basically a condition where a reverse overjet is seen **(Figure 4)**. Anterior cross bites can be further classified according to the number of teeth involved as

- Single tooth cross bite.
- Segmental cross bite .

B. Posterior cross bites can also be further classified according to the number of teeth involved as

- Single tooth cross bite.
- Segmental cross bite.

Figure 4: Single tooth anterior cross bite**(Singh, 2007)**

Figure 5: Segmental anterior cross bite**(Singh, 2007)**

1.2.3.2.2 Aetiology of crossbite

A. Dental cross bite.
B. Skeletal cross bite.
C. Functional cross bite.

A. Dental crossbites : are generally single tooth or sometimes-segmental cross bites. These usually result from arch length discrepancy or an abnormal path of eruption. These are usually not accompanied by any threat to general health of the patient, the problems arising due to such cross bites are periodontal or esthetic in nature **(Figure6)(Clifford, 1971**)

B. Skeletal crossbite :These include those cross bites, which are primarily due to mal-positioning or malformation of the jaws **(Figure7).** These can be inherited (e.g. Cross bites seen in patients with Class III skeletal pattern), congenital (e.g. cleft lip and palate cases) or arising ue to trauma at the time of birth (e.g. unilateral ankylosis of the TMJ) or later in life. They are capable of causing appreciable damage to a person's health and personality as the appearance may be compro-mised to a larger extent **(Adkins, 1990).**

C. Functional crossbites :These cross bites are usually caused due to the presence of occlusal interferences during the act of bringing the jaws into occlusion. These can be caused by the early loss of deciduous teeth, decayed teeth or ectopically

erupting teeth. If not corrected early, these can ultimately lead to skeletal cross bites **(Pinto *et al*., 2001).**

Figure 6: Dental crossbite leading to compromised patient**(Clifford, 1971**).

Figure 7: Skeletal crossbite causing facial asymmetry(**Adkins, 1990).**

1.2.3.2.3 Treatment of crossbite

1.2.3.2.3.1 Slow Arch Expansion

Slow arch expansion is also known as dento-alveolar expansion. The changes produced are primarily of dental changes with very minimum or negligible amount of skeletal changes when used in older adults. But can produce skeletal changes along with dental changes when used in either deciduous or early mixed dentition. Slow arch expansion uses mild force of 2- 4 pounds as compared to 10-20 pounds used in rapid maxillary expansion. The expansion produced with slow expansion is more physiologic with greater stability of having least relapse tendency as compared to that of rapid maxillary expansion **(Phullari, 2011).**

McAndrews demonstrated that the application of light continuous forces in the areas of perisoteal growth allows normal arch dimensions to develop at any age without undue tipping of abutment teeth. Increased fibroblastic, osteoclastic and osteoblastic activity seems to occur when the maxilla is widened slowly. The neuromuscular adaptation of the mandible to the maxilla in slow expansion allows a normal vertical closure **(Pereira *et al*., 2017).**

1.2.3.2.3.1.1 Appliances used for Slow Arch Expansion

A. . **Jackscrew (Figure 8)**
B. **Coffin Spring(Figure 9)**
C. **NiTi expander brings about slow expansion(Figure 10)**
D. **Quad Helix Appliance(Figure 11)**

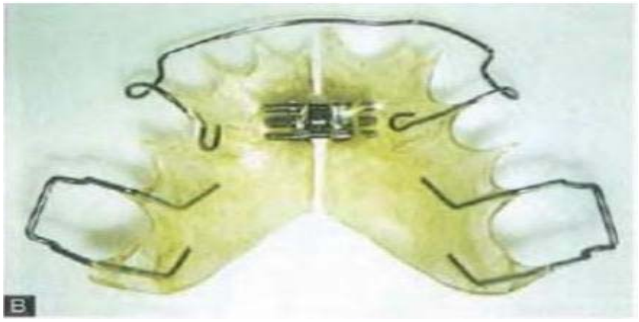

Figure 8: Jackscrew removable appliance spring **(phullari, 2011).**

Figure 9: Coffin spring **(phullari, 2011)**.

