

SPACE MAINTAINERS IN PEDIATRIC DENTISTRY - A REVIEW

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ABSTRACT

Maintenance of arch length during the primary, mixed and early permanent dentition is of great significance for the normal development of future occlusion. Premature loss of primary tooth before natural shedding time can result in arch length deficiency leading to malocclusion. Early interception and prevention of developing malocclusion reduce or eliminate the need for complex orthodontic treatment in later stage. Appropriate space maintainer appliance should be advocated for holding the space until the eruption of permanent teeth. This article has reviewed and summarized the different types of space maintainers, their selection, indication, contraindication, advantages, disadvantages in treatment of primary and mixed dentition stage.

KEYWORDS

Space maintainer, Interceptive orthodontics, Premature loss

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INTRODUCTION

Deciduous tooth have a great impact in growth and development of a child. It not only help in speech, chewing, esthetics and function but also guide and hold space for the permanent tooth until it is ready to erupt. Any disturbance in shedding process of primary teeth like premature loss of due to caries, trauma, ectopic eruption or other causes that may lead to undesirable movement of primary and/or permanent teeth ultimately causes loss of arch length. This arch length deficiency can produce or increase the severity of malocclusion with crowding, rotations, impaction, ectopic eruption, crossbite¹. To avoid all these problems the best way is to preserve the primary tooth space in the arch until their normal exfoliation time is reached.

When premature loss of primary tooth is unavoidable the best way to maintain the arch space is by placing a space maintainer. According to Boucher the space maintainer is a fixed or removable appliance designed to preserve the space created by the premature loss of a primary tooth or a group of teeth. So the space maintainer appliance or restoration of carious primary tooth that can then act as a natural space maintainer may avoid the consequences of loss of arch length and the need for complex orthodontic treatment in future.

Careful consideration of many factors are required for planning of space maintainer. Radiographic assessment and space analysis are helpful in deciding space maintainer.

HISTORICAL PERSPECTIVE

From archeological survey the ancient mummies of 1,000 years AC was discovered with crude metal bands tied around the teeth might be used for tooth alignment. Reports of Romans 25 AC said the teeth could be moved by digit pressure. Between 400 and 500 AC. Hippocrates and Aristotle reported on the procedure of aligning teeth. Some devices for keeping up spaces and preventing the collapse of teeth also reported in ancient Greece. Around 1700 B.C. there were reports and evidence of the desire to align teeth. "Bandeau", a horseshoe-shaped appliance of precious metal was first used by Fauchard for expansion of arch and alignment of teeth. The idea of artificially maintaining the spaces left by the early loss of primary teeth seems belong originally to Angle, the father of modern orthodontics and proposed in 1907.

From literature since 1924 there are initiatives of use of space maintainers. Quinteros, Fischer, Goberer, Hogeboon, among others, are authors who described the rigid type space

maintainers with a few variations, bands were adapted to molars and welded wire joining the two extremes. Chapin, Strang, Bierman, Lancett, Foster, Morgan and Willet physiological maintainers with variable shape were first described in the literature which allow normal teeth movements².

OBJECTIVES OF SPACE MAINTENANCE

1. Prevent loss of arch length, width, perimeter by maintaining relative position of existing dentition.
2. For preservation of normal occlusal plane, primate spaces.
3. Anteriorly helps in phonetics, esthetics and posteriorly in mastication in some cases.

INDICATIONS

1. Where maintenance of space is required after premature loss of primary tooth to prevent loss of arch length by drifting or tipping of adjacent tooth.
2. Situations where there is a chance of midline shifting due to unilateral loss of deciduous tooth/teeth.
3. To prevent supraeruption of tooth from opposing arch into prematurely lost tooth space.
4. To improve and restore physiology of child's masticatory system and dental health optimally.
5. For the maintenance of esthetics anteriorly and reduction of psychological trauma.
6. If space maintainer will aid in future orthodontic treatment less complicated.

