CONCEPTS OF SPACE MAINTENANCE IN PEDIATRIC DENTISTRY: A REVIEW

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ABSTRACT:

Primary teeth play a key role in the nutrition and speech of the children as well as space maintenance in the permanent teeth. If dental caries and trauma lead to tooth loss, space maintainers should be used to preserve the space of the primary teeth. Space maintainers are appliances used to maintain space or regain minor amounts of space lost, so as to guide the unerupted tooth into the proper position in dental arch. Present review of literature provides information about indications, contraindications, types and recent designs of space maintainers used in Pediatric dentistry.

Keywords: Primary dentition, premature loss, Space maintenance, Space maintainer

I. INTRODUCTION:

The primary dentition plays a very important role in the child’s growth and development, not only in terms of speech, chewing, appearance and the prevention of bad habits but also in the guidance and eruption of permanent teeth. Exfoliation of primary teeth and eruption of permanent teeth is a normal physiological process. When this normal process is disrupted, due to factors like premature loss of primary teeth, proximal carious lesions etc, it may lead to mesial migration of teeth resulting in loss of the arch length which may manifest as malocclusion in permanent dentition in the form of crowding, impaction of permanent teeth, supraeruption of opposing teeth etc. The best way to avoid these problems is to preserve the primary teeth in the arch till their normal time of exfoliation is attained. Hence it is rightly quoted that primary teeth serve as best space maintainers for permanent dentition.

The term space maintenance was coined by JC Brauer in 1941. He defined space maintenance as the process of maintaining a space in a dental arch previously occupied by a tooth or a group of teeth. Hence a space maintainer is used to maintain the space created by the lost deciduous tooth or teeth till the eruption of their successors. Boucher defined space maintainer as a fixed or removable appliance designed to preserve the space created by the premature loss of a primary tooth or a group of teeth. Present review of literature provides detail information about Concept of space maintenance, indications, contraindications, types and recent designs of space maintainers used in Pediatric dentistry.
II. PREMATURE LOSS OF PRIMARY TEETH

Causes
Factors such as dental caries, infection, trauma, and crowding lead to premature loss of primary teeth, which along with congenital absence of permanent teeth, bad oral habits and possible presence of malocclusion increase the need for space management and orthodontic treatment.6

Effects
Space loss following premature loss of the first molar was first described in 1887. Despite all attempts made to prevent space loss, this phenomenon has still remained a common problem in pediatric dentistry. The worst consequences reported for space loss include:

1. Dental arch crowding
2. Ectopic eruption
3. Impaction of permanent teeth
4. First permanent molar tipping and poor molar relationship
5. Cross bite formation
6. Midline discrepancies
7. Increased overbite
8. Asymmetric arch7

Loss of Anterior Teeth
Unlike the loss of posterior teeth, premature loss of anterior teeth, in the case of eruption of primary canines, is not followed by space loss and does not interfere with the child’s chewing and eating. Of course, absence of these teeth may lead to defective speech if the child has not started speaking. The most important reasons for replacement of anterior teeth in children are aesthetic aspects and regaining self-confidence, which is done by fixed or removable appliances.8,9

Loss of Posterior Teeth
Premature loss of primary second molars leads to more space loss compared to the primary first molars, which reduces from 70% in primary second molars to 51% in primary first molars. However, the prevalence of malocclusion following tooth loss has been reported to be higher in mandible than in maxilla.3,10

Concepts of space maintenance
The following considerations are important when space maintenance is considered after the untimely loss of primary teeth:

Time Elapsed Since Loss
If space closure occurs, it usually takes place during the first 6 months after the extraction. When a primary tooth is removed and all factors indicate the need for space maintenance, it is best to insert an appliance as soon as possible after the extraction. Often, the best approach, if possible, is to fabricate an appliance before the extraction and deliver it at the extraction appointment.3

Dental Age of the Patient
The chronologic age of the patient is not as important as the developmental age. Grown studied the emergence of permanent teeth based on the amount of root development as viewed on radiographs, at the time of emergence. Teeth erupt when three-fourths of the root is developed, regardless of the child’s chronologic age.11
Amount of Bone Covering the Unerupted Tooth
If there is bone covering the crown, it can be readily predicted that eruption will not occur for many months, a space-maintaining appliance is indicated.12

Sequence of Eruption of Teeth
The dentist should observe the relationship of developing and erupting teeth adjacent to the space created by the untimely loss of a tooth.13

Delayed Eruption of the Permanent Tooth
In case of impacted permanent tooth, it is necessary to extract the primary tooth, construct a space maintainer, and allow the permanent tooth to erupt at its normal position. If the permanent teeth in the same area of the opposing dentition have erupted, it is advisable to incorporate an occlusal stop in the appliance to prevent supraeruption in the opposing arch.9