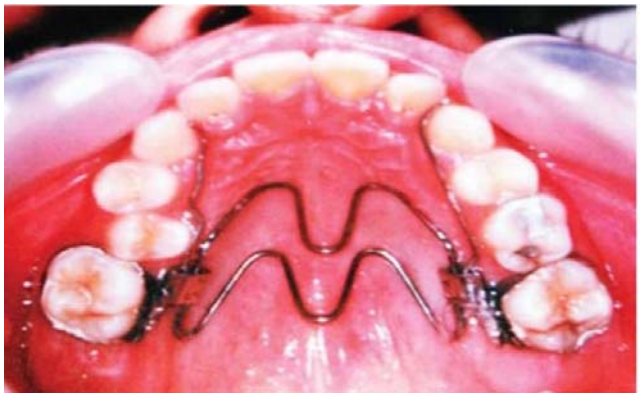

Figure 10: Nickel Titanium Palatal Expander**(ARNDT *et al*., 1993).**

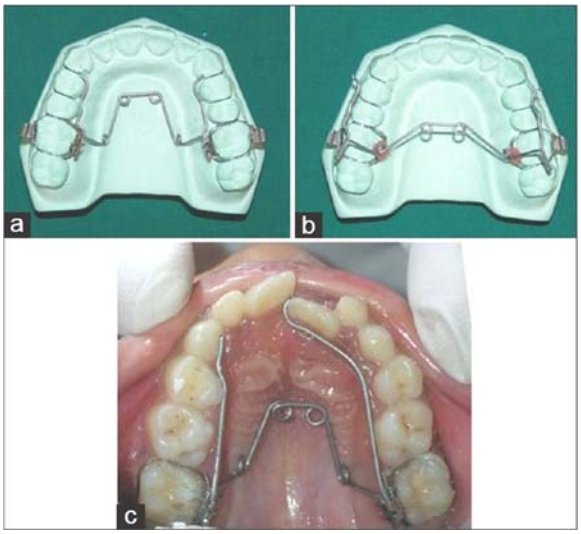

Figure 11: (a) Quadhelix on study model before activation, (b) Quadhelix on study model after activation , and(c) Quadhelix intraorally in the maxillary arch**(Kapadi , 2017).**

1.2.3.2.3.2 Rapid Maxillary Expansion (RME)

Rapid maxillary expansion appliances are the best appliances for the orthopedic expansion, the changes are produced mainly in the underlying skeletal structures rather than by the movement of teeth through the alveolar bone**(Graber, 2017).**

1.2.3.2.3.2.1 Rapid Maxillary Expansion effect

Rapid maxillary expansion not only separates the mid palatal suture but also affects the circumzygomatic and circummaxillary sutural systems. Rapid maxillary expansion device was first used by **(Emerson C Angel)** in the year **(1860)**. He used a jack screw type of rapid maxillary expansion device between two premolars in maxillary arch on palatal side in a 14 years old girl and achieved arch expansion by 1/4 inch in 14 days **(Phullari, 2011; Graber, 2017).** Retention period after maxillary expansion is six months of retention with either fixed or removable ap-

pliances seem to be enough to avoid relapse or to guarantee minimal changes in a short-term follow-up **(Costa *et al*., 2017).**

Table 1: Difference between slow and rapid maxillary expansion **(Phullari, 2011):**

Features	Slow Maxillary Expansion	Rapid Maxillary Expansion
Rate Of Expansion	Slow	Rapid
Durration Of Treatment	Prolonged	Short
Force	Mild	Heavy
Tissuue Response	Physiologic	Pathologic
Frequen Of Activaton	Less Frequent	More Frequent
Fabrication	Easy	Difficult
Type of Appliance	Can be Removable for Fixed Appliance	Mainly Fixed Appliance
Adjustment Required	Minimal	More
Repair Response	Greater	Less
Loss Of Attachment	Not Seen	Seen to Some Extent
Post Expansion Stability	Greater	Lesser
Trauma	Less	More
Relapse	Less Chances	More Chances

