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Skeletal Changes After Rapid Maxillary Expansion and Fixed Orthodontic Treatment

A Project Submitted to
The College of Dentistry, University of Baghdad, Department of Orthodontics
in Partial Fulfillment for the Bachelor of Dental Surgery

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Certification of the supervisor

I certify that this project entitled " Skeletal changes after rapid maxillary expansion and fixed orthodontic treatment " was prepared by the fifth-year student **" Zeena Saad Dhaher** " 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: **Dr. Samher Ali Al-shaham**

Date: /5/2023

Dedication

I dedicate this project to my (father, and mother) for standing by me for all twenty two of my life and giving me all the support and love to continue my study with success

I would like to dedicated it to my beautiful little sisters (doha and lena).

Acknowledgment

The first and foremost thanks be to "**Allah**" for fulfill my dream and reaching this stage. He has given me patience and strength to get success.

I would like to extend my deepest respect and gratitude to the Dean of College of Dentistry, University of Baghdad, **Prof. Dr. Raghad Al-Hashimi .**

My sincere thanks **to Prof. Dr. Dhiaa Hussein,** Head of Orthodontics Department, and all professors and seniors in the department for them pleasant cooperation..

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RME	Rapid maxillary expansion
RME	Rapid maxillary expansion
SME	Slow maxillary expansion
SARPE	Surgically assisted rapid palatal expansion
MTD	Maxillary Transverse Deficiency
MPS	Mid-palatal suture
PA	Posteroanterior
G	Gram
Kg	Kilogram
mm	Millimeters

Introduction

Maxillary expansion is one of the methods of gaining space in orthodontics (**Phulari, 2011**). The first reported use of expansion device, dates back to the year 1860, when Emerson C Angell first used a double jackscrew kind of an appliance to expand the maxillary arch in a 14 years old girl. After two weeks of turning the jackscrew, he noticed the widening of the upper jaw and spacing between the upper incisors, and concluded that he had indeed separated the two halves of the maxillary bone.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: rapid maxillary expansion (RME), slow maxillary expansion (SME) and surgically assisted maxillary expansion . Since each treatment modality has advantages and disadvantages, controversy regarding the use of each exists. Practitioners select treatment appliances based on : their personal experiences , on the patient's age, and malocclusion.**(Ficarelli, 1978; Bell, 1982)**

Normal palatal growth is nearly complete by age 6 **(Moyers, 1976**), and increasing interdigitation of the suture makes separation difficult to achieve after puberty **(Persson, 1977; Hicks, 1978).**

If the force is strong enough, separation occurs at the maxillary suture. During treatment, transverse forces tip the buccal segments laterally and with proper appliance design, 3rd-order moments will induce bodily translation.**(Storey, 1973; Ceylan, 1996)**

Aims of the study

1- To highlight on the importance of skeletal changes carried on maxillary arch on the mandibular dental arch growth and movement.

2- To provide a good establish base on the most skeletal changes impact orthodontic treatments needs and retention after rapid maxillary expansion.

Chapter one

(review of literature)

1.1- Maxillary Expansion

The expansion of the arch has been one of the oldest means of creating space of the dental arches **(Singh, 2007)**. 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 **(Phulari, 2011)**. Westcott first reported placing mechanical forces on maxilla in 1859. Emerson Colon Angell was the first person to publish a paper about palatal expansion in 1860 in Dental Cosmos **(Timms, 1999)**. He placed a screw between the maxillary premolars of a 14-year-old girl for 2 weeks. When she returned, he observed expansion in her upper arch. In 1877, Walter Coffin developed the Coffin Spring for the purpose of arch expansion. In 1889, J. H. McQyillen who was the President of the American Dental Association at that time, opposed Angell's idea regarding arch expansion. Goddard, in 1890, and Landsberger, in 1910, revisited the idea of arch expansion. Goddard standardized the expansion protocol in adjusting the expander twice a day for 3 weeks.

1.1.1- The clinical conditions indicating to maxillary expansion include:

- crossbite
- distal molar movement
- Pre-myofunctional appliance treatment
- surgical cases for instance arch coordination or bone grafts, to aid maxillary protraction
- mild crowding

Orthopedic skeletal expansion involving separation of the midpalatal suture is the treatment of choice. Three treatment alternatives are available for maxillary expansion :

1- rapid maxillary expansion (RME).

2- slow maxillary expansion (SME).

3- surgical-assisted RME (SARME).

1.1.2- Landmarks of Mid palatine suture and the Maxilla :

The hard palate is composed of the palatine process of the maxilla and the maxillary process of the palatine bones. The palatine bones together with the maxilla also form the floor of the nose and a part of the lateral walls of the nasal cavity. The palatine bone articulates with the maxilla by a transverse palatal suture and up the lateral wall of the nasal cavity. Posteriorly, the palatine bone articulates with the pterygoid process of sphenoid. The maxillary bones are joined posteriorly and superiorly to various bones, including the frontal, ethmoid, nasal, lacrimal, zygomatic, etc. Thus, the anterior and inferior aspects are relatively free **(Singh, 2007)**.

The interpalatine suture joins the paired palatine bones at their horizontal plates and is a continuation of the intermaxillary suture. Theoretically, it forms the junction of the three opposing pairs of bones - the premaxillae, the maxilla and the palatines. Practically, they are treated as a single entity—the mid-palatine suture (MPS) (Figures 1,2) **(Singh, 2007)**.