CONTRAINDICATIONS

- 1) When space needed by underlying permanent tooth is less than the space left by prematurely lost tooth.
- 2) If tooth is near to the crest of the ridge or one third of root is completed radiographically in succedaneous tooth.
- 3) When underlying permanent tooth is absent.
- 4) When forward drifting of molars are expected.
- 5) If there is no signs of closing of space.

FACTORS AFFECTING PLANNING OF SPACE MAINTAINERS:

Following factors are important when space maintenance is considered³.

1. Time elapsed since tooth loss - Maximum space loss occurs within six months after the primary tooth is lost and it is more rapid in maxillary arch than in mandible. So it is best to place an appliance as soon as possible after extraction.

2. Dental age of the patient - Estimation of dental age involves identification of teeth present in mouth in comparison to dental eruption chart and radiographic diagnosis of root development.

3. Rate of space loss - Breakspear stated that space loss after loss of first primary molar in maxillary & mandibular arch are 0.8mm and 0.9 mm. and space loss for second primary molar in maxillary & mandibular are 2.2mm and 1.7mm. respectively.⁴

According to Clinch and Healy space loss before eruption of permanent molar is 6.1mm and after eruption of permanent molar is 3.7mm.⁵

4. Amount of bone covering the unerupted tooth - According to McDonald 1mm of bone resorbs in 4 to 5 months. Bone covering over the crown of unerupted tooth indicates space maintenance.

5. Amount of space closure - Loss of maxillary second primary molars results in the greatest amount of closure up to 8 mm in a quadrant and loss of mandibular second primary molars shows the next greatest amount up to 4 mm of space loss in a quadrant. Clinically more severe space loss would be in lower arch as molar space is more difficult to regain in this arch.⁶

6. Eruption timing of successors - Normally teeth start erupting when three fourths of the root is completed⁷. Loss of primary molar before 7 years of age leads to delayed eruption of the successor tooth, whereas loss after 7 years of age causes early eruption. If primary molars are lost at 4 years of age, the eruption of premolars may be retarded upto 1 year, with emergence occurs at root completion. At 6 years of age, delay of eruption of premolars are more likely about 6 months, with emergence seen when root development approaches completion. Within 6-12 months of normal exfoliation timing there is accelerated eruption of permanent teeth.³

7. Delayed eruption of the permanent tooth - Over retained, ankylosed primary teeth or impacted permanent tooth requires extraction of primary teeth and construct space maintainer to hold the space for eruption of permanent tooth.

8. Direction of space closure - Maxillary posterior spaces close predominantly by mesial bodily movement and mesiolingual rotation around the palatal root of first permanent molar. Lower space closure occurs primarily by mesial tipping of the first permanent molars, along with distal movement and retroclination of teeth anterior to the space.

9. Congenital absence of the permanent tooth - Clinician must decide whether to preserve the space for future fixed appliance or let the space close by adjacent tooth. Orthodontic treatment will be needed for proper positioning of tooth.

REQUIREMENTS OF SPACE MAINTAINER

- 1) Should maintain adequate space for eruption of

permanent tooth.

- 2) Simple and easy to fabricate and low cost.
- 3) Should restore function and prevent over eruption of opposing teeth
- 4) Should be strong enough for withstanding functional force.
- 5) It must permit easy maintenance of oral hygiene.
- 6) It must not restrict normal growth and development of surrounding structures.
- 7) Do not exert undue pressure on tissues
- 8) Aesthetics where required.

SPACE ANALYSIS

Any space management measures should be carried out only after a space discrepancy analysis is done. They are : Moyer's mixed dentition analysis, Radiographic method, Hixon and old father's method, Tanaka- Johnston method etc.

Space maintainers are broadly classified as:

- Removable , fixed or semi-fixed
- Functional vs non-functional
- Active vs passive
- Unilateral vs Bilateral
- Certain combination of above

REMOVABLE SPACE MAINTAINERS

Designed for easy removal by the patient.