1.2.3.2.3.2.2 Types of Rapid Maxillary Expansion

A. Issacson type (Figure 12)

B. Hyrax type (Figure 13)

C. Hass type (Figure 14)

D. Derichweiler type (Figure 15)

E. Miniscrew Assisted Rapid Maxillary Expansion (MARPE)

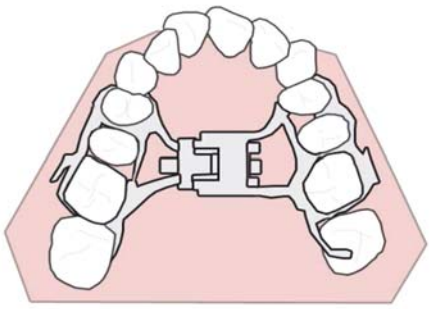

Figure 13: Hyrax type of expansion appliance **(Pavithra *et al*., 2017)**

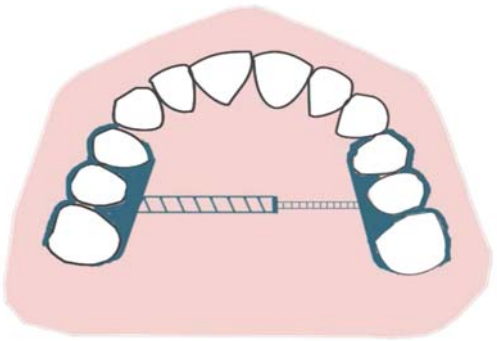

Figure 12: Isaacson type of expsion **(Pavithra *et al*., 2017)**

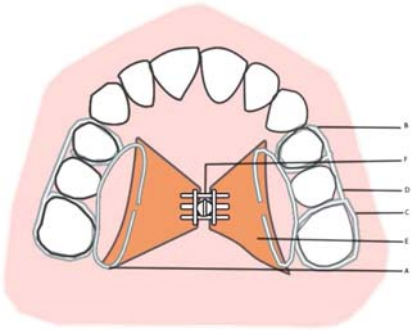

Figure 14: Hass type of expansion a. Lingual support wire. b. Premolar bands. C. Molar bands.d. Buccal support wire e. Acrylic plate f.Expansion screw**(Pavithra *et al*., 2017)**

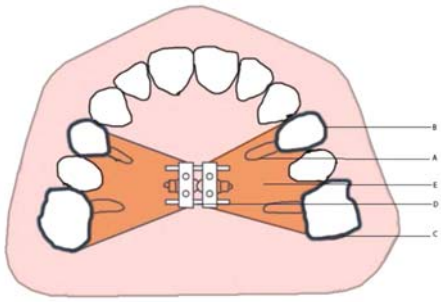

Figure 15: Derichsweiler type of expansion a. Wires tags. b. Premolar bands. C.Molar bands. d. Expansion screw e. Acrylic plate **(Pavithra *et al*., 2017)**

1.2.3.2.3.2.3 Miniscrew Assisted Rapid Palatal Expansion (MARPE)

Bone screw can be placed in the maxilla to serve as temporary skeletal attachments, force can be applied directly to the maxilla instead of teeth to transfer force to the bone, to expand the maxilla even if no teeth are present, to avoid tooth movement and produce skeletal change **(Figure16)(Kapetanović, 2021).**

Figure 16: MARPE Appliance **(De Oliveira *et al.*, 2021).**

. In **2010**, **(Lee *et al.*, 2010)** treated a 20-year-old patient with severe transverse discrepancy and mandibular prognathism. Before orthognathic surgery, the patient used an expansion appliance secured to the palate by means of miniscrews (miniscrew- assisted rapid palatal expander, or MARPE). Expansion was achieved with minimal damage to teeth and periodontium, with stable outcomes confirmed by clinical and radiographic examination.

Recently, **based on Lee's studies, Park and Hwang (2010), Moon (2003)** and **(MacGinnis *et al.*, 2014)** developed the maxillary skeletal expander (MSE, Biomaterial Korea, Seoul, South Korea) with four miniscrews installed into the expansion screw body, parallel to the midpalatal suture and to itself. Even more recently, **(Suzuki *et al.*, 2016)** changed the rapid maxillary expansion appliance, securing it by means of miniscrews (MARPE); however, with a different design **(Pe-**

clab, Belo Horizonte, Brazil) (Figure17). MARPE's new design has been used in a number of patients with atrophic maxilla, both young, growing patients and adult ones.