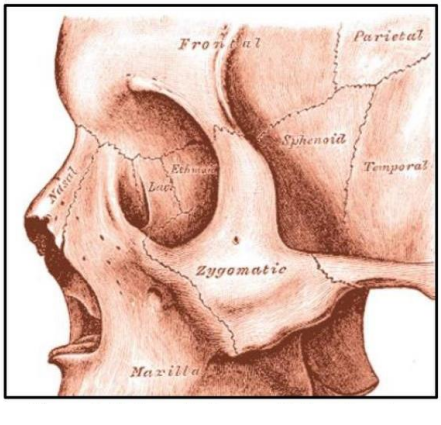

Figure 1 ; Sutures in the maxillofacial region (Kumar, 2020)

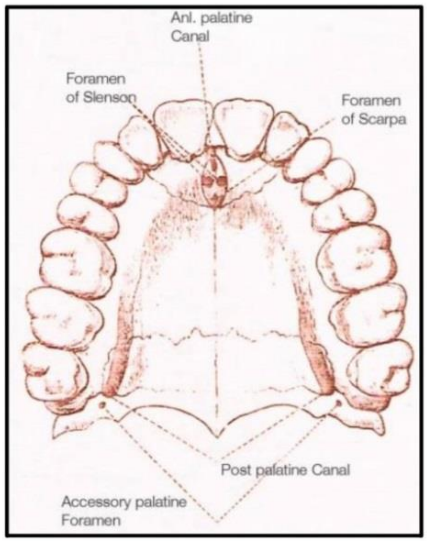

Figure 2; Anatomy of maxilla (Kumar, 2020)

Studies have indicated that the development of the mid-palatine suture passes through three distinct stages. Closure of palatine-suture shows a large individual variation, ranging from 15 to 19 years of age. A greater degree of obliteration occurs posteriorly than anteriorly with maximum obliteration in the third decade of life **(Phulari, 2011)**.

Mid Palatine Suture plays a key role in Rapid Maxillary Expansion (RME) **(Melson, 1975).**

a) Infancy - Y-shape (Figure 3)

b) Juvenile - T-shape

c) Adolescence - Jigsaw puzzle (Figure 4)

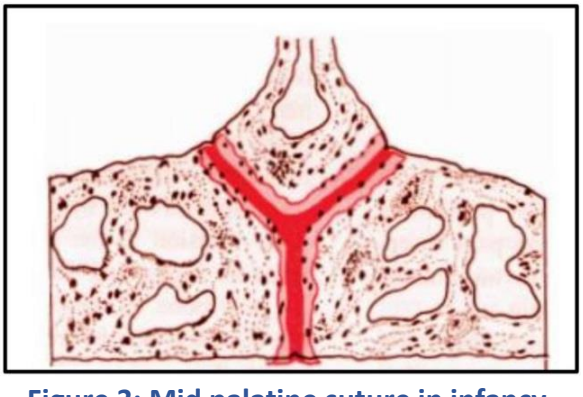

Figure 3; Mid palatine suture in infancy - Y shape (Kumar, 2020)

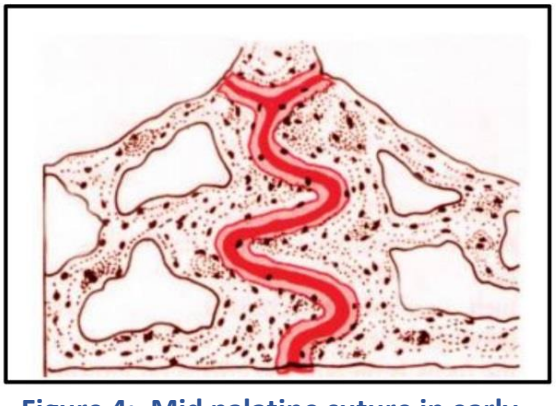

Figure 4; Mid palatine suture in early adolescence – jigsaw puzzle (Kumar, 2020)

As sutural patency is vital to RME, it is important to know when does the suture closes by synostosis **(Persson, 1977),** and on an average 5% of suture is closed by age 25 yrs. Earliest closure occurs in girls aged 15 yrs. Ossification comes very late anterior to incisive foramen – this is important when planning surgical freeing in late instances of RME **(Björk and Skieller, 1974)**

1.1.3- Types of Dental Arch Expander

Arch expansion can be slow or rapid, removable or fixed. Slow arch expansion brings about mainly dentoalveolar expansion whereas, rapid maxillary expansion brings about both skeletal as well as dentoalveolar expansion. Removable expansion appliance may be a simple expansion appliance with incorporated jackscrew or coffin appliance. Fixed arch expansion appliances are tooth borne expansion appliances (Hyrax, Issacson) or tooth and tissue borne expansion appliances (Derichsweiler, Haas) **(Phulari, 2011)**.

1.2 - RAPID MAXILLARY EXPANSION (RME):

Rapid maxillary expansion was first described by Emerson Angel in 1860 and later repopularize by Haas. **(Bell, 1982).** Rapid maxillary expansion appliances are the best appliances for the orthopedic expansion in that, the changes are produced mainly in the underlying skeletal structures rather than by the movement of teeth through the alveolar bone.

Rapid maxillary expansion not only separates the mid palatal suture but also affects the circum-zygomatic and circum-maxillary sutural systems. Rapid maxillary expansion is also called as palatal expansion or split palate. Rapid maxillary expansion is a skeletal type of expansion which produces skeletal changes by the separation of mid-palatal suture **(Phulari, 2011)**.

The main object of RME is to correct maxillary arch narrowness but its effects are not limited to the maxilla as it is associated with 10 bones in the face and head **(Ceylan, 1996)**. Advocates of rapid maxillary expansion believe that it results in minimum dental movement (tipping) and maximum skeletal movement **(Bell, 1982)**.

When heavy and rapid forces are applied to the posterior teeth, there is not enough time for tooth movement to occur and the forces are transferred to the sutures. When the force delivered by the appliance exceeds the limit needed for orthodontic tooth movement and sutural resistance, the sutures open up while the teeth move only minimally relative to their supporting bone. The appliance compresses the periodontal ligament, bends the alveolar process, tips the anchor teeth, and gradually opens the mid-palatal suture and all the other maxillary sutures **(Agarwal and Mathur, 2010).**

1.2.1- Effects of the RME :

1.2.1.1- Effect of RME on maxilla:

occlusally viewed, found that the opening of the midpalatine suture was nonparallel and triangular with maximum opening at incisor region and gradually diminishing towards the posterior part of palate.

