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Slow maxillary expansion: A review

K. Venkateshwaran
PG Student (Second Year),Department of Orthodontics & Dentofacial Orthopaedics, Desh Bhagat Dental College & Hospital, Desh Bhagat University, Mandi Gobindgarh

Sukhpal Kaur
Professor, Department of Orthodontics & Dentofacial Orthopaedics, Desh Bhagat Dental College & Hospital, Desh Bhagat University Mandi Gobindgarh

Shaon
Lecturer, Department of Public Health Dentistry, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh, India

***Abstract*---**Constricted maxillary arch is one of the most common problems faced by an Orthodontist while treating young as well as adult patients. Maxillary expansion occupies a unique niche in dentofacial therapy and it has been a topic of debate since centuries. Slow maxillary expansion, rapid maxillary expansion and surgically assisted rapid palatal expansion (SARPE) are the commonly used methods for maxillary expansion. Slow maxillary expansion is a procedure to expand the maxillary arch in transverse dimension to correct the constricted maxillary arch with light forces. This review article provides detailed information about various slow maxillary expansion appliances with their implications in orthodontics.

***Keywords*---**maxillary expansion, slow maxillary expansion, rapid palatal expansion, crowding.

Introduction

A major portion of the treatment rendered in any orthodontic practice is concerned with lack of space in the transverse and sagittal direction results in crowding of teeth within the alveolus. Orthodontic philosophies over the years have vacillated between a strict non-extraction approach and an approach, which requires the extraction of teeth[1]. Maxillary arch expansion has been studied since centuries. Both slow as well as rapid palatal expansion appliances employedto correct the constricted maxillary arch by expanding the arch in transverse dimension. Emerson C. Angell in 1860[2], reported his first case of successfully

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***Corresponding author**: Venkateshwaran, K.; Email: venkateshwaran138@gmail.com*
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splitting the maxilla using a jack screw appliance. He was considered as the father of rapid maxillary expansion. The effectiveness of transverse expansion of palate with opening up of the mid palatal suture was stressed by Farrarand Clark Godard later in the year 1893. Practitioners select treatment appliances based on their personal experiences and on the patient's age and malocclusion.[3,4] Normal palatal growth is nearly complete by age 6[5] and increasing interdigitation of the suture makes separation difficult to achieve after puberty[6-11]. Slow maxillary expansion can be also called as dentoalveolar expansion where appliances are used to increase the width of the palate in transverse direction. Although the expansion is purely dental, some amount of skeletal changes are seen.This article aims to review the slow maxillary expansion and commonly used appliances.

Slow maxillary expansion (SME)

Slow maxillary expansion involves the use of relatively lesser forces over long time period. Here the results are more stable when the maxillary arch is expanded at the rate of 0.5 to 1mm per week. Isaacson, Ingram and Zimring[12,13]have suggested that slower rates of expansion would allow for a physiologic adjustment at the maxillary articulations and would prevent the accumulation of large residual loads within the maxillary complex. 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 Rapid maxillary expansion. Slow maxillary expansion has been found to promote greater post-expansion stability[14,15], 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. Prefabrication eliminates extra appointments for impressions and the time and expense of laboratory fabrication. For SME, 10 to 20 newtons of force can be applied to the maxillary region that can produce expansion of 0.5 to 1 mm per week.[16-18]

Indications of SME

- Unilateral or bilateral crossbites
- To correct minimal crowding by gaining space.
- To correct dental crossbite in permanent dentition.
- To correct mild maxillary deficiency in cleft lip and palate patients by providing slow continuous forces.

Contraindicationsof SME

- Adult patients who have completed their growth.

Advantagesof SME

- It delivers a constant physiologic force until the required expansion is obtained.
- There is minimum tipping of anterior teeth.
- Least strain is exerted on anchored teeth.

- The appliance is light and comfortable to the patient.
- It can be used for sufficient retention after the expansion.
- Relapse tendencies are less.
- Time required for retention is less.
- It requires minimal adjustment throughout its use, and allows easy adjustment when necessary.
- Maintenance of sutural integrity and the reduced stress loads within the tissues
- Less pain and discomfort due to light forces.

Disadvantages of SME

- Longer treatment duration compared to rapid palatal expansion.

