

Space Maintainers in Paediatric Dentistry: From basic to innovative

Abstract:

The premature loss of primary teeth is a typical concern in paediatric dentistry, resulting in arch integrity disturbance. Interceptive orthodontic can prevent or lessen the severity of a growing malocclusion, the complexity of orthodontic therapy, overall treatment time, and expense. The most secure strategy to prevent future malocclusion due to tooth loss is to use an effective and long-lasting space maintainer. The focus of this article is to describe the numerous shifting trends in the application of space maintenance, as well as their benefits and drawbacks.

Key-words: Space maintainer; Preventive Orthodontics; Space management; Mixed dentition

Introduction:

The deciduous dentition is extremely important for a child's growth and development. It not only aids in mastication, speech, and aesthetics, but it also preserves space until their permanent replacements emerge.[1] The child's primary teeth are lost and replaced by well-fitting normal teeth under normal physiological conditions. However, pathological situations such as tooth decay, trauma, aberrant resorption, or systemic disorders can cause the dentition to be disrupted, resulting in premature dentition loss.[2] This causes existing teeth to migrate, arch space to be lost, and the normal configuration of newly growing permanent teeth to be disturbed this lead to arch length deficiency which can produce or increase the severity of malocclusion, crowding, rotations, impactions, ectopic eruptions and crossbite.[3,4]

Dental crowding can be classified according to the time of appearance as primary, secondary and tertiary. Primary crowding is of genetic origin where there is discrepancy between the tooth size and arch size. Secondary crowding is acquired and occurs due to premature loss of primary teeth, especially molars which in turn leads to consequent loss of arch length. Tertiary crowding also known as late lower incisor crowding, can occur towards the end of the peak of mandibular growth. [Proffitt et al, 2018]. To prevent

malocclusion, specifically in patients with potential future secondary crowding, the best option is to maintain arch space by placing a space maintainer. [Wright and Kennedy, 1978]⁵

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. The following factors must be taken into account before placing a space maintainer (Brothwell, 1997; Dean 2011):

- ✓ Specific tooth lost
- ✓ Time elapsed since tooth loss
- ✓ Occlusion and space assessment
- ✓ Dental age

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- ✓ Presence and root development of permanent successor
- ✓ Amount of alveolar bone covering permanent successor
- ✓ Patient's health history and medical status patient's cooperative ability
- ✓ Active oral habits
- ✓ Oral hygiene

Indications of Space Maintainers[6,7]

1. If the space left after the loss of primary teeth is showing signs of closing.
2. If using a space maintainer simplifies future orthodontic treatment
3. When the succedaneous tooth is not ready for eruption
4. When at least 1mm of bone coverage is present over the created space
5. Following space analysis when there is a risk of space deficiency for the permanent successor due to uneven pressures from adjacent teeth.

Contraindications of Space Maintainers[6,7]

1. Overlying the erupting permanent successor, there is no bone covering.
2. When the root of the succedaneous tooth has reached two-third development
3. When the succedaneous tooth is missing and the area has to be replaced
4. When the area created is less than the mesio-distal diameter of the permanent successor's crown.

Pre-requisites of Space Maintainers[8]

The space maintainers used should be able to fulfil the following requirements:

1. maintain the desired mesiodistal dimension of the space (Intra-Arch Space Maintenance)
2. Should not hinder the adjacent teeth's vertical eruption (Inter-Arch Space Maintenance)
3. The eruption of permanent teeth should not be hindered.
4. To open the mesiodistal space when it is necessary

Criteria for Case Selection[9]

1. Early loss of 2nd deciduous molar
2. In congenital missing 2nd pre molar, the permanent molar should be encouraged to drift mesially to close the space created.

3. In congenital missing permanent lateral incisors, the permanent cuspid should be encouraged to drift mesially to close the space created.
4. In case of missing/ extracted 1st permanent molar, the 2nd permanent molar should be encouraged to drift mesially to close the space created.
5. Delayed eruption of permanent anteriors may lead to tongue thrusting.