These can be classified as-

- 1) Functional & Non-Functional
- 2) With Clasp & Without Clasp

A) Removable partial denture/ Functional space maintainer. It helps in mastication in the posterior region, improves esthetics in the anterior region³.

B) Simple acrylic plate: Non-functional space maintainer as it does not replace missing tooth only acrylic extension occupy lost tooth space. The removable unilateral space maintainers should not be used as its too small design present swallowing and choking dangers for children.

C) Removable distal shoe maintainer - When one or more second primary molars are lost before eruption of first permanent molar an immediate acrylic partial denture with an acrylic distal shoe extension successfully guides first permanent molar into position.

Indication

A. When there is bilateral loss of tooth more than one tooth.

B. Abutment tooth cannot support fixed appliance because of extensive caries or expected early loss due to normal root resorption.

C. Cleft palate patient

D. Adaptation of band not possible due to partially erupted permanent tooth.

Contraindication:-

A. Patient with severe caries or who cannot maintain proper oral hygiene

B. Epileptic patient

C. Child has not attained mental age.

Advantages:

1. Functional in true sense if it replaces the missing primary tooth and helps in chewing and speaking and maintain esthetic.
2. Easy to clean and helps in maintaining oral hygiene.
3. Maintains or restores vertical dimension.
4. Helps in keeping the tongue in its boundary and prevent development of oral habits.
5. Stimulates the eruption of permanent teeth.
6. Easy fabrication and less chair side time needed.

Disadvantages:

1. Patient cooperation is necessary.
2. Appliance may be lost or broken.
3. It may restrict the lateral jaw growth if clasps are incorporated.
4. May cause irritation and allergy to underlying tissue.

FIXED SPACE MAINTAINERS

These appliances are fixed to the tooth with bands or crowns and cannot be removed by the patient.

Advantages

- 1) Bands are used without tooth preparation or with minimum preparation if stainless steel crowns are used.
- 2) Easy manipulation.
- 3) Does not interfere with passive eruption of abutment and jaw growth.
- 4) Succedaneous teeth are properly guided into occlusion.
- 5) Can be used for uncooperative patient.
- 6) Help in mastication if pontics are placed.

Disadvantages

- 1) Elaborate instrumentation and skills required.



Fig.1: Hollywood bridge

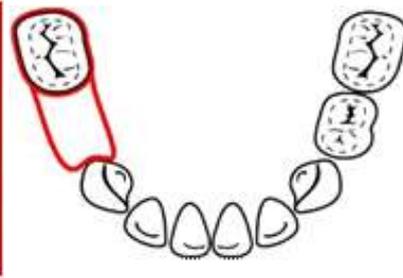


Fig.2 : Band and loop space maintainer

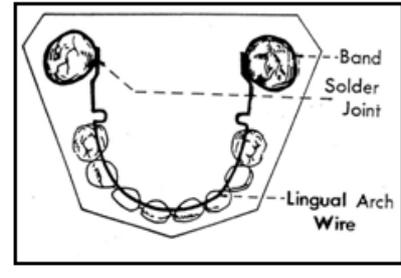


Fig.3: Lingual arch space maintainer

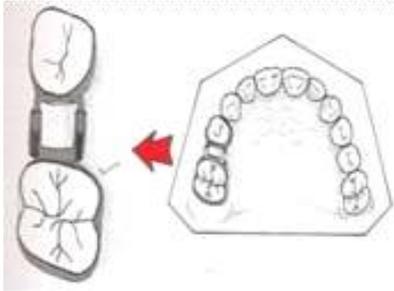


Fig.4 : Gerber space maintainer



Fig.5 : EZ space maintainer

2) Banded tooth is more prone to caries and decalcification.

3) Supraeruption of opposing tooth.

FABRICATION OF FIXED SPACE MAINTAINERS

- Band construction
- Impression taking and cast preparation
- Loop fabrication
- Soldering
- Polishing
- Cementation.