Age factor on treatment outcome

According to Profitt[19] expansion in younger children can be produced with 1-2lbs of forces. However in adolescents, more dental changes are observed compared to the skeletal changes. Hicks stated that expansion in adults produced more dental changes by tipping of the posterior teeth, increased activation provided minimal expansion whereas aggressive activation lead to tipping of the anchored teeth which are mainly the molars. In his study he used 2 lb force with estimated expansion rates of 0.5 to 1.0 mm per week, however he achieved maxillary arch width increase of 3.8 to 8.7 mm during treatment. According to him the skeletal changes represented 24 to 30 percent of the total arch width increase in 10 to 11-year-old patients whereas in 14-15 years old,it was 16 percent.

Effects of SMEon mid-palatal sutures

According to Storey et al in 1973 stated that the opening of the mid-palatal suture occurs when sutural integrity is maintained during remodelling of maxilla. Ekstrom et al in 1977 proved that with SME there is less traumatic disruption, a greater reparatory reaction, and greater sutural stability than rapid expansion of sutures. According to Bell[20] et al in 1982 the rate of midpalatal suture separation by slow expansion systems apparently allows a more physiologically tolerable response by the sutural elements than the disruptive nature of rapidly expanded maxillary segments. Moyers et al in 1974 mentioned that slow expansion procedures increase the percentage of orthodontic movements as the tensile strength of the suture elements is not overwhelmed. Zachrisson et al in 1982 did a comparative study on slow and rapid palatal expansion and concluded that periodontal breakdown on the buccal aspects of the posterior teeth occurred in both the groups however the groups which were treated with rapid palatal expansion the occurrence of attachment loss was higher.

Appliances for slow maxillary expansion

Expansion of the arch is a tempting means of gaining space, with the added advantage of being a conservative procedure that does not require extraction of teeth as an actual part of therapy. Slow maxillary appliances can be broadly classified as follows:

- REMOVABLE
  - ✓ Coffin spring
  - ✓ Y plate
  - ✓ Shwartz appliance
  - ✓ Active plate
- FIXED
  - ✓ W arch
  - ✓ Quad helix
  - ✓ Spring jet
  - ✓ Niti palatal expander
  - ✓ Minnie expander
  - ✓ Spring loaded expander
  - ✓ Magnets

Coffin Appliance (fig.1)

Given by Walter Coffin–1875. It is a removable appliance capable of slow dento alveolar expansion. The appliance consists adam's clasp in the first premolars and first molars of both sides with an omega-shaped wire of 1.25 mm thickness, placed in the midpalatal region. The free ends of the omega wire are embedded in acrylic covering the slopes of the palate. The spring is activated by pulling two asides apart manually. The appliance is mainly indicated to bring about dentoalveolar changes in cases of unilateral or bilateral crossbite, Cases where lateral expansion is indicated, Cases requiring antero-posterior expansion, and when space requirement 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.

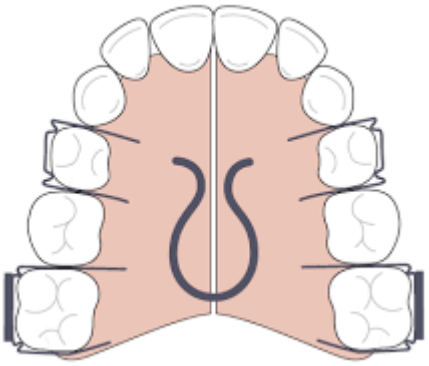

Fig.1. Coffin appliance

Y Plate (fig.2)

It is an active type of removable expansion appliance which is similar to that of the bite plate with Adams clasps serving as an anchorage or retentive component in the premolars and molars region.The labial bows fitted in the anterior region and the retentive arm is embedded in the acrylic. The acrylic plate is splitted into Y shaped and has two jack screws placed between the anterior and posterior half

of the acrylic plate which exerts a distalizing force[21]. The jackscrews on activation exert a distalizing force on the buccal segment teeth and a reciprocal force is delivered to the anterior palatal contour and maxillary incisors. To avoid the incisors to tip labially and dislodge the entire appliance the jackscrews are activated alternatively.The Y plate is indicated in patients with first premolars erupted, giving increased anchorage, upright incisors and where no extensively bodily movement are required.

Fig.2. Y-Plate

Shwartz Appliance (fig.3)

The Shwartz appliance was introduced by Shwartz in 1966. It is a removable expansion plate mainly given in the mandible. The appliance is indicated during the mixed dentition phase. The appliance basically consists of an acrylic plate with a midline split incorporating one or two expansion screws, the acrylic does not cap the occlusal surface or incisal edges. The appliance in addition has a labial bow & is retained by means of Adam's or ball end clasps. The Schwarz appliance can be used in patients who have arch length deficiencies and/or posterior teeth that have an abnormal lingual inclination. The gradual expansion of Schwarz appliance produced by activation of midline screw, simply tips the posterior teeth in a lateral direction .This is followed by rapid maxillary expansion which would stabilize mandibular dentoalveolar position during the retention period.

