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Paediatric Space Maintainers: An Updated Review

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ABSTRACT

The exfoliation of deciduous tooth and eruption of its permanent successor is a normal physiological process. When this normal process is disrupted as seen due to premature loss of deciduous teeth, there is loss in arch length which results in malocclusion. Extractions owing to dental caries, ectopic eruption, and/or trauma are still considered as of the most frequent etiological causes for space loss in children. In such cases the necessity of the preservation of spaces in the mixed dentition arch becomes evident requiring greater professional skill and knowledge of the basic biological principles of changes during the different phases of the occlusal development. The role of pediatric dentist is to expect future arch length discrepancies and formulation of adequate treatment plan consisted space maintainers as and when required as a part of pediatric interceptive orthodontics.

Keywords: Space maintainers, successor teeth, space loss, premature.

INTRODUCTION

When a person senses happiness, pleasure, humor or greetings, a smile develops. Smile makes a lot in our good physical appearance. A good smile can be achieved by good dentition and normal ideal occlusion. When this normal physiological process of deciduous tooth exfoliation and eruption of its successor is disrupted, a series of changes are observed which result in loss in arch length. This unnecessary loss in arch length can be prevented either by proper management of space in the primary and mixed dentition or by interception of the developing malocclusion so that a functional, well aligned and balanced adult occlusion can be achieved [1].

Space maintainers are fixed or removable appliance designed to preserve the space created by the premature loss of a primary tooth or a group of teeth. The space maintainers came under preventive orthodontic which is defined as the action taken to preserve the integrity of what appears to be normal occlusion at a specific time. The objectives of space maintenance includes preservation of primate spaces, preservation of the integrity of the dental arches, preservation of normal occlusal planes and in cases of anterior space maintenance, it should aid in esthetics and phonetics [2].

The proper management of available space during the transition of the dentition may be sufficient to resolve minor to moderate tooth size/arch size discrepancies, particularly if judicious interproximal reduction is used after the permanent dentition has erupted. Therefore, when a primary tooth is prematurely lost, a careful clinical and radiographic examination should be done in order to determine the correct treatment to maintain the arch-length. If a primary tooth is lost during the mixed dentition stage, a set of study models and an analysis of the mixed dentition should be included in the clinical examination [3].

The most important function of space maintainers is to maintain the mesio-distal relationship in a given arch when it is indicated. The use of space maintenance prompted by the untimely loss of primary tooth can prevent or reduce the severity of a developing malocclusion [4]. The preferable approach for space management is to evaluate the space available whether the space is sufficient for eruption of permanent teeth or the regaining of space is necessary.

Model analysis: The study models provides a three dimensional view of the maxillary and mandibular dental arches. Model analysis involves the study of the maxillary and mandibular arches in all the three planes of spaces (saggital, vertical

and transverse planes) and are valuable tools in orthodontic diagnosis and treatment planning. In addition study models are important pre treatment record taken prior to use of fixed or removable orthodontic appliances [5].

The loss of first deciduous molar may be maxillary, mandibular or both, and unilateral or bilateral. Space maintainers should always be placed whenever a deciduous molar is lost prematurely as a general rule. **McDonald** stated that an abnormally high tongue position coupled with a strong mentalis muscle may be damaging to the occlusion after the loss of a mandibular primary molar [2]. A collapse of the lower dental arch and distal drifting of the anterior segment will be the result. The presence of oral habits like thumb or finger sucking provide abnormal forces on the dental arches resulting in collapse of anterior arch after extraction of mandibular primary molar [6].

The potential for space loss when first deciduous molar is lost depends on the different stages of eruption of first permanent molar teeth. When the first deciduous molar is extracted before active eruption the first permanent molars there is obviously no influence on the arch or on the second deciduous molar teeth to cause space loss. The potential for space loss is great during eruption of the first permanent molars since this is the time when the permanent molar exerts a strong eruptive force against the distal crown surface of the second deciduous molar. The lower first permanent molar erupts directly against the deciduous distal crown surface and exerts the strong eruptive force. If the deciduous first molar is lost after the eruption of first permanent molar and are in occlusion with one another, the space loss will occur because of occlusal forces and mesial drift. Most of the principles, problems and procedures which apply for the loss of the first deciduous molar also apply when the second deciduous molars are lost. The potential for space loss is even greater when the second deciduous molars are lost because they normally serve as a buttress for permanent molar eruption. The mandibular first permanent molar strongly depends on the presence of the deciduous second molar distal crown surface for eruptive guidance. Thus, if the deciduous tooth is lost during permanent molar eruption the latter will continue its mesial eruption pathway to produce a severe space loss and tipped position [7].