Figure 17: MARPE appliance in which miniscrews are incorporated to the screw support design, with measures determined on the basis of morphology of thepalatal region parallel to the midpalatal suture: A) MSE expansion appliance; B) MARPE appliance modified by Suzuki. C) computed tomography after expansion (in B) **(Suzuki *et al*., 2016).**

In the appliance developed by **(Lee *et al*., 2010)** the miniscrews are secured to the turn-key by means of extensions welded to the expansion screw, and joined with light-curing resin. With miniscrews kept away from the midpalatal suture, there is an increase in the risk of perforating underlying structures (such as canals and nerves in both anterior and posterior regions), as well as on the sides, which is even more serious, as there would be four sites to be chosen individually.

(Alves *et al*., 2012) mapped the areas of risk implied in securing miniscrews onto the human palate. In **MSE (2013) and MARPE (2015)** appliances, miniscrews are used as a support for the expansion screw and would be secured in a more even manner parallel to the suture, with a view to aiming at a thicker bone area, so as to increase primary stability and provide a more efficient propagation of forces to the nasomaxillary complex.

The midpalatal suture is located right behind the incisive foramen, which represents the mouth of a canal that goes up in posterior direction. It might have an opening at the nasal cavity, as high as the line tangent to the distal surfaces of both maxillary canines **(Figure18).** The risk of screws affecting this structure is little, although this might occasionally happen **(Suzuki *et al*., 2016).**

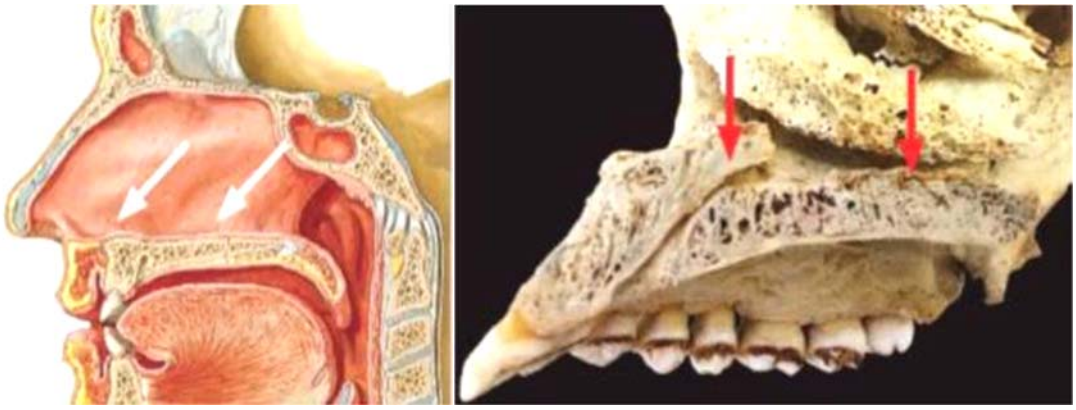

Figure 18: Midpalatal suture: note that the incisive canal distinguishes the anterior and middle segments. It goes in posterior and upward direction. The incisive canal has got vessels, nerves, salivary glands and nasopalatine canal remnants. The posterior segment is relative to the suture transversal to the palatal bone **(Suzuki *et al*., 2016).**

In general, the anterior palate offers an outstanding amount and quality of bone, particularly an area distal to the third rugae extending medially toward the bicuspids and over the midpalatal suture posteriorly. Clinicians refer to this area **(Figure 19)** as the "T-zone"(**Ludwig *et al*., 2011; Wilmes *et al*., 2016**) Extensive research has been done in the anterior palate region and confirmed the presence of adequate quality bone for miniscrew placement.(**King *et al*., 2007; Winsauer *et al* ., 2014)**When viewed from the profile, that is, looking at a cephalometric radiograph, maxillary bone tapers from anterior to posteriorly.