The fixed space maintainer generally constitute the following components namely A) Band, b) Loop / arch wire, c) Solder joint, d) Auxillaries

Band Construction:

A) Forms of band used are-

- 1) Loop bands
- 2) Tailored bands
- 3) Preformed seamless bands

which are made up of precious metal or Chrome alloy.

B) Sizes of Band Materials used

- o Anterior teeth: $0.003 \times 0.125 \times 2$ inches
- o Bicuspid: $0.004 \times 0.150 \times 2$ inches
- o Primary molars: $0.005 \times 0.180 \times 2$ inches
- o Permanent molars: $0.006 \times 0.180 \times 2$ inches.

C) Methods- Direct method (formation of band in mouth), Indirect method (It is done in the cast) or Preformed bands are used.

ANTERIOR REGION

“Hollywood” bridge (Fig.1):- For the replacement of lost primary incisor tooth the denture teeth are attached with a rigid stainless steel wire (0.036- or 0.040-inch) framework which is retained with bands or stainless steel crowns on the primary molars may be a predictable option. Additional stabilization can be obtained by placing an occlusal rest on the first primary molar, using a Nance button, or by covering the ridge with acrylic resin.¹³ Chang, Chen and Chang reported an appliance to replace prematurely lost upper anterior teeth using a double stainless steel crown on abutment teeth and artificial teeth⁸.

Groper Appliance - Similar to Nance holding arch, but acrylic teeth are attached to metal cleats that have been soldered to the palatal wire bar. The teeth sit directly on the alveolar crest without any acrylic extending into the vestibule or on to the palate.

Glass fibre reinforced composite resin⁹- It is translucent and made of glass fibers, thermoplastic polymer, and light-curing resin matrix for reinforcing the dental polymer. Anterior acrylic tooth is attached to a strip and fixed with both sides of the abutment tooth.

Pin and tube space maintainer: Used in cases of loss of primary incisors. Pin is allowed to slide partially out of the tube in response to the lateral growth of the arch.

POSTERIOR REGION

1) Band and loop space maintainer (Fig.2)- It made up of a band cemented onto the tooth posterior to the edentulous space and a loop of wire across the space abutting the anterior tooth. The loop should be fabricated wide enough so that the succedaneous tooth can erupt into it. Indicated in premature loss of single, unilateral or bilateral upper and lower primary molars.

Modifications

Band and loop space maintainer with occlusal rest- A small occlusal rest is designed on the loop wire to prevent the mandibular first permanent molar from tipping .

Crown and loop - stainless steel crown is used instead of band .

Crown-band and loop - stainless steel crown is first placed on abutment tooth, then it is banded.

Reverse band and loop- Given when there is loss of primary 2nd molar and the permanent molars have not fully erupted to support a band. In this cases primary 1st molar is banded and a loop is made that touches just below the marginal ridge of permanent molars

Band and bar : Abutment tooth on either side of extracted space are banded and connected to each other by a bar.

Broken Stress Functional Space Maintainer-prevents intolerable loads from being thrust on the supporting teeth.

- Bonded band and loop
- Long band and loop

Meyne's space maintainer : Designed by W R Mayne. It is Band and loop appliance but the loop is halved.

2) lingual arch space maintainer (Fig.3)

It is a bilateral, nonfunctional, passive/active, mandibular fixed space maintainer appliance.

Indications:

Unilateral or bilateral loss of primary molars after eruption of lower lateral incisors.

Advantages:

- 1) It helps maintaining arch perimeter by preventing both mesial drifting and lingual movement of molar and also lingual collapse of anteriors.
- 2) Can also be used to regain space.

Modifications:

Hotz lingual arch-with U loop

Omega bends-in canine region to prevent interference

3) Semi-fixed removable type of lingual arch : The distal end of the lingual arch is placed in precision made tube present on lingual surface of the molar band and it is tied with ligature wire. Advantages are easy removal and adjustment of the appliance intra-orally .