Factors affecting planning for space maintainers:

1. **Time elapsed since tooth loss:** Space closure takes place within first 6months after extraction and hence appliance should be inserted just after extraction.
2. **Rate of space closure:** Space closure is rapid during the first 6months after extraction and is more rapid in younger children.
3. **Amount of bone coverage over the tooth:** According to McDonald resorption of 1mm of bone requires 4-6months and hence if there is bone coverage over the erupting successor teeth space maintainer should be planned.
4. **Dental age of the patient:** It is calculated as per the age of the last permanent tooth erupted in normal eruption sequence.
5. **Tooth formation status:** Tooth erupts in the oral cavity when 3/4th of its root formation is completed irrespective of the chronological age of the patient.
6. **Abnormal oral habits:** If there is tendency for the development of abnormal oral habits after premature loss of primary teeth, space maintainers should be planned to prevent of exertion of pressure to the dental arch.

Adverse effects of space maintainers:

1. Dislodged, broken, and lost appliances.
2. Plaque accumulation
3. Increased risk of infection- Candida albicans was found to be prevalent among patients with removable appliances, but salivary Enterococcus faecalis was isolated from patients with fixed appliances.
4. Increase in periodontal index scores
5. Caries
6. Damage or interference with successor eruption
7. Undesirable tooth movement
8. Inhibition of alveolar growth
9. Soft tissue impingement
10. Nicle is common and severe allergen
11. Local pain and discomfort
12. Gingival hyperplasia and mucosal overgrowth.

Frequently used Space Maintainers:

- a) **Removable non functional Space Maintainer:** It is made of acrylic placed over alveolar mucosa within the space created without any artificial teeth.

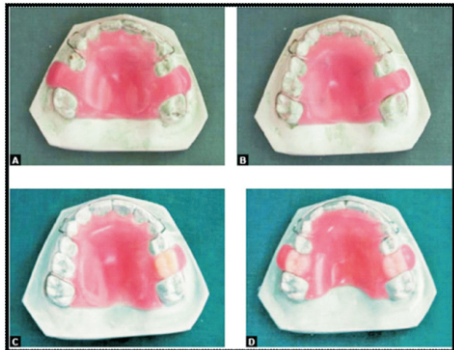


Fig1- A & B- Bilateral and unilateral Non-functional Space Maintainers
C&D- Unilateral and Bilateral Functional Space Maintainers

- b) **Removable functional Space maintainer:** It is made of acrylic plate with artificial acrylic/ composite teeth to replace the lost primary teeth. It is usually bilateral and used to restore aesthetics and mastication.
- c) **Band and Loop Space Maintainer:** These are the most common fixed space maintainers used in single primary molar loss before permanent incisor eruption and loss of 2nd primary molar after 1st permanent molar eruption



Fig2- Band & Loop Space Maintainer

- d) **Nance Palatal Arch Space Maintainer-** When there is bilateral premature loss of primary teeth, a fixed, non-functional maxillary space maintainer is indicated to maintain the maxillary 1st permanent molar in place.

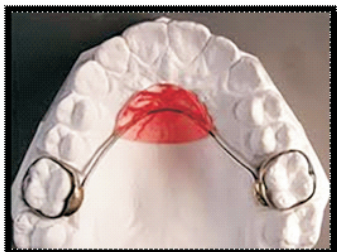


Fig3- Nance palatal arch Space Maintainer

- e) **Trans Palatal Arch Space Maintainer:** When primary molars require extraction, a unilateral, non-functional, passive maxillary fixed space maintainer is indicated to maintain the maxillary 1st permanent molar in position.