Congenital absence of the permanent tooth
If permanent teeth are congenitally absent, the dentist must decide whether it is wise to hold the space for many years until a fixed replacement can be provided or it is better to allow the space to close. If the decision is made to allow the space to close, there will rarely if ever be bodily movement of the teeth adjacent to the space. Therefore, orthodontic treatment will be needed to guide the teeth into a desirable position.6

Presentation of problems to parents
Explain existing conditions & discuss the possibility of the development of a future malocclusion if steps are not taken to maintain the space or to guide the development of the occlusion. Also explain that the space-maintaining appliance will not correct an existing malocclusion but will only prevent an undesirable condition from becoming worse or more complicated.14

Space maintainer appliances The selection of appliance for space maintenance depends on factors such as:

1. The child’s developmental and growth stage
2. Involved jaw
3. Number of lost teeth
4. Presence of occlusion

However, the patient’s age and ability to cooperate and tolerate the fixed or removable appliances are highly important in the selection of the type of space maintainer.15

Properties of an ideal space maintainer
1. Maintaining the mesiodistal space due to tooth loss
2. Maintaining the function as much as possible and preventing the overeruption of the opposite teeth
3. Easy manufacturing
4. Adequate strength for strong functional pressures
5. Lack of too much pressure on the base teeth
6. Possible observation of hygiene
7. Absence of limitation in the development and usual adjustments of occlusion during changes from primary to permanent dentition
8. Non-interference with different functions8,16.
The best choice for the treatment of primary first molar loss is placement of band and loop on the primary second molar. The problem of band and loop in primary second molar loss is that the primary first molars are lost before eruption of primary second premolars and band and loop will not have its proper anchorage. Hence, the lingual arch or palatal arch is preferred. Exceptions to this are when the mandibular permanent incisors are impacted and when placement of lingual arch interferes with their eruption.\(^{17,18}\)

**Crown and loop Space maintainer**

Crown and loop is similar to band and loop except that SSC is used instead of band on the base tooth. The characteristics of this space maintainer include maintaining the space of one tooth, inexpensiveness and easy manufacturing, failure to restore the occlusal function of the missing teeth.

**Indications**

1. Unilateral missing of the primary first molar before eruption of the permanent first molar
2. Bilateral missing of primary molar before eruption of permanent incisors.\(^{17,18}\)

**Distal shoe Appliance**

This appliance was first introduced by Willets in 1932 as a bar type gingival extension, which was modified by Roche in 1942 as a V-shaped gingival extension. It is used in the primary second molars before lost permanent first molars as well as in impacted permanent first molars. In these conditions, there is no abutment for the band and loop maintenance. In turn, a metal wire is inserted into the gingiva to maintain the space until eruption of the permanent tooth. Exact radiographic measurement and correct placement are required to ensure correct guidance of the permanent molar by a blade.\(^9\)

**Lingual arch**

This appliance consists of two bilateral bands on the molars connected passively by a thick wire on the cingulum of mandibular incisors. Its function is not only to control the posterior-anterior movements but also to prevent the arch reduction by controlling the lingual collapse. The omega loop in premolars passively makes the adjustment of the appliance possible by wire heating at the band connection point and rear part of cingulum.
Indication
1. Bilateral loss of mandibular primary molars after eruption of permanent incisors
2. Unilateral loss of more than one tooth in mandibular arch\textsuperscript{19}

Recent modification in space maintainers
1. **3D Band and loop space maintainer:** The use of 3D printing in pediatric dentistry, initially, an ideal mixed dentition cast was poured of a standard dye, for a trial design of 3D printed SM by digital scanning and designing. The cast was scanned using a 3D digital dental scanner followed by the designing of the band and loop similar to the conventional SM, on the Dental CAD 2.2 Valletta. Two types of SMs were printed: (i) using titanium based powdered metal material by Micro Laser Sintering Technology which offers all benefits of an additive manufacturing process and (ii) using a clear photopolymer resin by Formlabs.\textsuperscript{20}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{image}
\caption{3D Band and loop space maintainer}
\end{figure}

**Advantage 3D Band and loop space maintainer**\textsuperscript{20}
- The use of digital designing of SM, and printing it by the help of 3D printer increases the precision of the appliance to the next level, minimizing human error.
- The extensive laboratory work, stabilizing the loop, and more importantly, soldering the loop on the band at two places and polishing, is also not required which saves chair side time.
- The appliance is printed as one unit minimizing the breakage, thus reducing failure of the appliance.
- Compared to a conventional appliance, a 3D printed model has a more complex structure with a higher level of detail.

