REVIEW ARTICLE

Space regainers in pediatric dentistry

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Abstract

Premature loss of deciduous teeth due to caries or any other iatrogenic factors prevents development of normal occlusal relationship. In interceptive orthodontics, the severity of developing malocclusion and complex orthodontic treatments are minimized or reduced which further may help in reducing the overall treatment time. In the recent era, for successful resolution of space discrepancies, various interceptive measures involving non-extraction approaches were satisfactory. This article is an overview which depicts a range of space regaining appliances used to overcome or reduce space discrepancies.

Introduction

Premature exfoliation or extraction of deciduous tooth or teeth can frequently lead to the development of malocclusion. Early orthodontic interventions are often in the beginning of developing dentition help to promote favorable developmental changes.[1] The term interceptive orthodontics includes timely management of hostile features of a developing occlusion. Interceptive orthodontics is defined as a phase of science and art of orthodontics employed to recognize and eliminate the potential irregularities and malpositions in the developing dentofacial complex.[2] Guiding the erupting and developing deciduous and permanent teeth and developing occlusion forms an essential part of the preventive care of pediatric patients. Such assistance will lead to the development of a permanent dentition in a harmonious, functional and esthetically acceptable occlusion.[3] In 1998, Hoffding and Kisling reported that premature loss of primary teeth caused space loss.[4] As a result of space loss, the permanent tooth may remain impacted, or it may erupt buccally or lingually.[5] In the case of premature loss of primary second molars, the space closure is much more than premature loss of primary first molar. In such circumstances, where there is space loss, routinely we require space regainer. Various appliances will help for both regaining the lost space as well as its maintenance for the eruption of the permanent tooth. At the initial appointment, the appliance is activated to regain the lost space and then it is kept passive till the tooth is erupted into the oral cavity. The dual function of the appliance will reduce the cost to the parents and saves time for both the dentist as well as for the patient.[3]

For performing any interceptive measures like space regaining or any mesial or distal movement of teeth, diagnosis is of utmost importance. If the attention is not given to the segment in which tooth is missing, it may become the frequent cause of failure in attempting to regain the space.[1] Treatment considerations include the alignment of the teeth and the space required for the teeth to align in the basal bone, the position of the teeth within the arch, the occlusion in both transverse and sagittal plane, and the relation of the maxilla and mandible with the cranium and the soft tissue. The diagnostic aids necessary to develop a database for the above consideration include study models, radiographs of all periapical structures, clinical assessment of facial asymmetry and proportions, and possibly cephalometric analysis. Interceptive orthodontics is employed to recognize and eliminate potential irregularities and malposition in the early maxillofacial complex. The various techniques recommended for reducing or eliminating developing irregularities and malocclusion are serial extractions, space regaining, etc., In preventive and interceptive orthodontics, if the right treatment is done at an early age, then no further treatment would be needed.[6]

Diagnosis

Radiographs and study models are used for assessing space required and alignment of the tooth in the arch. The forces

required for tipping teeth for aligning the teeth are easily manageable than the forces required to bodily return tooth to its proper position in the arch. So it is essential to diagnose whether teeth have moved bodily into the space or tipped axially. Another important aspect in the diagnosis is the position of the erupting tooth distal to the tooth to be moved, i.e. permanent second molars as they have the potential to be impacted by the severe distalization of permanent first molar. Radiographs of the periapical structures are necessary.[1,2]

Space regaining procedure required certain dental alignment considerations that are rotation of the tooth, improper contacts and transverse relation of teeth. Study models will provide the best data resource for these considerations. Study models permit visualization of vertical, transverse and sagittal dental relationship that might hinder stability of Moyer's mixed dentition analysis and will be a good aid to determine measurement of space loss against an estimation of the space needed by the unerupted permanent tooth. Estimation based on radiographs demonstrates variance because of difficulties in standardized film placement, especially in the small mouth of the child with early mixed dentition.[6]

