Expansion In Orthodontics –Review

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Abstract:

Constricted maxillary arch and posterior cross bite are one of the most common problems faced by orthodontist. It requires expansion of palate by combination of orthopedic and orthodontic tooth movement .Expansion can be achieved by three treatment modalities: slow maxillary expansion, rapid maxillary expansion and surgically assisted maxillary expansion (SARPE). This article explains about these treatment modalities and appliances used in these expansion.

Keywords: Rapid maxillary expansion, slow maxillary expansion, surgically assisted maxillary expansion (SARPE).

Introduction:

Arch expansion is a method of gaining space. Expansion of palate was first achieved by Emerson C. Angell in 1860. [1]

Emerson C. Angell is credited as being the father of fast maxillary expansion since he described his first instance of successfully splitting the maxilla with a jack screw appliance in 1860. Farrar and Clark Godard (1893), emphasised the value of transverse palate expansion together with opening up of the mid palatal suture. Latham held the view that growth at the midpalatal suture stops at the age of three years, however Bjork and Skieller's work using implants in the year 1974 disproved Latham's theory and proved that growth at the midpalatal suture can last up to 13 years. Correction of the transverse discrepancy usually requires expansion of the palate by a combination of orthopaedic and orthodontic tooth movements. Three expansion treatment modalities are used today: rapid maxillary expansion (RME), slow maxillary expansion (SME) and surgically assisted maxillary expansion. Since conventional rapid palatal expanders that are either tooth-borne (hyrax type) or tooth-and-tissue borne (Haas type) cause questionable effects on the basal bone, a rigid element that delivers the expansion force directly to the basal bone could be a solution. For this purpose, a miniscrew-assisted rapid palatal expander (MARPE) was designed and used in an adult patient. [4]

Rapid maxillary expansion:

Rapid maxillary expansion was first described by Emerson Angell in 1860 and later repopularized by Haas. 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. Advocates of rapid maxillary expansion believe that it results in minimum dental movement (tipping) and maximum skeletal movement. The appliance compresses the periodontal ligament, bends the alveolar process, tips the anchor teeth, and gradually opens the midpalatal suture and all the other maxillary sutures. [3] RME appliances are fixed and generate 3-10 pounds of force (Zimring and Isaacson, 1965) and products increase in the transverse width of the maxillary basal bone. [1]

INDICATIONS OF R.M.E:

- Cases with transverse discrepancy=4mm
- Maxillary molars are buccally inclined
- To facilitate max. protraction in class 3
- In cleft lip and palate patients with collapsed maxillae
- Moderate maxillary crowding

TYPES OF R.M.E APPLIANCE:

- Removable appliances
- Fixed appliance
  - Tooth borne
    1. Isaacson type
    2. Hyrax type
  - Tooth and Tissue borne`
    1. Derichsweiler type
    2. Hass type [1]

Tooth borne :

I) Isaacson type:

It is a tooth borne appliance without any palatal covering. This appliance has a special spring-loaded screw called a MINNE expander, consists of a coil spring having a nut that can compress the spring, expander is activated by closing the nut so that the spring gets compressed. (Figure 1)

Figure 1 Isaacson type

II) Hyrax Type:

It is a tooth borne appliance, which was introduced by William Biederman in 1968. This type of appliance makes use of a special screw called HYRAX (Hygienic Rapid Expander).