Frontally viewed, the maxillary suture separates supero-inferiorly in a nonparallel manner. It is pyramidal in shape with the base of pyramid located at the oral side of the bone.**(Isaacson, 1964).**

Maxillary halves: the maxilla be frequently displaced downward and forward.

Palatal vault: the palatine process of maxilla was lowered as a result of outward tilting of maxillary halves.

Alveolar process: Because bone is resilient, lateral bending of the alveolar processes occurs early during RME, which rebounds back after a few days **(Gray, 1975) .**

Maxillary anterior teeth: From the patient's point of view, one of the most spectacular changes accompanying RME is the opening of a diastema between the maxillary central incisors. This distema is self-corrective due to elastic recoil of the transseptal fibers.

Maxillary posterior teeth: There is buccal tipping and extrusion of the maxillary molars.The posterior maxilla expands less readily because of the resistance produced by the zygomatic buttress and pterygoid plates.

RME and nasal airflow: Anatomically, there is an increase in the width of the nasal cavity immediately following expansion thereby improves in breathing. The nasal cavity width gain averages of 1.9 mm, but can be as wide as 8 to 10 mm (**Isaacson, 1964).**

It is important to remember that the main resistance to midpalatal suture opening is probably not the suture itself, but in the surrounding structures particularly the sphenoid and zygomatic bones. **(Isaacson, 1964)**

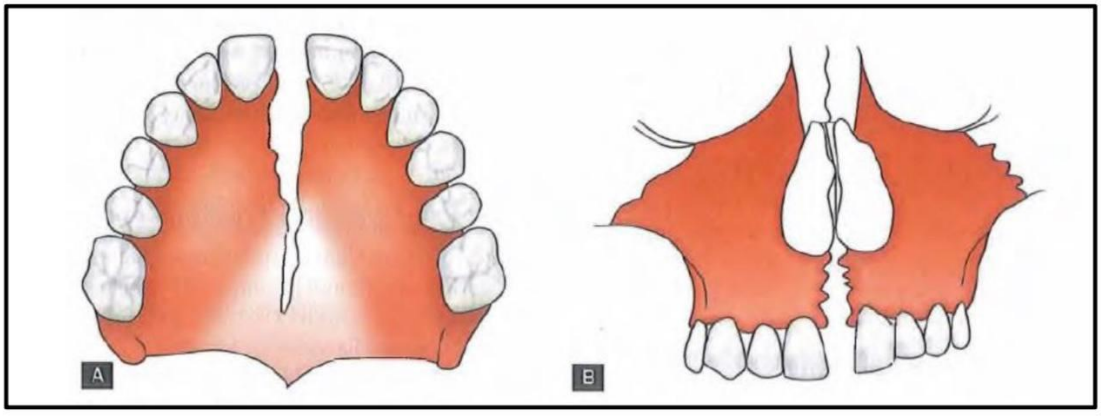

Figure 5; RME causes triangular or fan-shaped opening of the mid-palatal suture with maximum opening in the maxillary incisors region and gradually diminishing towards the posterior part of the palate. (A) Transverse view. (B) Frontal view (Phulari, 2011)

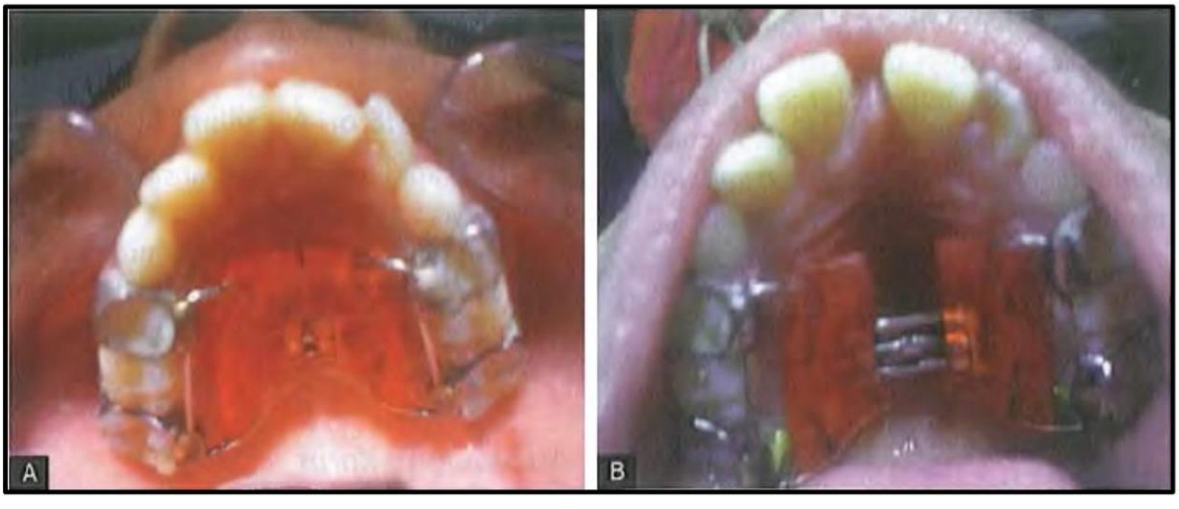

Figure 6. Effect of RME on maxillary anterior teeth: (A) before activation of RME. (B) after activation of RME. Note the appearance of midline diastema (Phulari, 2011)

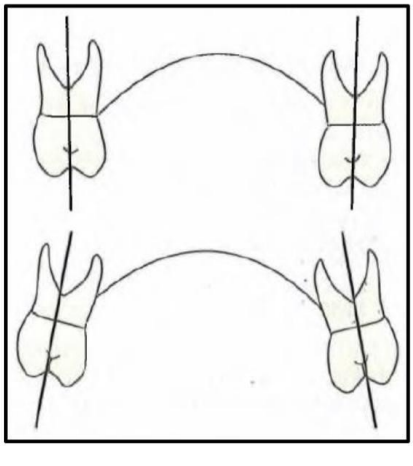

Figure 7; Effect of RME on maxillary posterior teeth (Phulari, 2011)

1.2.1.2- Effect of RME on mandible:

There is a concomitant tendency for the mandible to swing downward and backward **(Isaacson, 1964)**.