Several problems are associated with the regaining procedures. Usually, minimal space loss can be regained better. The space regaining procedure that involves tipping of first permanent molar can be accomplished more easily in the maxillary arch than in the mandibular arch. The procedure should be limited to those cases in which the occlusion is Class I, there is adequate anchorage, the second permanent molar is unerupted and there is favorable relationship of second permanent molar with the first permanent molar.[6]

For positioning the first permanent molars with use of an appliance, the reciprocal force which will be produced will get dissipated on the anterior teeth and surrounding supporting tissues which ultimately can lead to a detrimental movement of teeth anterior to the space loss e.g. flaring of the anterior teeth. This particularly occurs during the mixed dentition period when the permanent incisors are incompletely erupted and adversely influenced by even minimal forces. Furthermore, the forward movement of the unerupted, second permanent molar accompanies the forward movement of first molar, and any attempt to tip or reposition the first permanent molar may produce an impaction of the second molar.[6]

In favorable situations, an effort should be made to regain space. Various removable and fixed appliances are used for space regaining. However, distalization or bodily movement of molars can be most satisfactorily achieved by headgear appliance.[2]

Removable Space Regainers

Goodale described three types of removable space regainers.

Free end loop spring space regainer

It utilizes a labial archwire which provides stability and retention, a back-action loop spring of no. 0.025 wire and an acrylic base of the appliance. At certain intervals of time, the free end of the loop is activated to achieve desirable movement of the tooth. A light force on the tooth to be moved is desired. The appliance should be checked and adjusted as often as necessary to maintain the light force on the molar. The type of loop spring wire can be changed to fit any situation, depending on the position of the tooth and the distance it needs to be moved.[3]

A free-end loop space regainer for the lower arch has a shorter wire loop, resulting in less distortion when the child inserts the appliance.

Split-block space regainer

Split- block space regainer or split saddle space regainer differs from the free end spring type of space regainer. It consists of a dumbel constructed with a no. 0.025 wire which extend buccolingually and an acrylic block that is split buccolingually. The acrylic plate is split with the disk to form an activator portion, and the appliance is activated buccolingually periodically for tooth movement. The activator portion of the split block appliance is essentially the same as one that has been designed to establish a space for fixed bridge therapy. The unilateral type used for adults should not be used in the child's mouth, however because of the risks of loss of swallowing[2] [Figure 1a].

Fixed loop-spring space regainer

It differs from other types only in the design of the spring activation. This appliance resists breakage and provides a satisfactory method of moving the molar distally. The mesial portion of the spring loop is embedded in the resin and passed out through the edentulous space. This portion of the wire should contact the distal surface of the tooth which is mesial to the space. This prevents distal movement of this tooth. A loop is then formed, and the wire returned back to contact the mesial surface of the first permanent molar. At this end, the wire is bent around a stable embedded in the resin. The spring loop should be allowed to move freshly on the staple. Retention of

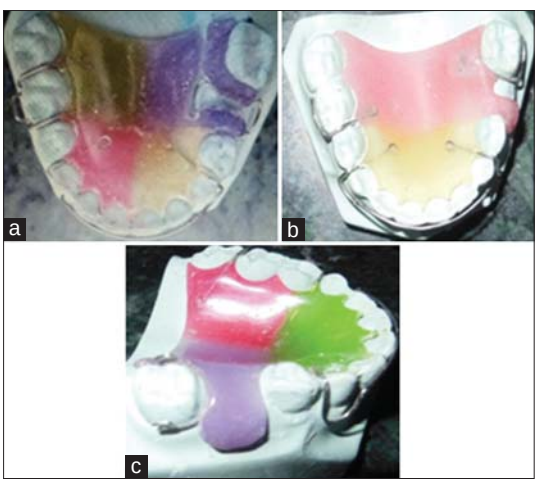

Figure 1: (a) split saddle, (b) fixed loop and spring, (c) sling shot

this appliance is gained by the use of wire clasps. Orthodontic wire of no. 0.025 or no. 0.030 dimension is embedded in the acrylic resin, brought through the embrasure and then bent down to contact the teeth below the contact points. After the desired movement of the permanent molar has been attained, the appliance may be used as a space maintainer by soldering the activator portion of the spring to the guide wire in its passive position, or by filling in the edentulous region with additional resin[2] [Figure 1b].