Therefore, placing miniscrews outside the T-zone may be problematic for achieving adequate bone support and may, therefore, cause pronounced dislocation in the miniscrew positions. From an ergonomic point of view, it makes sense to host all four miniscrews within the anterior palate hosted within a reasonable amount of cortical and trabecular support. Within this framework, a new MARPE concept was designed to position the expansion screw directly on the incline of the anterior palate **(Wilmes *et al.*, 2016).**

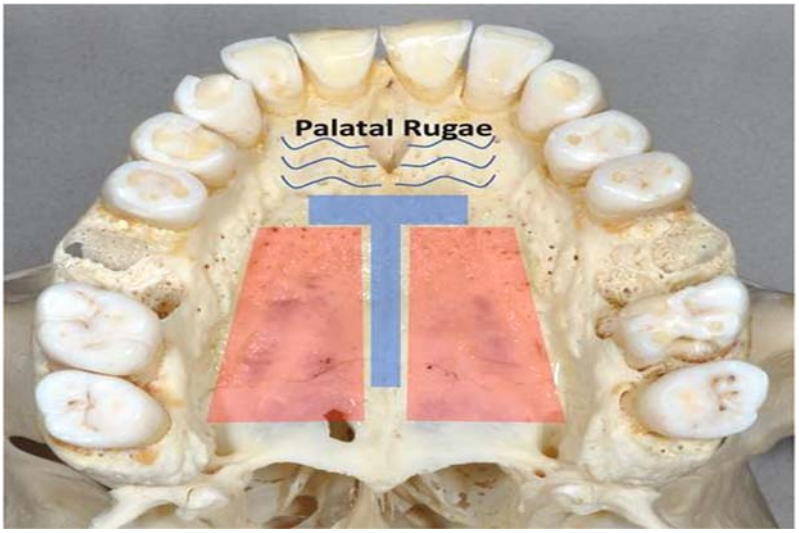

Figure19 : The "T zone": redrawn from **(Wilmes *et al* ., 2016).**

1.2.3.2.3.2.2.1 Indications for MARPE (Kumar *et al*., 2021):

A. Certain Class II div 1 malocclusion cases which in which there is an extreme narrowing of the upper arch associated with a unilateral or bilateral crossbite. • Selected arch length discrepancy cases: Borderline case with good facial patterns.

B. True maxillary deficiency case: Cases in which mandible is normal with under developed maxilla with a straight profile in a midface region and are also associated with crossbite.

C. Relative Maxillary deficiency case: A case in which a larger size of mandible with a normal maxilla.

D. Asymmetries of condylar position: Skeletal response during MARPE redirects the developing posterior teeth into normal occlusion and corrects asymmetries of condylar functional shifts and possible temporomandibular joint dysfunction.

E. Class II cases with mouth breathing: A narrow nasal aperture literally filled by concha, with deviated nasal septum, is often seen in these patients increasing the internasal capacity to facilitate nasal respiration.

F. Maxillary deficiency in Class III Cases: MARPE is of value in the Class III malocclusions with maxillary deficiency and also with flattened profile in the middle third of the face, crowding of maxillary arch and cross bite which maybe either unilateral or bilateral and the teeth are often inclined buccally.

G. Bilateral or severe unilateral expansion in class I cases.

1.2.3.2.3.2.3.2 Advantages of MARPE (Suzuki *et al*., 2016)

Treatment duration is very less, one to four weeks of active expansion period, when compared to other conventional expansion, 2-6 months of period for expansion. MARPE independent of any anchor teeth units supports a simultaneous fixed orthodontic therapy and expansion as an added advantage. Maximal skeletal displacement can be achieved with minimal dental tipping effects. More stable on completion of treatment because the maxillary posterior teeth are not tipped buccally as much as in conventional expansion procedures**.**

1.2.3.2.3.2.3.3 Disadvantages of MARPE(Suzuki *et al*., 2016)

A. are the difficulty in keeping the area clean

B. the invasiveness of the micro-implants, and the increased risk of infection

1.2.3.2.3.2.3.4 The Design of MARPE appliance

Dr Won Moon proposed the original MARPE design **(Carlson *et al*., 2016)** which was placed at the centre of the palate banded to the molars. Later Dr Kee-Joon Lee modified the design by banding the first premolars along with first molars. This provided good anchorage and adaptation based on the topography of the palate for effective separation of the midpalatalsuture.Conventional Hyrax Rapid Palatal Expander was modified to derive the the Maxillary Skeletal Expanders or miniscrew assisted rapid palatal expanders by incorporation of miniscrews in the design by