CLASSIFICATION OF SPACE MAINTAINERS

According to Hitchcock, Space maintainers may be classified in various ways includes removable or fixed or semi fixed, with bands or without bands, functional or non functional, active or passive and certain combinations of the above.
Hinrichsen in 1962 [8] classified space maintainers as follows:

A) Fixed appliances
- Class – Ia) Nonfunctional types
  - i) Bar type
  - ii) Loop type
- Class – Ib) Functional types
  - i) Pontic type
  - ii) Lingual arch type
- Class – II Cantilever type (distal shoe, band & loop)

B) Removable
Acrylic partial dentures.

Mathewson [9] classified the different type of space maintainers as:

1. The band (crown) and loop is used to maintain the loss of a single primary first or second molar.
2. The Nance holding arch maintains the maxillary arch length after the premature loss of more then one primary maxillary molar in the same quadrant or after a bilateral loss of primary molars.
3. The fixed lingual arch is used to maintain mandibular arch length and prevent mesial tipping and/or rotation of the permanent first molars. The fixed lingual arch prevents lingual tipping of the permanent incisors.
4. The intra-alveolar (“distal shoe”) appliance is used to prevent mesial migration of the unerupted permanent first molar after premature loss of the primary second molar.

CRUCIAL FACTOR OF AGE [3,4]

The age of the patient is particularly important. Most girls, for example, are one and a half to two years ahead of the boys in their tooth exchange. Thus, the dentist can expect the eruption of the permanent teeth earlier in girls than in boys. Assuming that the occlusion is normal, that adequate leeway space is present and that the inclined plane of the teeth are not completely flat and have some locking value, a rule of thumb can be established. If it appears that the permanent successor will erupt within a year or less after the loss of deciduous tooth, space maintenance is probably not necessary but frequent,

periodic, watchful waiting is the order of the day. This means careful measurements of the edentulous area with a pair of dividers and a periapical radiograph of the erupting tooth at 2 month intervals.

FIXED SPACE MAINTAINERS [10,11]

They are the appliances which are fixed onto the teeth and utilize bands or crowns for their construction. Authors studied the longevity of 88 fixed space maintainers fitted in 61 patients followed for a maximum of 53 months. The overall incidence of failure was 31%. Solder failure accounted for 37% of the total failure, 33% were due to loss of cement, 19% involved soft tissues lesions and 11% were caused by interference with the eruption of permanent teeth. Nance appliances and band and loop space maintainers had a 70% survival rate, while the lower lingual holding arches had a 40% survival rates after 36 months of cementation.

BAND AND LOOP

It is indicated when there is premature loss of any primary first molar in the primary dentition or the primary maxillary first molar in the transitional dentition. In these cases the unerupted premolar usually is more then 2 years from clinical eruption and its root length is less than one third mature and premature loss of a primary second molar as the permanent first molar is erupting clinically. Various authors conducted a study to prospectively investigate the success and median survival rate of band and loop space maintainers using glass ionomer luting cement for attachment. They concluded that although the overall median survival time was clinically acceptable (19.9 months), the failure rate of the band and loop space maintainers in general was high (57.5%). The main reason for failure was de-cementation of the band. Further studies are required to compare glass ionomer cements with more recent resin modified luting cements.

Figure 1a & 1b: Showing unilateral and bilateral band and loop space maintainers.

Crown And Loop

Most of the space controlling indications for the band-loop also apply to the crown-loop. However, the crown is used in preference to the band when the abutment tooth is highly carious, exhibits marked hypoplasia, or has been pulpotomized. Another approach to the crown and loop appliance is to place a band – loop appliance over the crown. In this manner, the need for a temporary crown is eliminated. If difficulty is experienced when fitting a band over the crown, the next largest size crown can be modified by cutting out the occlusal surface and using it as a band.

Band And Bar

These are similar to crown and loop, but instead of placing a loop a bar is placed. The modification of band and bar or crown and bar include “Broken stress” type appliance – that prevent intolerable loads from being thrust on the supporting teeth. The stress breaker should be designed to allow vertical movement of the supporting teeth consistent mesiodistal relationship for this reason, one of the most successful types of retainers.

Mayne Space Maintainer

Designed by WR Mayne [12], it is one type of nonfunctional space maintainer that permits minor adjustments for space control while the tooth in question is erupting. Using an orthodontic band or a full metal crown for the first permanent molar, a 0.036 inch medially extending cantilever arm initially engages the first deciduous molar. When it is lost, it can be bent to contact the erupting first premolar and to guide it mesially to create adequate space. Minor adjustments may be made on the erupting second premolar, moving it lingually or distally.