Sling shot space regainer

Sling shot space regainer distalizes molar with a wire elastic holder with hooks as an alternative to spring which transmits a force against the tooth to be distalized. It is termed as sling shot appliance, as the forces to distalize tooth were produced by the elastic which was stretched on the middle of the lingual and the buccal surface of the molar to be moved. The child places new elastic between the hooks while the appliance is outside the mouth. It is slipped into place then the child's fingers can guide the elastic into proper position. If the appliance is of a removable type, periodic checking should be done to evaluate whether the patient is using it or not, whether there is any distortion or breakage of the appliance or irritation of soft tissues. If the teeth are emerging underneath the appliance, the portion of the acrylic is cut off to give way for the teeth to erupt into position. In case of fixed appliances, check for any breakage of the appliance at the soldered joints or band material. It is also checked that whether the appliance is loose due to dissolution of cement which may result in food lodgement and caries. The appliance is removed every 6 months or 1-year depending on the situation and the abutment tooth is checked for any caries or decalcification. Polishing of the abutment is done followed by fluoride application. Then the appliance is recemented in position. Regular radiographic examination of developing permanent teeth is also necessary. The appliance can be removed or discarded soon after the succedaneous teeth erupted into proper position in the oral cavity[3] [Figure 1c].

Fixed Space Regainers

Jaffe appliance

An appliance for certain minor tooth movements was described by Jaffe (1963), is useful when the presence of ankylosed tooth, early loss of a deciduous molar or an extraction result in filling of adjacent segments into proximal dental area. Movement is obtained by the use of light spring pressure against a sliding section or arch. The appliance consists of buccal and lingual arms of molar bands and the sliding arch to move the desired tooth or teeth.[3]

Gerber space maintainer

It is the type of appliance which may be fabricated chair side with relatively short duration of the appointment as it does not require tedious laboratory procedures. A band is prepared for the abutment tooth and fitted, and the mesial surface is marked for placement of "U" loop, which may be stabilized by welding or soldering. The wire "U" assembly is placed in the molar tube, and the appliance is allowed to contact the tooth mesial to the edentulous space. Expanded center and lower left views show occlusal rest added to the wire section to reduce cantilever effect. An eyelet may be welded to a flattened part of the tube. Next to the band weldable tube stops are soldered on wire portion (lower right) and open coil spring sections are cut to fit over the wire between "stops" and ends of "U" tube. The length of open coil spring is measured by establishing the assembly in desired position and the distance between mesial contact or solder point to the entry of wire in the tube and add the amount of space required or regained, plus additional 1-2 mm to ensure activation of spring. Load springs, tie floss or steel ligature through eyelet and over "U" wire to hold stored force in compressed spring. Compress springs so that the assembly should fit in the edentulous space and cement the assembly in place. After cementation, cut the ligature and remove to activate regainer[2,3] [Figure 2a].

Hotz lingual arch

Another method for moving molars distally utilizes the looped Hotz lingual (Hitchcock 1974). Hotz lingual arch is indicated in situations where the permanent tooth moves mesially rather than distal movement of mesial teeth and also in cases where sufficient space is present for eruption of permanent second molar. The lingual arch provides compound anchorage from all the other teeth which the lingual arch touches. A horizontal spur can be soldered perpendicular to the arch wire contacting the distal surface of the premolar or canine. This compounds the anchorage additionally. The loop on the active side is adjusted periodically once a month. After adjustment, the wire is forced forward and then slipped downward into appropriate space[2] [Figure 2b].