1.2.2- INDICATIONS OF RME:

Rapid maxillary expansion is indicated in cases

1- With a transverse discrepancy equal to or greater than 4 mm.
2- Where the maxillary molars are already buccally inclined to compensate for the transverse skeletal discrepancy.
3- Use to facilitate maxillary protraction in class III treatment by disrupting the system of sutures, which connect the maxilla to the cranial base, cleft lip and palate patients with collapsed maxillae are also RME candidates.
4- Use the procedure to gain arch length in patients, who have moderate maxillary crowding.

1.2.3- CONTRAINDICATIONS OF RME:

It is contraindicated in patients

1- who have passed the growth spurt
2- have recession on the buccal aspect of the molars
3- anterior open bite
4- steep mandibular plane
5- convex profiles
6- who show poor compliance.

It appears that approximately 1 millimeter per week is the maximum rate at which the tissue of the midpalatal suture can adapt. The amount of orthopedic vs. orthodontic change depends greatly on the patient's age. RME appliances require

frequent activations and generate heavy forces—as much as 2-5 kg per quarter-turn with accumulated loads of more than 9 kg.**(Hass, 1965)**

1.2.4- The Disadvantages of using Rapid Maxillary Expanders include:

1- discomfort due to heavy forces used
2- traumatic separation of the midpalatal suture
3- bite opening
4- relapse
5- microtrauma of the temporomandibular joint and midpalatal suture
6- root resorption
7- tissue impingement
8- requirement of patient or parent cooperation in activation of the appliance
9- pain and labor-intensive procedure in fabrication of the appliance.

1.2.5- Clinical management of RME

The patient/parent should be informed in advance about the upper midline diastema during the expansion phase. This is likely to close spontaneously during the retention period. Patients should be instructed to turn the expansion screw one-quarter turn twice a day. This may be associated with minor discomfort. Force levels tend to accumulate following multiple turns and can be as high as 10 kg following many turns. Patients should be reviewed weekly and some clinicians recommend that an upper occlusal radiograph be taken one week into treatment to ensure that the midpalatal suture has separated. If there is no evidence of this, it is important to stop appliance activation as there is a risk of alveolar fracture and/or periodontal damage. Active treatment is usually required for a period of 2-3 weeks, after which a retention period of three months is recommended to allow for bony infilling of the separated suture **(Gill *et al.*, 2004)**.

1.2.6 - APPLIANCES FOR RME

a- Removable Appliances

b- Fixed Appliances

- Tooth borne

- Tooth and tissue borne

1.2.6.1- Removable Rapid Maxillary Expansion Appliances :

Removable appliances produce skeletal expansion by the splitting of mid-palatal suture, when they are used in the deciduous or early mixed dentition. The reliability of these appliances in producing skeletal expansion is highly questionable when used in older adults **(Phulari, 2011)**.

Removable rapid maxillary expansion appliances consist of an expansion screw in the midline with split acrylic plate. It may also consist of retentive clasps ("C" or Adam's clasp) on the posterior teeth and a labial bow on the anterior teeth (Figure 8) **(Phulari, 2011)**.

Activation of screw is done by placing expansion screw key in the central bossing of screw and turning the key up for 90° or 45° will produce split of mid-palatal suture and movement of the maxillary shelves away from each other **(Phulari, 2011)**.

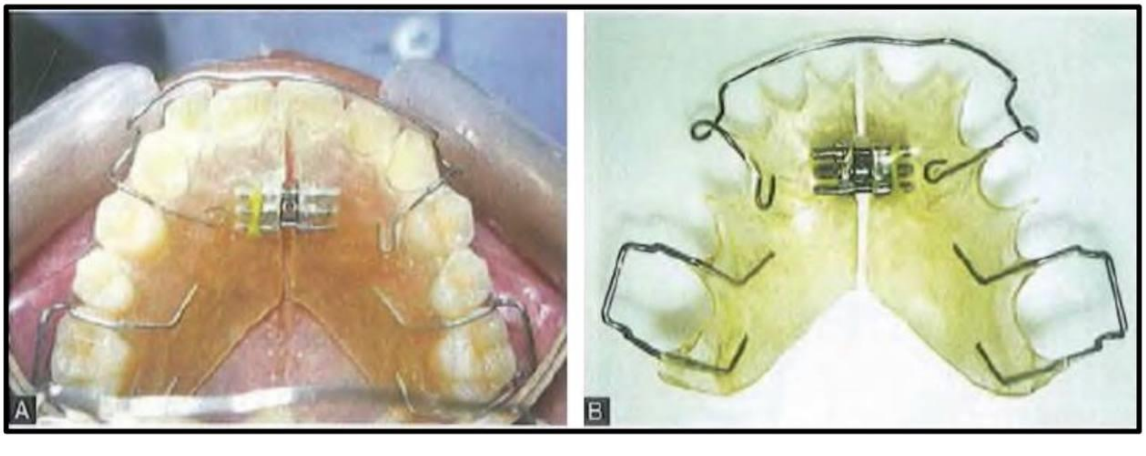

Figure 8. Removable rapid maxillary expansion appliances (Phulari, 2011)

1.2.6.2- Fixed Rapid Maxillary Expansion Appliances:

Fixed rapid maxillary expansion appliances are fixed expanders and cannot be removed by the patient. These fixed expanders can be classified into tooth and tooth tissue borne appliances **(Phulari, 2011)**.