2. **CAD-CAM Band and loop space maintainer:** BruxZir is a CAD/CAM-fabricated material and has to be digitally designed by a technician using a digital scanner and design software. The file was “nested” or positioned in the zirconia disk and milled to a full contour approximately 30 percent larger than the final restoration. Once the restoration was milled and removed from the disk, it was dipped in the appropriate colouring solution and sintered in an oven for 6.5 hours at 1,530 degrees Celsius where it shrunk to its final size. The gingival shade was added in the area of the missing tooth to enhance aesthetics. This property gives it high impact resistance to the high masticatory forces in the mouth. It also has excellent resistance to thermal shock with a low thermal expansion which means the restorations will remain stable in the mouth on intake of hot and cold fluids. BruxZir is available in all the vita classic and gingival shades which would fulfill the aesthetic demands of the patient. Hence, BruxZir can consider as the ideal material for fabrication of the space maintainer.\textsuperscript{21}
Advantages of CAD CAM Band and loop space maintainer

• It has high strength due to monolithic design.
• There is no gingival lacerations and trauma as no band pinching is required.
• There is no nickel allergy and corrosion.
• The tipping of teeth is prevented as there is tooth support on the both sides.

3. Tube and Loop Space Maintainer: It is a tube and loop space maintainer designed by Srivastava N et al. (2016) also known as Nikhil appliance. It is less time consuming and does not require impression taking, lengthy laboratory procedure and soldering like the conventional band and loop space maintainer.

Advantage of Tube and Loop Space Maintainer

• Innovative design of “Tube and Loop” SM is simple, quick and easy. It can be completed in a single sitting without any laboratory work.

4. Functional Band and Loop space maintainer: The first step is to construct a conventional band and loop space maintainer in the region of premature tooth loss. This is followed by the placement of an acrylic tooth in the edentulous area of the cast and stabilization with modeling wax. The occlusion is then checked with the cast of the opposing arch and adjusted. Cold cure acrylic is used to attach the pontic to the loop. The completed appliance is then finished and polished. Trial fit is done in patient’s mouth, and the appliance is checked for the presence of soft tissue irritation or occlusal interferences and adjusted accordingly. The final cementation of the appliance is done.
5. **EZ space maintainer:** This appliance has many advantages compared to the removable and cemented types. It is composed of two 1-mm steel wire arms and segmental tubes (internal diameter of 1.2 mm). It has two bases at its end that are bonded to the buccal surface of the missing incisors. Plaque accumulation is much lower in this appliance than in other types. However, the first week after bonding is the most important time for patient adaptation and observation of oral hygiene.²³

6. **Fiber reinforced composite loop space maintainer:** It is made of fibre reinforced composite resin usually developed to rectify the disadvantages of a conventional band and loop space maintainer. Subramaniam P et al. (2008) found Fiber reinforced composite loop space maintainer to be a suitable alternative to the conventional fixed space maintainer. These space maintainers are easy to apply and require only one visit. There is no need for making impressions and cumbersome laboratory procedures are eliminated. Patients are satisfied because these space maintainers are esthetic, less bulky, occupy less space in the oral cavity, and feel natural.²⁴

7. **Pontic–Crown Fixed Space Maintainer:** In the method, the adjacent tooth is crowned as an abutment, and a SSC is soldered to it as a pontic form. In addition to maintaining space and preventing the tilt of the adjacent tooth, crown–pontic fixed-space maintainer prevents excessive growth of the opposite tooth and establishes the occlusion. Eshghi A et al. (2018) found Pontic–crown space maintainer as a suitable alternative for band and loop space maintainer in treating the early loss of primary molars.²⁵
1. **Light Cure Acrylic Resin space maintainers**: Souror YR et al. (2018) presented a case report in which a pink color sheet of LCAR Triad® VLC (Custom Tray) product was used to construct a space maintainer. After complete examination, full arch isolation was performed using rubber dam and suction. Both the abutment teeth were cleaned with pumice slurry and then etched with 35% orthophosphoric acid for 30 seconds for primary first molar and 20 seconds for the permanent first molar. The teeth were rinsed, air-dried, and wetted with an adhesive that was light-cured for 20 seconds. A thin layer of flowable composite was applied to the buccal surfaces of the abutment teeth without light-curing it. The cut length of LCAR was placed over the flowable composite extending from the buccal aspect of permanent first molar to buccal aspect of the primary second molar. The ends of the LCAR were adapted to the teeth surfaces with a plastic instrument. The composite and LCAR was light-cured for 2 minutes for each end of LCAR. Author found that the Light Cure Acrylic Resin space maintainers can be a new alternative to the traditionally fixed space maintainers used in pediatric dentistry.26

![Figure 9: Light Cure Acrylic Resin space maintainers](image)

**Conclusion:** An early intervention with space maintainer is important when there is premature loss of primary teeth after considering the factors affecting planning of space maintainers. Various types of designs are used to maintain the space of primary teeth. Space maintenance helps prevent mesial migration of the permanent first molars when there is premature loss of primary molars. The band and loop is a safe choice for premature loss of a single primary molar.

**REFERENCES**


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