The main advantage of this expander is that it does not irritate the palatal mucosa and 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 0.2 mm of lateral expansion and it is activated from front to back. (Figure 2)

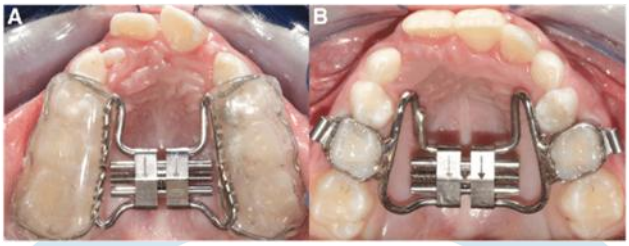

Figure 2 Bonded and Banded Hyrax

Tooth and tissue borne:

I. Derichsweiler type:

The first premolar and molars are banded. Wire tags are soldered to these bands and then inserted to the split palatal acrylic, which contains the screw. (Figure 3)

Figure 3 Derichsweiler type

II. Haas type:

The rapid palatal expander as described by Haas is a rigid appliance designed for maximum dental anchorage that uses a jackscrew to produce expansion in 10 to 14 days.14 He believed that this will maximize the orthopedic effects and forces produced by this appliance have been reported in the range of 3 to 10 pounds. (Figure 4)

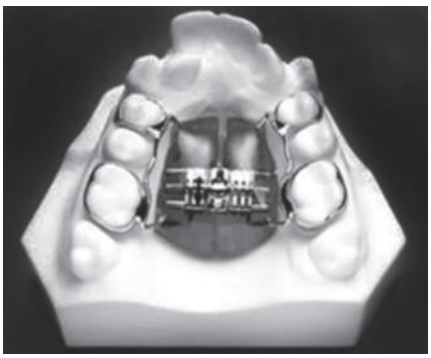

Figure 4 Haas Type

Mid palatine sutures play a key role in R.M.E: (figure 5)

- Shape of mid palatal suture in Infancy - y shape
- Shape of mid palatal suture in Juvenile - t shape
- Shape of mid palatal suture in Adolescence-jigsaw puzzle

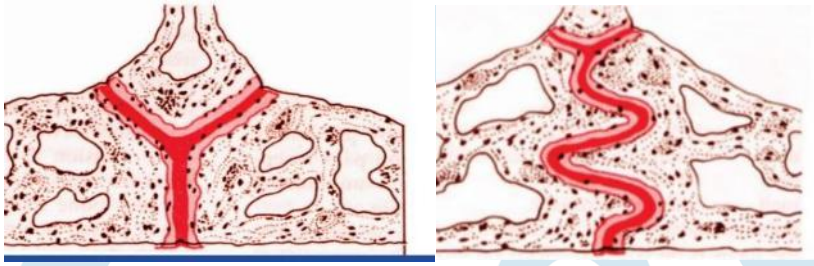

Figure 5 Shape of Midpalatine Suture

- **Slow Maxillary Expansion:**

SME procedures produce less tissue resistance around the circummaxillary structures and, therefore improve bone formation in the intermaxillary suture.

Slow expansion has been found to promote greater post-expansion stability, 2if given an adequate retention period.

Prefabrication eliminates extra appointments for impressions and the time and expense of laboratory fabrication. For SME, 10 to 20 newton's 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.

Advantages of SME:

It continuously distributes physiologic force, until the necessary expansion is attained

1. There is minimum tipping of anterior teeth.
2. Least strain is exerted on anchored teeth.
3. The appliance is light and comfortable to the patient.
4. Relapse tendencies are less.
5. It can be used for sufficient retention after the expansion.
6. Time required for retention is less.
7. Throughout its use, it takes little adjustment and makes adjustments simple when needed.
8. Maintenance of sutural integrity and the reduced stress loads within the tissues
9. Do to lighter force application, patient experiences less discomfort and pain.

Disadvantages of SME:

Longer treatment duration compared to rapid palatal expansion.

Classification of Slow Maxillary Expansion Appliances:

Slow maxillary appliances can be broadly classified as follows:

- **Removable**
    1. Coffin spring
    2. Active palate
    3. Y- plate
    4. Schwartz appliance
- **Fixed**
    1. Quad helix
    2. Minnie expander
    3. Spring loaded expander
    4. W arch
    5. Spring jet [1-4]

1) Coffin spring:

In the year 1875, Sir Walter Coffin invented the coffin spring.