Most commonly used fixed expander of tooth and tissue borne appliances are:

- ***Derichsweiler-type expander:*** Derichsweiler expansion appliance consists of molar bands on right and left permanent first molars and first premolars with wire tags soldered into the palatal surface of all molar and premolar bands. The outer free ends of wire tags are inserted into split palatal acrylic, incorporating a jack expansion screw in its center (Figure 9) **(Derichsweiler, 1953)**.

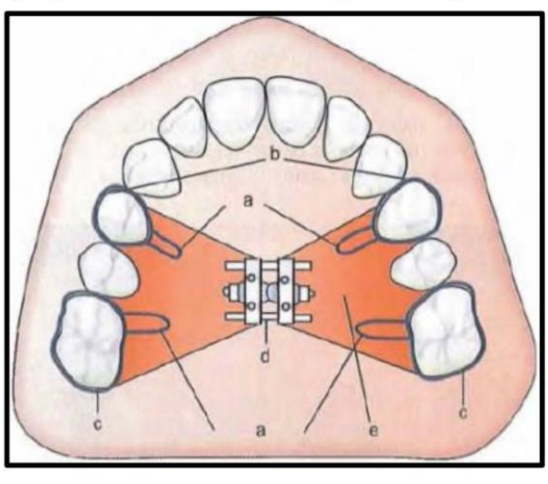

Figure 9 ; Parts of derichsweiler expansion appliance, (a) wire tags, (b) premolar bands, (c) molar bands, (d) expansion screw, (e) acrylic plate (Phulari, 2011).

- ***Haas-type expander:*** This appliance consists of molar bands on right and left permanent molars and premolars. A jack screw is incorporated in the midline into the two acrylic pads that closely contact the palatal mucosa. Support wires also extend anteriorly from the molars along the buccal and lingual surface of the posterior teeth to add rigidity to the appliance (Figures 10,11) **(Haas, 1961)**.

Haas states that more bodily movement and less dental tipping is produced when acrylic palatal coverage is added to support the appliance thus permitting the forces to be generalized not only against the teeth but also against the underlying soft and hard palatal tissues **(Haas, 1961).** Tooth borne appliances are:

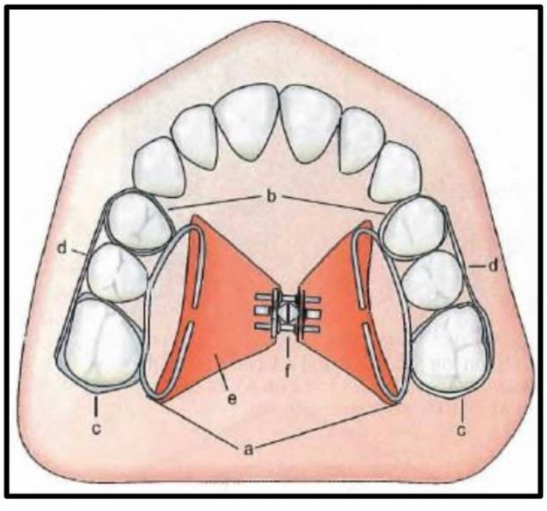

Figure 10. Haas type of expansion appliance, (a) Lingual support wire, (b) Premolar bands, (c) Molar band, (d) Buccal support wire, (e) Acrylic plate, (f) Expansion screw (Phulari, 2011)

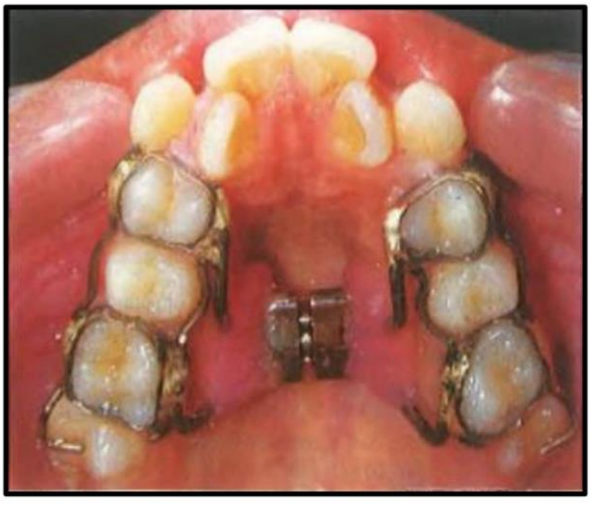

Figure 11. A case treated with Haas Derichsweiler type of expansion appliance (Phulari, 2011)

- *Hyrax-type expander*: The more commonly used type of banded RME appliance is the Hyrax-type expander. This type of expander is made entirely from stainless steel. Bands are placed on the maxillary first molars and first premolars. The expansion screw is localized in the palate in close a proximity to the palatal contour, buccal and lingual wires may be added for rigidity. The main advantages of it are that it does not irritate the palatal mucosa and it is easy to keep clean. It is capable of providing sutural separation of 11 mm within a very short period of wear and a maximum of 13 mm can also be achieved. Each activation of the screw produces approximately 0.2mm of lateral expansion and it is activated from front to back (Figure 12 A and B) **(Bishara and Stalye, 1987)**.