Palatal Arch Appliances

Palatal arch wires are designed to prevent mesial migration of the maxillary molars. They differ from mandibular lingual arch, which not only prevents mesial migration, but also the lingual collapse or tipping of incisor teeth.

Nance Palatal Holding Arch

The Nance arch is simply a maxillary lingual arch that does not contact the anterior teeth, but approximates the anterior palate. The palatal portion approximates an acrylic button that contacts the palatal tissue, which theoretically provides resistance to the anterior movement of posterior teeth. Nance palatal arch may be used in maintaining the maxillary first permanent molar positioning when there is bilateral premature loss of primary teeth, with no loss of space in arch and a favorable mixed dentition analysis. If space maintenance is combined with habits like tongue thrusting etc., it is also sued to break the habits by incorporating spurs in the acrylic button.

Figure 2: Showing Nance Palatal space maintainer

Transpalatal Arch Appliance

The transpalatal arch has been recommended for stabilizing the maxillary first permanent molars when the primary molars require extraction. The appliance does not use an acrylic button. It seems to gain its efficiency through its rigidity. It has been clinically observed that it satisfactorily maintain the first permanent molars in their position. The best indication for transpalatal arch is when one side of the arch is intact, and several primary teeth on the other side are missing. It is also indicated when primary molars are lost bilaterally. However there is a controversy that, both permanent molars may tip anteriorly despite the transpalatal arch and in these cases a conventional lingual arch or Nance palatal holding arch is preferred. The appliance is designed to prevent the molars from rotating around the palatal roots, which is the first movement resulting in loss of space in the arch perimeter.

Figure 3a & 3b: Showing Transpalatal space maintainer

Lingual Arch Space Maintainer

These are indicated for maintenance of arch perimeter, not just quadrant perimeter, because of premature loss of primary teeth. It is used almost exclusively in the mandibular arch, maintenance or prevention of mandibular changes in arch length, over jet, and overbite from incisor repositioning in the traditional dentition and retention or stabilization of the positions of the mandibular anterior teeth after tooth movement to prevent relapse in mandibular anterior crowding and changes in bite depth. The lingual arch appliances are modified based upon the individual requirements of the cases. A study was performed to evaluate the effect of heat treatment on 0.036" diameter stainless steel, wire to stimulate a lingual arch

appliance as space maintainer. They concluded that when 0.036" diameter stainless steel orthodontic wire was bent into an arch shape and subjected to heat treatment, a significant increase in interarch width was seen as immediate result of the heat treatment.

Figure 4a, 4b & 4c: Showing lingual arch space maintainer and modifications.

Intra-Alveolar Appliance (Distal Shoe)

The main objective is to retain and guide the permanent first molar into normal eruptive position. The intra-alveolar appliance consists of a stainless steel crown placed on a primary first molar. A stainless steel L-shaped bar, manufactured specially for this procedure, is spot welded and soldered to the distal surface of the crown. The bar extends posterior to a position even with the mesial surface of the permanent first molar or the distal root socket of the primary second molar. The horizontal extension is off the gingival tissue, occluding somewhat with the maxillary dentition. A right angle bend is established in the bar, directing it along the mesial surface of the permanent molar or into the distal root socket.

The indication for this appliance is as a replacement for a primary second molar, irretrievably impaired by caries or infection, which is abutted to an unerupted permanent first molar. Contraindication for the appliance would be a hopelessly damaged abutment, which in this case would be the primary first molar. A technique for chair side fabrication of distal shoe appliance with a stainless steel crown was described. The author stated that this technique was an efficacious and cost effective for guiding the unerupted permanent first molar into position after premature loss or extraction of the second primary molar.

Periodic Recall - It is very important to impress on the child's parent the need for periodic recall. Observing the patient at 3 month intervals is most appropriate. The distal shoe space maintainer, when used in the appropriate situation and with parents who are cooperative, prevents a potential orthodontic problem.

Removable Space Maintainer

A removable space maintainer is like partial denture. Not only mesio-distal space is maintained, but vertical space maintenance is also assured. In addition, masticatory functions restored to some extent, besides, in the anterior region,

esthetic improvement is considerable, and speech defects are prevented, as is the development of poor oral habits. However, the removable space maintainers has disadvantage of reliance on patient cooperation.

CONCLUSION

Space maintainers in pediatric dentistry are designed to prevent interferences with normally developing occlusion and correct problems in a developing malocclusion. Early orthodontic treatment is considered the initial phase of a multiple phase therapy. The preferable approach for space maintenance is to evaluate the space available whether the space is sufficient for eruption of the succedaneums teeth or regaining space is necessary. Failure to recognize the deviation from the normal exfoliation and eruption sequence results in unnecessary orthodontic treatment.

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