(Carlson *et al*, 2016)They claimed that their design produced more of a parallel expansion of maxillary bone and negligible dental tipping. The changes suggested were Bi-cortical anchorage of the mini-screws implants, posterior placement of the implants, and reduction in the rigidity of the connecting wires**(MacGinnis, 2014).**

Adding a transpalatal bar inevitably transforms the appliance design into a combination of a tooth- and bone-borne expander. In a study where pure bone-borne MARPE (supported with only four miniscrews) was compared to the tooth- and bone-borne combination MARPE (four-miniscrews and a palatal bar between the first molars) 100% success was achieved in midpalatal suture separation. However, the bone-borne appliance caused a significantly more significant skeletal width increase, fewer dental side effects, and less buccal bone reduction than the combination MSE appliance **(Sarraj *et al*., 2021).**

1.2.3.2.3.2.3.5 Insertion factor considerations

- **Appliance position (MacGinnis, 2014)**

A. Anteriorly Distal to the 3rdrugae along the anterior palate increases the primary stability due to thick palatal bone, propagating the forces to the naso-maxillary complex.
B. Middle-on the flat palatal but thinner bone surface of second premolar region. This promotes a close contact area with the jackscrew but significantly increases the risk for bi- cortical penetration.
C. Posteriorly- immediately anterior to the soft palate, at the region of the first permanent molar. This results in an increased orthopaedic effect due to the resistance offered by the pterygoid plates.

- **Appliance insertion(Cantarella *et al*., 2018)**

Temporary Anchorage Device (TAD) placement is cumbersome sometimes due to lack of torque and directional control to drive the implant into hard palatal bone with anengine mounted or a conventional straight driver. A uniquely designed palatal driver (**L'il One,FavAnchorTMSAS,India**) is favorable in maintaining the torque and angulation for precise insertion and placemen to miniscrews**(Cantarella *et al*., 2018).**

- **Appliance activation(Brunetto *et al*., 2017)**

The activation protocol varies based on the treatment objective and patient biotype. Activation schedule guidelines **(Table 2**) should be followed for better treatment progress. On an average, 0.2mm of separation is achieved per turn. Activation is terminated when an edge to edge contact is achieved between the lingual cusps of maxillary first molars and the buccal cusps of the mandibular first molar. If the activations exceed the permissible limits, the expander loses rigidity and undergoes deformation **(Table 3) (Brunetto *et al*., 2017)**.

Table 2: activation limits

MSE Size	Maximmum Number Of Activaions
8mm	40
10mm	50
12mm	60

Table 3:Activation schedule

Age Group	Initial Expansion Rate	Expansion After Opening MPS (Diastema Formation
Beginning of adolescence(13-16 years)	3-4 turns/week	3 turns/week
End of adolescence (16-19 years)	1 turn /day	1 turn/day
Young adult (19-25 years)	2 turn per day	1 turn/day
Adult (older than 25 years)	2 or more turn per day	1 turn/day

1.2.3.2.3.2.3.6 Contraindications of MARPE(Kummar, 2021)

a. A person who shows soft tissue pathology in pressure bearing areas.
b. Patient with severe tendency to gingival enlargement as in Dilantoin hyperplasia.
c. Patient with cover bite (maxillary teeth completely outside the mandible).
d. Patient with normal buccal occlusion in lateral aspect.
e. Patients who cannot co-operate with the clinician.
f. Patients with severe anteroposterior and vertical skeletal discrepancies.
g. Patient with single teeth cross bite, anterior open bite, steep mandibular planes and convex profiles.
h. Patient with skeletal asymmetry of maxilla or mandible.