The appliance comprises of an omega-shaped wire put in the mid-palatal area and an adam's clasp in the first premolars and first molars on both sides. The appliance's components are embedded within an acrylic base plate and constructed from 1.2 mm stainless steel wire. The appliance is largely suggested to cause dentoalveolar alterations in cases of unilateral or bilateral crossbite, cases requiring lateral expansion, cases requiring anteroposterior expansion, and cases where the space required is less than 3 mm. However, some amount of skeletal changes can also be brought about in mixed dentition period if proper retention protocol is maintained. [5] (Figure 6)

Figure 6 Coffin Spring

2) Active plate:

Pierre Robin first proposed the idea of an active plate in 1902. He fabricated a split acrylic plate with a screw in the middle to allow the arch to expand. According to Proffit, the majority of screws open 1mm every full rotation, translating to 0.25mm of tooth movement per quarter turn. The active plate are most useful when few millimetres of space is required (1.5-2mm per side). [3] (Figure 7)

Figure 7 Active Plate

3) Schwartz appliance :

In 1966, Schwartz developed the Schwartz appliance. It is mostly constructed for the mandible and is a removable expansion plate. The appliance is indicated during the phase of mixed dentition. The device is secured with ball or Adam's end clasps and has a labial bow as well. The Schwarz appliance may be helpful for patients with short arch lengths and/or posterior teeth with abnormal lingual inclinations. The activation of the midline screw, which causes the Schwarz appliance to gradually expand, only causes the posterior teeth to point laterally .This is followed by rapid maxillary expansion which would stabilize mandibular dentoalveolar position during the retention period. [3] (Figure 8)

Figure 8 Schwartz Appliance

4) Quad Helix:

Robert Ricketts first introduced it in 1975. It is an upgrade of the W arch appliance. The indications include the following:

a) All crossbites require upper arch extension;

b) Cases of crowding necessitating mild expansion.

c) Class II cases requiring molar distal rotation;

d) Class III instances requiring maxillary arch surgery;

e) Situations involving tongue thrusting;

f) Patients with cleft lip and palate.

The .038 Elgiloy, No. 4 Gold, or 1 mm S.S. that makes up the quad helix is used. The distal surfaces of the canines are level with the anterior bridge. The palate is where the anterior helices are located. Distal to the first molars is where the posterior helices are located. These slope in a straight line with the palatal surface. Prior to cementation, the activation is completed. To separate the midpalatal, Ricketts advises 500 mg force. [6] (Figure 9)