4) Nance arch holding appliance¹⁰

Bilateral, nonfunctional, passive, maxillary fixed appliance consisting of a heavy gauge stainless steel wire soldered to the palatal aspect of the first permanent molar bands and anteriorly approximates rugae area via acrylic button. It is developed by H.N. Nance in 1947.

5) Transpalatal arch¹⁰

It is non functional, active/passive maxillary fixed appliance described by Robert Goshgarian in 1972, consist of a heavy gauge stainless steel wire that extends from one maxillary first permanent molar band , along the contour of the palate, to the contralateral first molar band. An omega loop is usually incorporated in the middle of the span.

6) Distal shoe space maintainer or Cantilever type

It was first proposed by Willets (1932) and introduced by Gerber and extended by Croll. Nowadays the commonly used one is that advocated by Roche (1942) is a crown or band and bar appliance with intragingival extension. It is used to maintain space or guide proper eruption of first permanent molar when there is premature loss of second primary molar before eruption of first permanent molar. The intragingival extension should be about 1-1.5 mm below the mesial marginal ridge of the molar, or just sufficient to capture its mesial surface as the tooth erupts and moves forward. Proper extension of the distal shoe should be checked radiographically.

Contraindications:

- 1) If several teeth are missing
- 2) Certain medical conditions such as blood dyscrasias like hemophilia, immune-suppression, congenital heart disease, history of rheumatic fever, diabetes, kidney problem, generalized debilitation.

7) Glass Fiber-reinforced Composite Resin

The newer adhesive directly bonded splints made up of Glass fibre reinforced composite resins

e.g. Ribbond, Everstick used as fixed space maintainers. Advantages of this material includes its ease of adhesion to the dental contours, faster placement as it eliminate cumbersome laboratory technique and good strength.

8) Gerber space maintainer (Fig.4): This kit can be used as space maintainer or space regainer a compressed coil spring or open coil spring is introduced between the tube and the wire. When the space is regained, the assembly is left in mouth as the space maintainer.

9) EZ space maintainer (Fig.5): It is invented by Dr. Enis Güray and made up of two 1mm stainless steel wire arms, tube segments with an internal diameter of 1.2mm, and two bonding bases that are fixed to the buccal surfaces of the teeth adjacent to the extraction space. The 6-8mm tube segments are soldered to the posterior arm to accommodate the anterior arm. It is adjusted according to the mesiodistal dimension of the extraction space, then stabilized by squeezing one of the tubes. It can be adjusted using the NiTi coil to regain space.

Advantage - It is a cost-effective, less time-consuming than traditional one. It requires no impressions, no laboratory construction, and can be directly bonded in a single visit. It is more aesthetic, hygienic, simple to use.

10) Stainless steel crown space maintainer

These crowns are used to restore carious primary molars where one or two proximal surfaces have extensive carious lesions and if restoration is needed to last more than two years. These crowns are also indicated in restoration of fractured primary molars and in localized or generalized developmental problems e.g Enamel hypoplasia, Amelogenesis imperfecta, and Dentinogenesis imperfecta to maintain arch length.

Adverse effects of space maintainer

- (1) Dislodged, broken or lost appliances
- (2) Plaque accumulation
- (3) Caries
- (4) Interference with successor eruption
- (5) Undesirable tooth movement
- (6) Inhibition of alveolar growth
- (7) Soft tissue impingement

EVALUATION OF SPACE AND MONITORING : Patients are advised for regular follow up at appropriate interval and intraoral radiographs are taken to evaluate eruption status of permanent tooth for which space maintainer has been placed. When tooth is visible space maintainer is discontinued if deciduous tooth supporting the appliance sheds, space maintainer should be removed.

CONCLUSION

Well maintained or properly restored primary tooth are best natural space maintainer until their normal exfoliation. But when these are prematurely lost it is essential to implement space maintainer therapy. Space maintainers play a vital role in interceptive orthodontics by preventing the development or greatly reduce the treatment of malocclusion. To a pedodontist for successful space maintenance not only require sound knowledge of the principles of space management, dynamic development of occlusion but also regular follow up and recall visit.

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