1.2.3.2.3.2.3.7 Effects of MARPE in the adult population

MARPE showed promising clinical findings in young adults when employed as a non-surgical treatment alternative(**Choi *et al*., 2021**). However, due to the inherent limitations of the mechanical aspects of miniscrews(**Choi *et al*., 2021**) and biological patient-related limitations, absolute success may not be possible in adult patients because the outcome of midpalatal suture separation becomes more complex to predict as the age increases. For instance, while the combined success rate of suture separation for individuals that are between 15 and 29 is slightly above 80%, it declines to 20% from 30 to 37 years(**Oliveira *et al*., 2021).**

Between 19 and 29 is an interesting group because of the increased chances that skeletal expansion would succeed. In this age group, there are some patients that even a hybrid expander could be deemed successful. However, others do not respond to the same design (**Figure 20**). This mixed response to the application may seem frustrating. However, it is vital to communicate effectively with the pa-

tients and let them know about the possibility of failure. Most clinicians make careful patient selections, and when it is deemed that the midpalatal suture is not responding to the treatment, they change their expansion protocol to slow expansion to camouflage the transverse deficiency dentally. For instance, the clinical expansion protocol could start at two turns a day until a successful split is obtained in the midpalatal suture. If successful, the rate could be slowed down to 1 turn/a per day. If not successful, a slow expansion protocol of 1–2 turns/a week should provide adequate dentoalveolar expansion in cases where it may be indicated and will not harm the periodontal support (**Oliveira *et al*., 2021**).

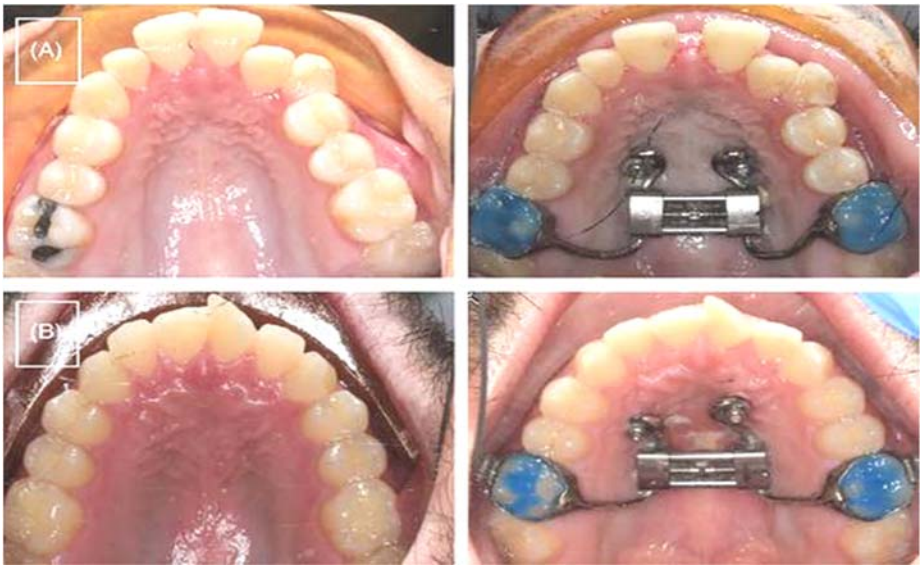

Figure20: A) Successful maxillary skeletal application in a young adult with a hybrid MARPE. (B) Another young adult in the same age not responding to MARPE**(Oliveira *et al*., 2021**).

Chapter Two

Discussion

2.1 Discussion

the MARPE have been tested in orthodontic patients with hopes of avoiding the un- wanted side effects of traditional RPE. While the MARPE has shown evidence of clinical success(**Tausche, 2008; Hansen, 2007**), most are limited in the precise evaluation of the bio- mechanical effect of orthopedic forces, and it is difficult to suggest exactly what is taking place physiologically.

Recent studies have demonstrated that **Finite Element Method (FEM)**is a viable method to study stress, strain, and force distributions when evaluating orthodontic problems, specifically transverse deficiencies(**Lee et al,. 2007; Jafari et al., 2003**) In a non-invasive way, FEM makes it possible to compare the effects of conven- tional hyrax and MARPE expansion forces on the cra- niofacial complex.

Chapter Three

Conclusions And Suggestios

3.1 Conclusions

• This study it has been conclude that MARPE can be beneficial in patients with sutures that are fused.

• MARPE is also beneficial in young dolichofacial patients by helping to prevent bone bending and dental tipping.

• In MARPE. We gain more bone movement than dental tipping.

3.2 Suggestions

• Expand the study by make a clinical trial about MARPE.

• Make a study a bout the difference between the conventional RME and MARPE.

Chapter Four

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