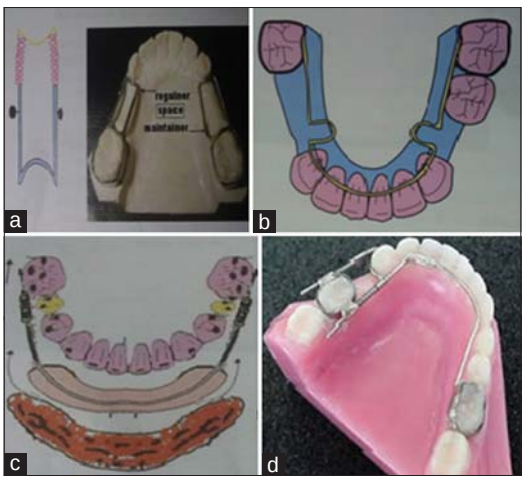

Figure 2: (a) Gerber's space regainer, (b) hotz lingual arch, (c) lip bumper, (d) king's appliance

Lip bumper appliance

Lip bumper appliance is used in the mandibular arch for gaining space or for distalization of molar and its counterpart in the maxillary arch is Denholtz appliance. Molar bands are prepared on permanent first molar and molar tubes are welded on the buccal side of each molar band. Labial archwire is then engaged in both the buccal tube and acrylic button is prepared on the labial vestibule. It transfers forces from lips directly on to the buccal aspect of first molar to distalize the molar[2] [Figure 2c]. It is used in early primary dentition for minimum distalization of molar. Also useful in uprighting the mesially tipped molars to regain space in the arch.

King appliance

King (1977) described an appliance for regaining of space in both maxillary and mandibular arch. The anchorage unit for the mandibular arch is basically a fixed lingual arch with bands fitted on the first deciduous molar of the treatment side and the first permanent molar on the opposite side. Then an edgewise bracket is spot-welded to the buccal surface of the primary molar band, and the completed anchorage unit is cemented in place. A band with an angulated buccal tube is cemented on the malpositioned molar, and a straight section of wire with an open coil spring is introduced into the buccal tube and ligated into the bracket. The anchorage unit must be modified for the treatment in the maxillary arch. A millimeter a month is satisfactory progress in the repositioning of first molar. When a Class I or cusp to cusp molar relation is achieved, a conventional space maintaining appliance should be given[3] [Figure 2d].

Anterior space regainer

Two 0.018 × 0.025 standard labial tubes are adapted into the mouth. A stainless steel mesh is spot welded and trimmed to the tubes. The enamel of the labial surfaces of left central and right lateral incisors is etched with 35% phosphoric acid, and each labial tube is individually bonded to each abutment tooth. When the composite is polymerized, a piece of 0.014" standard round wire is introduced into the lateral incisor tube. The wire is then inserted in a 0.036" × 0.009" open coil spring previously selected and passed through the labial tube of the central incisor. A distal bend is made 2 mm from the distal ends of the tube. After 3 weeks, the coil spring is activated, and after the space is slightly over widened, 0.016" round wire is inserted with the same coil spring. 3 weeks later the wire is changed to a 0.018" and finally to a 0.018" × 0.025" wire, leaving the coil spring only for retention. After that, an acrylic pontic is fixed over the wire and coil spring, using the same type of composite already in the patient's mouth.[3]"

Space Regainer Cum Space Maintainer

A band is made or selected for an abutment tooth, alginate impressions of the both arches are taken keeping the band in place and models are prepared. The wire component for the space regainer comprised of a canine retractor (22 or 23 gauge of wire) or a 'U' loop (21 gauges of wire). The 'U' loop or the canine retractor should be placed a little away from the band on either side of the tooth (buccal or lingual side) depending on space available, eruption pattern of the tooth to avoid heating while soldering the appliance. After soldering the appliance with band, appliance is cemented on teeth. The activation of the appliance comprises of opening the 'U' loop or the coil spring of the canine retractor[7] [Figure 3]. It is indicated for space closure after the premature loss of one tooth. This appliance is effective for space regaining when space is present mesial to the erupting or erupted tooth. Its limitation is in case of severe space loss with multiple unerupted teeth.