Fig.3. Schwartz appliance

Active Plate (fig.4)

The concept of active plate was introduced by Pierre robin in 1902. He constructed a split acrylic platewith a screw incorporated in the midline for arch expansion.The active plate consists of acrylic base which serves as a base in which screws or springs are embedded and to which clasps are attached. The expansion screws are the active components of this removable appliance. According to Proffit most screws open 1mm per complete revolution, so that a single quarter turn produces 0.25mm of tooth movement.The active plates are most useful when few millimetres of space is required (1.5-2mm per side).

Fig.4. Active plate

W-Arch (fig.5)

The "W" expansion appliance was originally used by Ricketts and his colleagues[22] in the year 1975 to treat cleft palate patients. The W-arch is a fixed horseshoe shaped appliance constructed of 36 mil steel wire soldered to molar bands on either side. To avoid soft tissue irritation, the lingual arch should be constructed so that it rests 1-1.5 mm off the palatal soft tissue. It is activated simply by opening the apices of W-arch and is easily adjusted to provide more anterior than posterior expansion, or *vice versa* if this is desired. The appliance delivers proper force levels when opened 3-4 mm wider than the passive width and should be adjusted to this dimension before being inserted. Expansion should continue at the rate of 2 mm per month until the cross bite is slightly overcorrected.

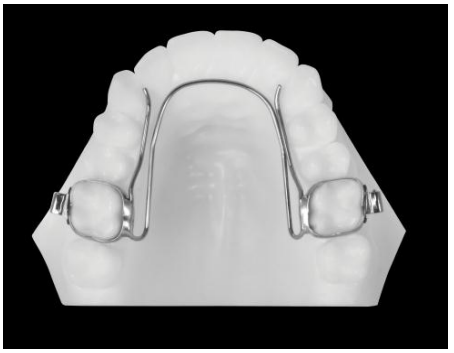

Fig.5. W-arch

Quadhelix (fig.6)

The quadhelix appliance is a modification of Coffin's W-spring and was described by Ricketts. The incorporation of four helices into the W-spring helped to increase the flexibility and range of activation. The length of the palatal arms of the appliance can be altered depending upon which teeth are in crossbite. A new generation of prefabricated appliances, constructed from nickel titanium, have been introduced more recently. The advantages of using nickel titanium over stainless steel include its more favourable force delivery characteristics as it has superelastic properties. This may help to produce more physiological tooth movement with more rapid correction of crossbites.

Fig.6. Quadhelix appliance

Mode of action

The quadhelix appliance works by a combination of buccal tipping and skeletal expansion in a ratio of 6:1 in prepubertal children.

Clinical management

The desirable force level of 400 gm can be delivered by activating the appliance by 8 mm, which equates to approximately one molar width. Patients should be reviewed on a six-weekly basis. Sometimes, the appliance can leave an imprint on the tongue, however this will rapidly disappear following treatment. Expansion should be continued until the palatal cusps of the upper molars meet edge-to-edge with the buccal cusps of the mandibular molars. A degree of overcorrection is desirable as relapse is inevitable. A three-month retention period, with the quadhelix in place, is recommended once expansion has been achieved. If fixed appliances are being used, the quadhelix can be removed once stainless steel wires are in place.

- *Advantages:* It provi
  Desgood retention, a large range of action, orthopaedic effect, differential expansion, act as habit breaker, fixed appliances can be incorporated, molar rotation/torque, non-compliance and cost-effective.
- *Disadvantages:* Molar tipping, bite opening, limited skeletal change.

Spring Jet (fig.7)

It is a is a prefabricated appliance which consist of a Niti coil spring(active component) and supporting components are made up of stainless steel wire.TheNiti coil spring jet is soldered or attached to the molar bands on both sides. The telescopic unit is placed upto 5 mm from center of molar tubes so that the forces pass close to the center of resistance of maxillary teeth, but it should be 1.5 mm away from palatal tissue. Force applied in mixed dentition is 240 gm and 400 gm in the permanent dentition. Activation is done by moving the lock screw horizontally along the telescopic tube. A ball stop on the transpalatal wire allows the spring to be compressed. The spring jet is activated by turning the lockscrew by 90 degrees every two weeks to keep the spring compressed for slow palatal expansion.