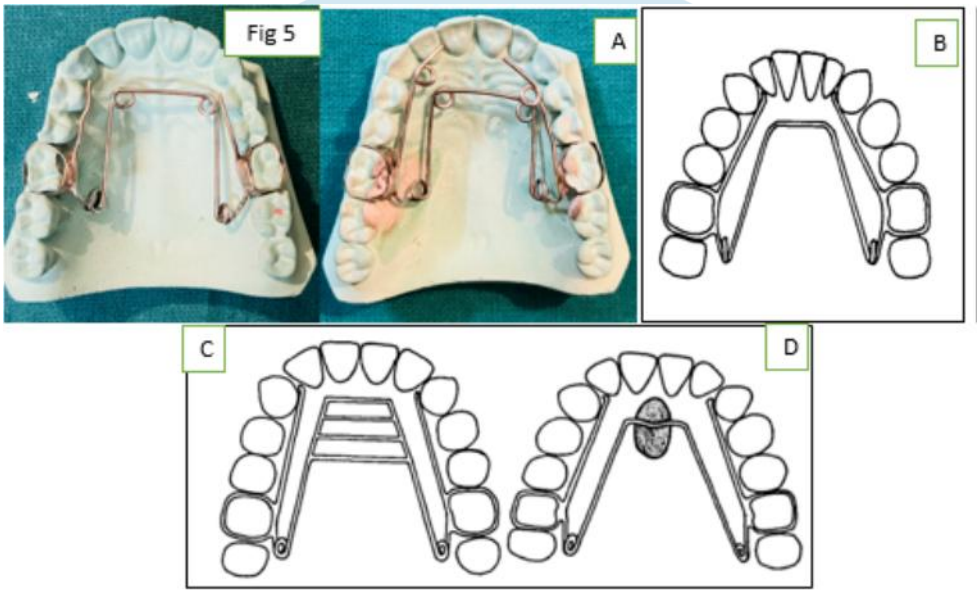

Figure 9 Quad Helix And Modifications of Quad Helix

➢ **Modifications:**

The quad helix appliance may be modified in a number of ways. Modifications usually fall into one or more of the following categories:

1. Increased number of helices: Extra helices may be introduced to procline the upper incisor teeth in order to allow for anteroposterior extension. If space maintenance and molar derotation rather than upper arch extension are the goals of treatment, a palatal button may be exchanged for a palatal button with fewer helices and anterior helices omitted. (Figure 9A)

2. By convention, a device with only posterior helices that is positioned in the lower arch is referred to as a "bihelix." (Figure 9B)

3. Addition of habit breaking auxiliaries, Bench et al. (1978) describe the addition of tongue spurs and grids to discourage digit or tongue sucking habits. [7](Figure 9C)

5) W arch:

Robert Ricketts first created the W arch appliance in 1975.

It is a fixed device in the form of a horseshoe that is attached to the molar bands on either side. In the maxilla and mandible, where modest growth is favoured, it is advised. The construction of the lingual arch is done 1-1.5 mm away from the palate in order to prevent any harm to the soft tissues. The W arch appliance is activated by opening the apices of the appliance. The appliance is preactivated before insertion by opening up the apices by 3mm in order to give the proper force levels. [6] (Figure 10)

Figure 10 W Arch

6) Spring Jet:

The molar bands are soldered to or otherwise connected to the spring jet's active components. To ensure that forces pass close to the centre of resistance of maxillary teeth, the telescopic unit is positioned up to 5 mm from the centre of the molar tubes. However, it should be 1.5 mm away from the palatal tissue. In the mixed dentition, 240 gm of force is used, and 400 gm in the permanent dentition. The lock screw must be moved horizontally along the telescopic tube to activate. A ball stop on the transpalatal wire allows the spring to be compressed. (Figure 11)

Figure 11 Spring Jet

7) Spring Loaded Expander:

Leone debuted the spring-loaded expander (SLE) in 2003.

SLE has the ability to generate either a 500g or an 800g of force, depending on the requirement for expansion. Every six weeks, the gadget receives an average of 4 to 8 activations (0, 4-0, 8 mm). The force applied to the dental structures will remain consistent in intensity regardless of the number of activations (500 or 800g.). Since the screw will become inactive once it has expanded by the predetermined amount, there is no chance

of over-expansion. However, fast maxillary growth can also be accomplished utilising SLE by altering the activation sequence. [6] (Figure 12)

Figure 12 Spring Loaded Expander

➢ SURGICALLY ASSISTED RAPID PALATAL EXPANDER (SARPE):

Surgically assisted RPE is an alternative method which reduces resistance of the closed midpalatal suture to correct maxillary constriction in an adult. It helps to achieve effective maxillary expansion in a skeletally mature patient.

INDICATIONS OF SARPE:

- To increase the maxillary arch perimeter
- To correct posterior crossbite, and when no additional surgical jaw movements are planned,
- To widen the maxillary arch as a preliminary procedure, even if further orthognathic surgery is planned,
- To widen maxillary hypoplasia associated with clefts of the palate.

COMPLICATION:

Palatal tissue irritation is a frequent complication of SARPE. [1]

Modification of palatal expander:

➢ Leaf expander(LEX):

The design of the Self Expander is similar to that of a Leaf Expander, [10] except that it is equipped with three preactivated, nickel titanium double springs instead of a leaf spring and a reactivation screw. These leaf springs, which are compressed during fabrication in the laboratory, recover their shape during deactivation, generating a constant 450g of force for as much as 9mm of calibrated expansion.