Recent Advances

Unilateral spring space regainer

The molar to be distalized and contralateral canine or premolar is banded, and a lingual sheath (0.036" × 0.072") is welded to the band. Impression is taken, and a working cast is prepared by pouring with dental stone. Then adapt two 0.036" stainless steel wires on the model following the curvature of the gingival contour and solder them on the molar band and the bands on the opposite canine or premolar. A Ni-Ti spring is then fabricated and placed in such a way that one end of the wire is inserted in the lingual sheath. On the model, the spring is placed at a level 5-6 mm apical to the center of resistance of the molar. The Nance button is fabricated which covers the palate except the body of the spring with the acrylic resin. Uncovered spring helps in the activation of the appliance by opening of spring 3-4 mm extraorally and then reinserts the sping palatally. This appliance moves the molar distally without any transverse movement when the force is applied from the both buccal and palatal aspects. To counteract rotational movement of teeth both in sagittal and transverse plane, a nickel-titanium open coil spring (0.010" × 0.030")), compressed 10 mm to its resting length should be ligated on the buccal aspect of the molar. The force applied gingival to the center of resistance which results in palatal clockwise movement is counteracted by buccal force applied occlusal to the center of resistance, results in counter clockwise movement. This results in bodily movement of molars without any rotation[8] [Figure 4].

Advantages of USSR are it is easy to construct, cost-effective, produces steady and equivalent forces, allow bodily movement with little or no tipping and efficient where second permanent molar is fully erupted. Limitations of USSR are activation is difficult and strict control of the appointments.

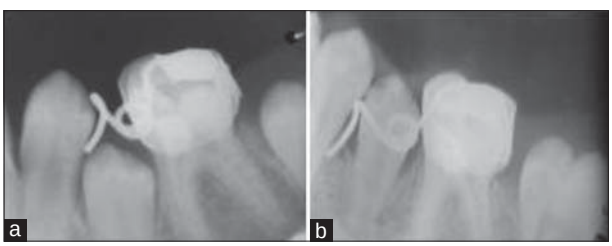

Figure 3: (a and b) Space regainer cum space maintainer

Lingual arch crossbow and double-banded space regainer

The appliance is used for space closure of the primary canines and also missing primary second molar and space is regained by the moving distal teeth distally. A lingual arch space maintainer is prepared to avoid mesial drifting of permanent first molar. Molar tubes (1.1 mm diameter, 10 mm length) are welded to molar bands buccally and lingually. A curved stainless steel wire (0.9 mm width) is constructed angled medially forward, and posteriorly its free ends passing through molar tubes and contains NiTi open coil springs distal to the permanent first molar. Medially angulated wire facilitates distalization of premolar without any transverse movement. Lingal arch crossbow is cemented, and the curved wire is engage the mesio-cervical margin of first premolar by dragging it forward. This forward pull results in compression of the open coil spring to half of their original lengths. These compressed spring exert force between molar tube and posterior free end of the wire which likely to push the wire tags posteriorly that leads to distalization of premolar simultaneously. As the required space is regained, a spring is deactivated by adding self-cure acrylic. This prevents further gain of space, and it works as a space maintainer till the eruption of permanent teeth in its normal occlusal position[9] [Figure 5].

Figure 4: (a and b) Unilateral spring space regainer

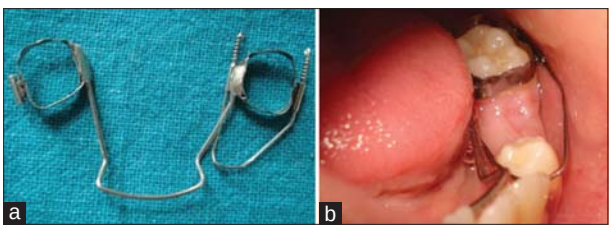

Figure 5: (a and b) Lingual arch crossbow and double-banded space regainer

Conclusion

Management of space problems in the mixed dentition plays an important role in pediatric dental practice. An understanding of the development in the primary and mixed dentitions can help in deciding when and how to intercept the malocclusion due to premature loss of deciduous teeth. Proximal stripping and serial extraction are irreversible and invasive techniques for treating a malocclusion while space regaining with removable and fixed space regainer appliances are noninvasive techniques and helps in interception of malocclusion.

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