Fig.7. Spring jet appliance

NiTi Expander (fig.8)

The Nickel Titanium Palatal Expanders were introduced by Wendell V[23]. It generates optimal, constant expansion forces. The central component is made of a thermally activated NiTi alloy and rest of component is made of stainless steel. The expander may be used simultaneously with conventional fixed appliances, requiring only an additional lingual sheath on the molar bands. The action of the appliance is a consequence of nickel titanium's shape memory and transition temperature effects. The nickel titanium component has a transition temperature of 94° F. At room temperature, the expander is too stiff to bend for insertion. Chilling the expander softens the central component allowing easy manipulation. Once placed, stiffens and begins to return to its original shape. A 3 mm increment of expansion exerts only about 350 gm of force[24] and the nickel titanium alloy provides relatively uniform force levels as the expander deactivates. Nickel titanium expanders are available in eight different intermolar widths, ranging from 26mm to 47mm, and generates forces of up to 180-300g. The 26-32mm sizes have softer wires that produce lower force levels for younger patients. Marzban et al in 1999 stated that it delivers a uniform, slow, continuous force for maxillary expansion, molar rotation and distalization, and arch development. This appliance expands at a rate that maintains tissue integrity during repositioning and remodelling of the teeth and bone.

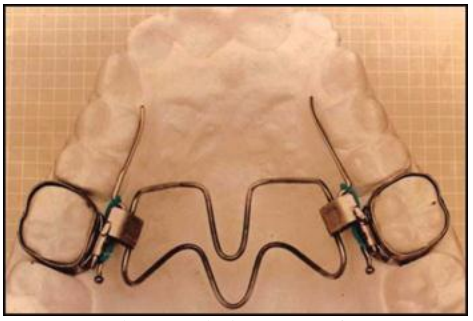

Fig.8. NiTi Expander

MinneExpander (fig.9)

Minne Expander is a fixed, slow maxillary expansion appliance cemented to the first permanent molars and first premolars. It is used to increase maxillary width by activating the palatal compressed-coil spring. According to Hicks 1978, the Minne-expander appliance spring applies forces of up to 10 N which is up to 2 pounds. Each incremental activation of the Minne-expander produces 0.125mm of expansion .It has lessened effect to the maxillary sutures and the consequent healing and repair of the latter during the expansion procedure makes it more physiologic in nature. The disadvantage of this appliance includes poor oral hygiene maintenance.

Fig.9. Minne Expander

Spring Loaded Expander (fig.10)

The spring loaded expander (SLE) was introduced by Leone in 2003. The SLE is a new expansion device that produces slow palatal expansion with light continuous forces. The appliance is indicated in patients whose growth is completed. They produce accurate force levels due to the control on the spring. Depending on the need of expansion SLE can produce either 500g or 800g of force. The appliance consists of bands surrounding the molar with screw attached to the centre. The spring provides a continuous force, sufficient to promote a dentoalveolar remodelling that is biologically ideal and biomechanically controlled. The screw has a self-stop mechanism at the end of expansion to prevent it from

disassembling in case of excessive activation. The device is activated on average, 4-8 activations (0, 4-0, 8 mm) every 6 weeks. A different number of activations will not alter the intensity of the force delivered to the dental structures, as this stays constant (500 or 800g.).There is no risk of over-expansion as the screw, upon reaching the pre-determined expansion, will become passive. However, by changing the activation pattern, rapid maxillary expansion can also be achieved using SLE.

Fig.10. Spring loaded Expander

Magnets

Repulsive magnetic forces for maxillary expansion were first described by Vardemon et al 1987.[25] Banded magnets produced more pronounced skeletal; versus overall expansion effects. The continuous force of 250-500 gm could generate dental and skeletal movements, the degree depending on patients status (age, growth, etc). Disadvantage of magnets is that they tend to be oxidized in the oral environment due to the potential formation of corrosive products but this can be overcome by coating magnets. The advantage of these magnets is that they impart measured continuous force over a long period of time, hence the risk of external root resorption is decreased. These magnets are quite bulky as they must be adequately stabilized and contain stout guide rods to prevent the magnets becoming out of line and causing unwanted rotational movements.

Conclusion

Arch expansion is considered one of the safe and ideal means of gaining space. Expansion of the maxilla and the maxillary dentition may be accomplished in numerous ways. The type of skeletal and dental pattern greatly influences the type of expansion chosen and the type of expansion selected can greatly facilitate the overall treatment objectives. Although both rapid as well as slow maxillary arch expansion have proven to produce long term stability, due to the aggressive nature of rapid palatal expansion on tissues, researchers are inclined towards both skeletal and dental effects of slow maxillary palatal expansion. However further clinical trials have to be carried out to discuss the effects of SME on dentition.

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