Like the Leaf Expander, the Self Expander is typically anchored to the deciduous teeth, [11-12] with the upper first permanent molars left free to expand spontaneously (Figure 13). The body of the 11mm × 12mm × 4mm screw can be adapted to fit a narrow palate or an arch with transverse deficiency. The arms connecting the screw and the lateral components must be kept about 2.5mm clear of the palatal mucosa to avoid ulceration. The screw is blocked with metal ligatures that are removed immediately after cementation to start the self-expansion.

The patient should be monitored monthly for expansion and oral hygiene. Active expansion takes about six months, after which the appliance should be maintained passively in place for three months of retention. [13] (Figure 13)

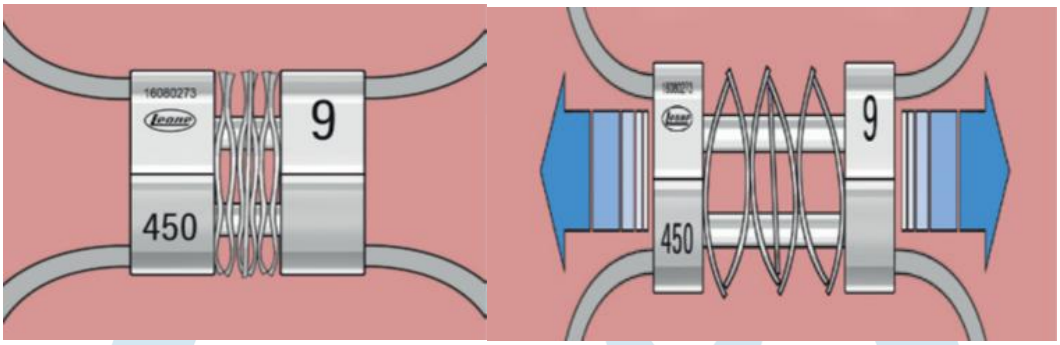

Figure 13 Leaf Expander

A. Self-expander with three double-leaf springs compressed by laboratory before delivery.

B. Springs decompress during treatment and generate constant 450g of force.

➢ MICRO IMPLANT ASSISTED R.M.E:

To achieve maximum skeletal expansion by overcoming the undesirable dento-alveolar effects, a non-surgical MICROIMPLANT-assisted R.M.E technique was introduced. [8]

Miniscrews are employed onto the maxillary expanders that recruits palatal and nasal cortices which provides anchorage that facilitates opening of midpalatal suture and helps to overcome resistance from circummaxillary sutures.

Paramedian area 3mm lateral to the suture in 1st premolar region is considered the most appropriate site for placement of miniscrews, anterior screws are placed in rugae. [9]

TREATMENT OBJECTIVES:

- To establish acceptable buccal occlusion
- To minimize buccal tipping
- To maximize skeletal expansion
- To maintain sound periodontal and bone support

As the appliance is tooth and tissue borne, it is used in late teens to mid-twenties. Clinical observations suggest that MARPE prevents many adverse effects of RPE and is preferred as effective alternative for the same.

CONCLUSION:

In the past, it was thought that extracting teeth was the best way to make room. Nonetheless, the question of whether the dentition and associated structures can endure tooth extraction. Arches are among the simplest and safest ways to increase your available space. Although it has been shown that both rapid and slow maxillary arch growth result in long-term stability, researchers are leaning toward the skeletal and dental effects of slow maxillary palatal expansion because of the aggressive nature of rapid palatal expansion on tissues.

There are several methods for achieving maxillary dentition and maxilla expansion. The kind of growth is significantly influenced by the skeletal and dental patterns chosen, as well as the kind of expansion that is chosen, can significantly aid in achieving the overall goals of treatment.

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