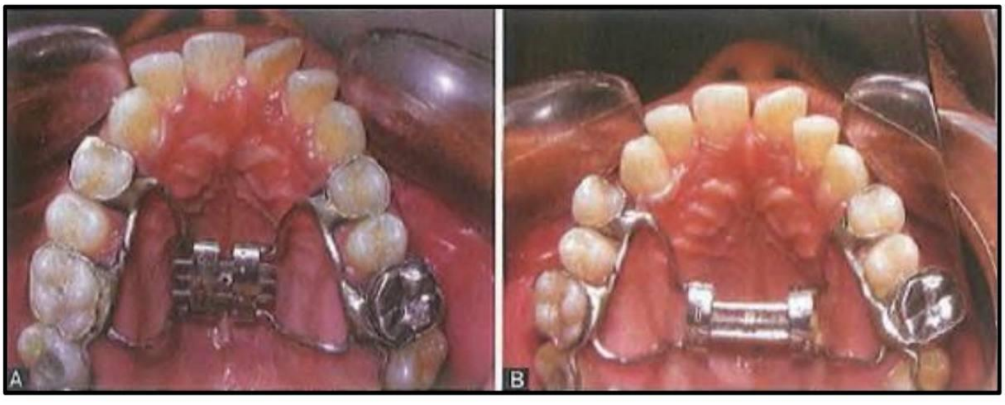

Figure 12; Hyrax type of expansion appliance: (A) pre-treatment, (B) post-treatment of a patient treated with hyrax rapid expander (Phulari, 2011)

-Isaacson expansion appliance: Isaacson expansion appliance is a fixed tooth borne appliance without acrylic covering. This appliance consists of molar bands on first right and left permanent molars and premolar bands on right and left permanent premolars. Metal flanges are soldered into the molar and premolar bands on buccal and palatal sides (Figure 13) **(Bishara and Staley, 1987)**.

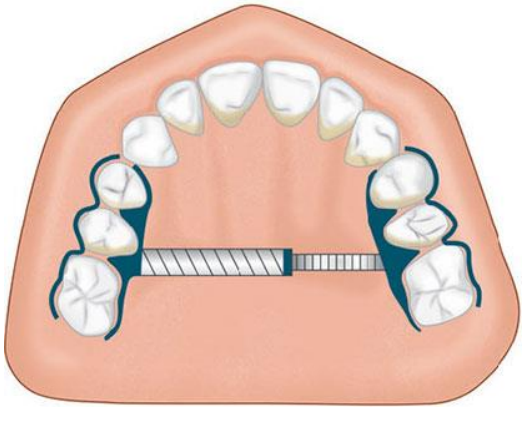

Figure 13; Isaacson type of expansion appliance (Phulari, 2011)

A spring-loaded expansion screw (MINNE) expander, having a nut, which can compress the spring and is made to extend between palatal metal flanges.

1.2.7- Treatment Evaluation during RME

Treatment evaluation of rapid maxillary expansion is done either by clinically or radiographically.

Clinically: The most noticeable feature during RME is the appearance of midline diastema. Studies by various authors show that the amount of incisors separation is roughly half of the amount of jackscrew separated. Hence, the amount of expansion achieved cannot be assessed on the amount of incisors separation (Midline diastema) alone **(Phulari, 2011)**.

Radiographically: Either maxillary occlusal view or PA (posteroanterior) cephalogram are used for the assessment of amount of expansion achieved. Radiographic assessment is considered to be the most reliable way in establishing the amount of rapid maxillary expansion **(Phulari, 2011)**.

1.3 - SLOW MAXILLARY EXPANSION (SME):

SME procedures produce less tissue resistance around the circummaxillary structures and, therefore improve bone formation in the intermaxillary suture, which theoretically should eliminate or reduce the limitations of RME.

Slow expansion has been found to promote greater post-expansion stability, if given an adequate retention period. It delivers a constant physiologic force until the required expansion is obtained. The appliance is light and comfortable enough to be kept in place for sufficient retention of the expansion. For SME, 10 to 20 newtons of force should be applied to the maxillary region only 450 to 900 gm of force is generated, which may be insufficient to separate a progressively maturing suture.Maxillary arch-width increases ranged from 3.8 to 8.7 mm with slow expansion of as much as 1 mm per week using 900 gm of force **(Isaacson, 1964).**

1.3.1- Indications of SME

1. Unilateral or bilateral crossbites
2. To correct minimal crowding by gaining spaces
3. To correct dental crossbite in permanent dentition
4. To correct mild maxillary deficiency in cleft lip and palate patients by providing slow continuous forces **(Naidu and Suresh, 2019).**

1.3.2- Contraindications of SME

- Adult patients who have completed their growth **(Naidu and Suresh, 2019)**.

1.3.3- Advantages of SME According to **(Naidu and Suresh, 2019) :**

1. It delivers a constant physiologic force until the required expansion is obtained.

2. There is minimum tipping of anterior teeth.

3. Least strain is exerted on anchored teeth.

4. The appliance is light and comfortable to the patient.

5. It can be used for sufficient retention after the expansion.

6. Relapse tendencies are less.

7. Time required for retention is less.

8. It requires minimal adjustment throughout its use, and allows easy adjustment when necessary.

9. Maintenance of sutural integrity and the reduced stress loads within the tissues.

10. Less pain and discomfort due to light forces **.**

1.3.4- Disadvantages for **SME** are:

- Longer treatment duration compared to rapid maxillary expansion **(Naidu and Suresh, 2019)**.
- minor maxillary and mandibular plane changes
- poor fit
- fracture or loss of the appliance
- palatal irritation.**(Starnbach,1964 ; Hass, 1965).**

1.4- Surgically Assisted Rapid Maxillary Expansion (SARME) :

The effect of dental arch on the maxillary base diminishes as age advances so, surgically assisted expansion techniques can be considered.

1.4.1- Indications of surgical expansion are:

1- To widen the arch.
2- To correct posterior crossbite when large amount (>7 mm) of expansion is required to avoid the potential increased risk of segmental osteotomies.
3- To widen the arch following maxillary collapse associated with a cleft palate, in cases with extremely thin and delicate gingival tissue, or presence of significant buccal gingival recession in the canine-bicuspid region of the maxilla; and in condition, where significant nasal stenosis is found.