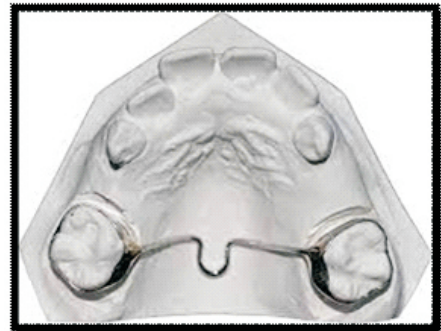


Fig4- Trans Palatal Space Maintainer

- f) **Distal shoe Space Maintainer:** It is also known as an intra-alveolar appliance and is used when the primary second molar is lost before the eruption of the first permanent molar.



Fig5- Distal Shoe Space Maintainer

- g) **Lingual Arch Space Maintainer:** After the eruption of the mandibular permanent lateral incisors, a bilateral, non-functional, active/passive, mandibular fixed appliance is indicated in cases of unilateral or bilateral loss of primary molars.



Fig6- Lingual Arch Space Maintainer

Current Concepts in Space Maintainers:

a) Ribbond Space Maintainers (Woven Polyethylene Fibres): It is comprised of fibre reinforced composite resin and was designed to address the shortcomings of a traditional band and loop space maintainer.

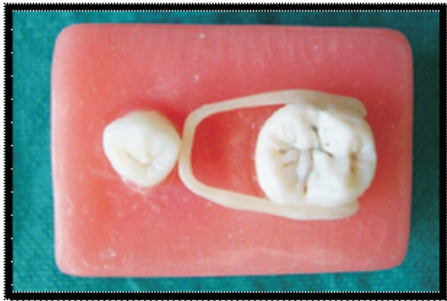


Fig7- Ribbond Space Maintainer

b) EZ- Space Maintainers: Compared to the conventional space maintainer, it is a more efficient and time-saving device. It can be directly bonded during a single dental appointment without the need for an impression or a laboratory procedure

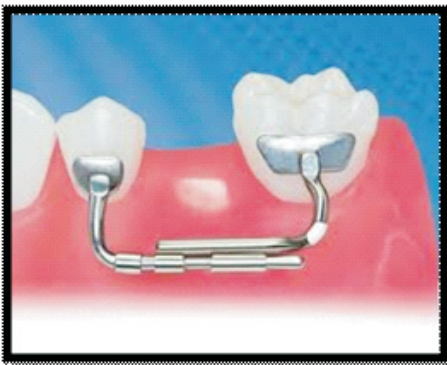


Fig8- EZ Space Maintainer

c) Nikhil Appliance[10]: It was designed by Nikhil Srivastava et.al as a tube and loop space maintainer. Unlike the traditional band and loop space maintainer, it doesn't need to be soldered, take impressions, or go through a lengthy laboratory procedure.



Fig9- Nikhil Appliance

d) H-Appliance[11]: It is a simplified space maintainer that was designed by Pheiroijam Herojit Singh. This appliance is simple and quick to construct as it does not involve the time-consuming steps of band fabrication, welding, and soldering that the traditional band and loop space maintainer does.

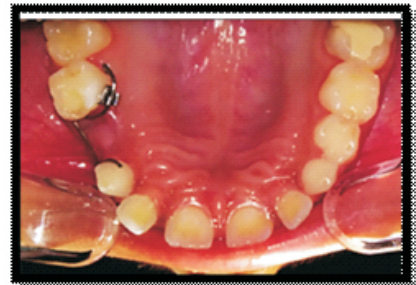


Fig10- H- Appliance

e) Pontic Crown Fixed Space Maintainers[12]: In treating the early loss of primary molars, Eshghi A et al. (2018) discovered that Pontic-crown space maintainers are an effective substitute for band and loop space maintainers.



Fig11- Pontic Crown Fixed Space Maintainer

The approach involves crowning the adjacent tooth to serve as an abutment and soldering an SSC to it to serve as a pontic form. Crown-pontic fixed-space maintainers, in addition to preserving space and preventing the tilt of the adjacent tooth, also prevent excessive growth of the opposite tooth and establish the occlusion.