Surgically assisted rapid palatal expansion (SARPE) has gradually gained popularity as a treatment option to correct MTD (Maxillary Transverse Deficiency). It allows clinicians to achieve effective maxillary expansion in a skeletally mature patient. Before surgery, orthodontic treatment involves moving the roots of the maxillary central incisors apart to improve surgical access to the osteotomy site. This is the technique of choice in patients, who

require expansion and have coexisting sagittal and/or vertical maxillary discrepancies.

SARME treatment has been successful in splitting the palatine suture and thus widening the maxilla in young adults (**Hass, 1970).** However, this surgical procedure is costly and requires outpatient surgery or hospitalization with attendant morbidity and loss of work time.

1.4.2- complications reported with the **SARME** are:

- tissue irritation
- hemorrhage
- infection
- pain
- unilateral or asymmetric expansion
- periodontal problems, and relapse.**(Timms, 1968)**

For these reasons, a careful cost effectiveness analysis should be made by patients and orthodontists before undergoing the procedure.**(Hass, 1970)**. Both SME and RME are indicated for growing patients, whereas SARME is the alternative selected for non-growing adolescent and young adult patients.
Even though RME treatments were reported to bring clinically stable results, **(Bell, 1982)** others reported relapse after expansion was attained.**(Lagravere, 2005)**

Because a direct relationship has been reported between increased resistance to skeletal expansion and increased patient age, the use of SME in adolescents may be questioned because it may not offer enough expansion force to separate the midpalatal suture in young adults.Even in young children.**(Timms, 1999)**.

1.5- Retention After Expansion

In cases of anterior crossbite with adequate overbite, there is no need for retainer. In cases of open bite, retainer is required. After expansion of posterior crossbite and overcorrection, the expander left for 3 months in situ as retainer then replaced with trans palatal arch until the end of treatments. Six months of retention with either fixed or removable appliances seem to be enough to avoid relapse or to guarantee minimal changes in a short-term follow-up **(Costa *et al.*, 2017)**.

Chapter two

(DISCUSSION)

Maxillary expansion is a widely accepted procedure performed by orthodontists to correct posterior cross bites and transverse maxillary deficiency and early treatment has been performed to correct the transversal discrepancy to avoid the need for future extraction. There are many kinds of maxillary expansion appliances and various recommended expansion rates which can result in rapid maxillary expansion (RME) or slow maxillary expansion (SME), however both treatment approaches were able to make some changes, especially at the dental level but RME could generate greater changes associated with anterior displacement of maxilla and or forward movement of the maxillary complex **(Haas, 1961; Gautam *et al.*, 2007)**.

The maxillary expansion causes more dentoalveolar and buccal tipping than skeletal expansion, and it could produce backward rotation of the mandible **(Lagravere *et al.*, 2005)**.

Expansion effects from RME consist of 3 components: the orthopedic expansion (skeletal/sutural separation), alveolar bending, and orthodontic expansion (dental tipping) **(Handelman, 2000).**

Due to treatment, maxilla was expanded transversally. Apical base was increased only in RME group and at bone crest level, RME and SME groups experienced expansion. Transversally the maxilla became larger only 2% at apical level and 63% at alveolar crest level more in RME group compared to SME group. Previous studies have shown maxillary expansion at apical and alveolar level and others have shown transversal changes just at alveolar level **(Podesser,2007; Garrett, 2008)** .

Greater effect at alveolar level can be explained by lateral rotation of the maxillary halves and lateral bending of alveolar crests with an inclination of the molars towards the buccal segmen **(Baumrind,1987).**

Intermolar angle increased due to maxillary expansion. RME group showed two times more buccal tipping than SME group. Buccal tipping has been reported as a common side effect in both(SME and RME)and can lead to root resorption.**(Haas,1965)** .To reduce tipping, authors have used bonded or occlusal splint **(Bell,1982)**

Tipping can be due to a lateral rotation of the maxillary halves with a fulcrum close to the frontomaxillary suture presenting a triangular expansion pattern.17,29 and lateral bending of alveolar crests with an inclination of the molars towards the buccal segment **(Wertz,1970; Podesser,2007).** However, RME leads to greater accumulation of force that dissipates a greater amount of anchoring teeth resulting in more sloping **(Isaacson, 1964).**

SME in adolescents may be questioned because it may not offer enough expansion force to separate the mid-palatal suture in young adults.**(Bell,1982)** Even in young children, no scientific evidence in favor or against is available **(Lagravere, 2005).**

Several disadvantages for SME are minor maxillary and mandibular plane changes, poor fit, fracture or loss of the appliance, and palatal irritation **(Sandikcioglu,1997).**

Chapter three:

Conclusions and Suggestions

2.1- Conclusions:

1- The type of skeletal and dental pattern greatly influences the type of expansion chosen which greatly facilitate the overall treatment objectives.

2- Maxillary transverse discrepancy usually requires expansion of the palate by combination of orthopedic and orthodontic tooth movement.

3- three expansion treatment modalities are used: rapid maxillary expansion, slow maxillary expansion and surgically assisted maxillary expansion.

4- RME promoted a forward movement of the maxilla and backward rotation of the mandible.

2.2- Suggestions :

1- Further reviews can be carried out to evaluate the skeletal changes in sagittal, vertical, and transverse dimension regarding the use of RME, SME.

2- C.T. scan can now days provide more data to be study on Rapid Maxillary Expansion.

3- Introduction of RME on variation age group with different orthodontic appliance to be study in more details .

References

(A)

- Agarwal, A. and Mathur, R., 2010. Maxillary expansion. International journal of clinical pediatric dentistry, 3(3), p.139.

(B)

- Baumrind S, Korn EL, Ben-Bassat Y, West EE. Quantitation of maxillary remodeling. 1. A description of osseous changes relative to superimposition on metallic implants. Am J Orthod Dentofacial Orthop. 1987 Jan;91(1):29-41

- Bell RA. A review of maxillary expansion in relation to rate of expansion and patient's age. Am J Orthod. 1982 Jan;81(1):32–37.