Digital Space Maintainers:

The term "Digital Space Maintainers" refers to space maintainers which use CAD-CAM or 3D printing technology with contemporary and biocompatible materials. By utilising this technology, the aforementioned difficulties and shortcomings of conventional manufacturing could be resolved.

a) 3D Band and Loop Space Maintainers[13]:

The cast is scanned using a 3D digital dental scanner, and then on the Dental CAD 2.2 Valletta, the band and loop are designed in a manner identical to the conventional SM. Two different kinds of SMs were printed: (i) using Formlabs' clear

photopolymer resin and (ii) Micro Laser Sintering Technology's titanium-based powdered metal material, which gives all the advantages of additive manufacturing.

b) CAD-CAM Fabricated Space Maintainers:

1- PEEK Polyme

Polyetheretherketone-based materials are rigid, opaque, and have a distinctive combination of strong mechanical properties. The material offers a wide range of processing options, dimensional stability, chemical resistance, and high-temperature stability.[14] Because it has a natural tooth-colored appearance, patients who are allergic to metals or dislike the metallic taste or weight can use this material.[15]

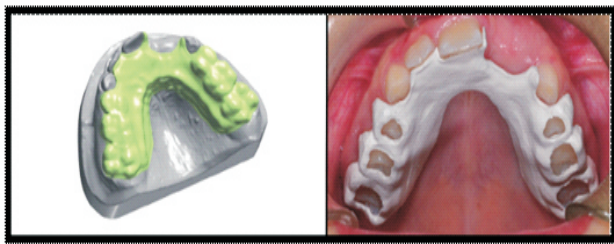


Fig12- PEEK Polymer

2- BruxZir:

With a flexural strength of up to 1,465 MPa, BruxZir has a fracture resistance that is three to five times more than that of regular zirconia. Due to this, the material has great impact resistance against the forces of mastication in the mouth. Because of its low thermal expansion, the material will remain in the mouth without altering shape or becoming loose in the teeth.[16]

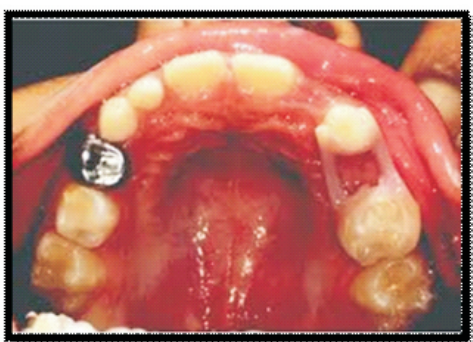


Fig13- BruxZir Space Maintainer

3. Trilor:

A CAD/CAM-processed FRC resin is called Trilor. Zirconia and metal are both heavy materials; this metal-free, biocompatible substitute weighs three to five times less. Some advantages include biocompatibility, low weight, elasticity, durability, and repairability.[17] Beretta and Cirulli used

Trilor to fabricate a Nance palatal arch SM that was directly attached to the palatal surface of the first primary molar.[18]

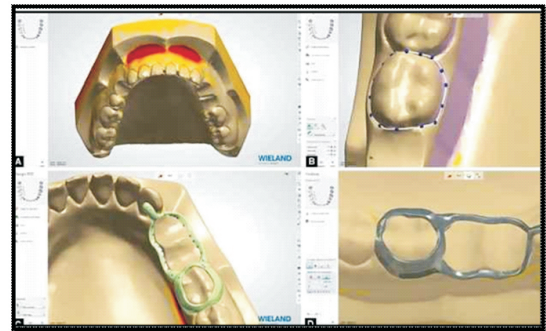


Fig14- Trilor

Conclusion:

After taking into account the variables influencing the planning of space maintainers, an early intervention with space maintainers is crucial when there is a premature loss of primary teeth. This will prevent the future need for expensive and time-consuming complex orthodontic treatment. Dentistry's digital workflow is always changing and introducing new methods. The SMs in paediatric dentistry have made significant progress in the area of customized orthodontics. Digital manufacturing techniques enable the production of durable and dependable devices. The use of CAD-CAM technology eliminates laborious manual fabrication phases.

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