- Bishara, S.E. and Staley, R.N., 1987. Maxillary expansion: clinical implications. American journal of orthodontics and dentofacial orthopedics, 91(1), pp.3

- Björk, A. and Skieller, V., 1974. Growth in width of the maxilla studied by the implant method. Scandinavian journal of plastic and reconstructive surgery, 8(1-2), pp.26-33.

(C)

- Ceylan, Í., Oktay, H. and Demirci, M., 1996. The effect of rapid maxillary expansion on conductive hearing loss. The Angle Orthodontist, 66(4), pp.301-308.

- Costa, J.G., Galindo, T.M., Mattos, C.T. and Cury-Saramago, A.D.A., 2017. Retention period after treatment of posterior crossbite with maxillary expansion: a systematic review. Dental press journal of orthodontics, 22, pp.35-44.

(D)

- Debbane EF. A cephalometric and histological study of the effect of orthodontic expansion of the midpalatal suture of cat. Am J Orthod. 1958;44(3): 187-219.

- Derichsweiler, H., 1953. Die gaumennahtsprengung. Fortschritte der Kieferorthopädie, 14(1), pp.5-23.

(F)

- Ficarelli, J.P., 1978. A brief review of maxillary expansion. The Journal of pedodontics, 3(1), pp.29-35.

(G)

- Garrett BJ, Caruso JM, Rungcharassaeng K, Farrage JR, Kim JS, Taylor GD. Skeletal effects to the maxilla after rapid maxillary expansion assessed with conebeam computed tomography. Am J Orthod Dentofacial Orthop 2008;134:8.e1- 8.e11.

- Gautam, P., Valiathan, A. and Adhikari, R., 2007. Stress and displacement patterns in the craniofacial skeleton with rapid maxillary expansion: a finite element method study. American Journal of Orthodontics and Dentofacial Orthopedics, 132(1), pp.5-e1.

- Gill, D., Naini, F., McNally, M. and Jones, A., 2004. The management of transverse maxillary deficiency. Dental update, 31(9),pp.516-523.

- Gray LP. Results of 310 cases of rapid maxillary expansion selected for medical reasons. J Laryngol Otol. 1975 Jun;89(6):601–614.

(H)

- Haas AJ. Palatal expansion: just the beginning of dentofa- cial orthopedics. Am J Orthod. 1970;57:219–255.

- Haas, A.J. Rapid expansion of the maxillary dental arch and nasal cavity by opening of the mid palatal suture. Angle Orthod. 31:73-90, 1961.

- Haas, A.J. The treatment of maxillary deficiency by opening the midpalatal suture. The Angle Orthodontist 1965; 35(3), pp.200-217.

- Handelman CS, Wang L, BeGole EA, Haas AJ. Non-surgical rapid maxillary expansion in adults: report of 47 cases using the Haas expander. Angle Orthod 2000;70:129-44.

- Hicks, E.P., 1978. Slow maxillary expansion: a clinical study of the skeletal versus dental response to low-magnitude force.American journal of orthodontics, 73(2), pp.121-141.

(I)

- Isaacson RJ, Ingram AH. Forces produced by rapid maxillary expansion, II. Forces present during treatment. Angle Orthod. 1964;34:261–270.

- Isaacson, R.J., Wood, J.L. and Ingram, A.H., 1964. Forces produced by rapid maxillary expansion: I. Design of the force measuring system. The Angle Orthodontist, 34(4), pp.256-260.

(K)

- Kumar, P., 2020. Evaluation of Pterygomaxillary Suture using Human Adult Dried Skulls (Doctoral dissertation, Ragas Dental College and Hospital, Chennai).

(L)

- Lagravere, M.O., Major, P.W. and Flores-Mir, C., 2005. Long-term dental arch changes after rapid maxillary expansion treatment: a systematic review. The Angle Orthodontist, 75(2), pp.155-161.

- Lagravère MO, Heo G, Major PW, Flores-Mir C. Meta-analysis of immediate changes with rapid maxillary expansion treatment. J Am Dent Assoc. 2006 Jan;137(1):44-53.

(M)

- Moyers, R.E., 1976. Standards of human occlusal development.
Naidu, S. and Suresh, A., 2019. Slow Palatal Expansion a Novel Method of Arch Expansion. Guident, 12(2), pp.46-50.
orthopedics, 91(1), pp.3-14.

(P)

- Persson, M. and Thilander, B. (1977). Palatal suture closure in man from 15 to 35 years of age. American Journal of Orthodontics, 72(1), pp.42–52.

- Phulari, B.S., 2011. Orthodontics: principles and practice. JP Medical Ltd.

- Podesser B, Williams S, Crismani AG, Bantleon HP. Evaluation of the effects of rapid maxillary expansion in growing children using computer tomography scanning: a pilot study. Eur J Orthod. 2007 Feb;29(1):37-44.

(S)

- Sandikcioglu M, Hazar S. Skeletal and dental changes after maxillary expansion in the mixed dentition. Am J Orthod Dentofacial Orthop. 1997;111:321–327.

- Singh, G. ed., 2007. Textbook of orthodontics. JP Medical Ltd.

- Starnbach HK, Cleall JF. The effects of splitting the midpalatal suture on the surrounding structures. Am J Orthod. 1964;50:923–924.

- Storey, E.: Tissue response to the movement of bones, Am J Orthod. 64:229-247,1973.

(T)

- Timms DJ. An occlusal analysis of lateral maxillary expan- sion with midpalatal suture opening. Dent Pract Dent Rec. 1968;18:435–441.

- Timms, D.J., 1999. The dawn of rapid maxillary expansion. The Angle Orthodontist, 69(3), pp.247-250.

(W)

- Wertz RA. Skeletal and dental changes accompanying rapid midpalatal suture opening. Am J Orthod. 1970 Juyl;58(1):41-66.