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RESEARCH ARTICLE

SPACE MAINTAINERS IN PAEDIATRIC DENTISTRY

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Abstract

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 deleterious habits but also in the guidance and eruption of permanent teeth. Exfoliation of deciduous teeth is a physiological process . Premature loss of deciduous teeth occurs owing to carious lesions; which may eventually lead to the mesial migration of teeth ;resulting in loss of the arch length. It may manifest as malocclusion in the permanent dentition in form of crowding, impaction of permanent teeth. Even supra-eruption of opposing teeth and unparalleled differences in median lines may be recorded. Therefore; the implementation of space maintainers is of profound significance; thereby helping in the successful maintenance of the arch length by means of regaining the lost occlusal harmony; function and aesthetics. Varied space maintainers; ranging from metal to fibre reinforced ones have come into existence; through gradual evolution of time.

Introduction:-

Premature loss of deciduous teeth is an unfortunate occurrence in children, due to lack of knowledge regarding oral hygiene procedures and gross ignorance towards maintenance of proper oral health. In the quest for providing optimal health care, the age-old maxim of "prevention is better than cure" hence holds true.

"**Space maintenance**" is an indispensable part of Pediatric Dentistry and is the primary preventive orthodontic care and is provided to avoid future problems, leading to malocclusion. The term 'space maintenance' was coined by **JC Brauer** in **1941.**

Moyers has importantly defined "**space supervision"** as "when the judgement of the dentist determines that the individual patient's occlusion will have a better chance of obtaining optimum development through supervised intervention of the transitional dentition then without clinician directed intervention".

Early loss of deciduous teeth causes shifting of adjacent teeth into the space created resulting in abnormal axial inclination spacing between teeth and shifting of dental midline. This prevents the normal eruption and deviation of their permanent successors from normal eruption pathways leading to malocclusion; hence the implementation of space maintainers is extremely significant in maintaining the arch length in early loss of teeth.

Objectives of Space Maintainers:
The objectives of space maintainers are as follows:

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(I) preservation of the primate space.
(II)Maintain the integrity of the dental arches and the normal occlusal planes .
(III) aid in aesthetics and phonetics in case of anterior space maintainer.
(IV)It helps to avoid future dental anomalies; thereby acting as a significant part of primary preventive orthodontic care.

Classification Of Space Maintainers
The classification of space maintainers may be as follows:
According to **Hitchcock**:
(i)Removable or fixed or semifixed,
(ii)With bands or without Bands,
(iii)Functional or Non-functional,
(iv)Active or passive,
(v)Certain combinations of the above.

According to Raymond C Thourow:
(i) Removable,
(ii)Complete Arch-Lingual arch and Extraoral Anchorage,
(iii)Individual tooth

According toHeinrichsen:
(i)Fixed Space Maintainers;
(ii)(A) Class I- Nonfunctional types-Bar type, Loop Type;
(ii)(B) Functional types-pontictype , lingual arch type;
(iii) Class II-(A)Cantilever type (Distal Shoe, Band and loop),
(B)Removable space maintainers-Acrylic partial denture

Requirements Of An Ideal Space Maintainer
(I) maintenance of mesiodistal dimensional space.
(II)Constructed simply.
(III) Strong enough to withstand occlusal forces.
(IV) Prevent supraeruption of the opposing teeth
(V) not restricting jaw growth.
(VI) No exertion of undue forces .
(VII) No hindrances of speech, mastication or deglutition.
(VIII)No interference or deviation of the normal eruption path of the successor.
(IX) cost effective.
(X)No food enlodgement; promoting easy cleaning.
(XI) Easily adjustable.

Indications Of Space Maintainers
(i)will aid in or make the future orthodontic treatment less complicated.
(ii) treatment of malocclusion at a later date is not indicated.
(iii) the space for a permanent tooth should be maintained for 2 years or longer.
(iv) In case; the abutment teeth cannot support a fixed appliance.
(v) Avoidance of supraeruption .
(vi) Improve the physiology of a child's masticatory system , restoring dental health optimally.
(vii) Suceedaneous tooth not ready for eruption.
(viii) At least 1 mm of bone coverage over the space.
(ix)Possibility of space inadequacy for the permanent successor due to unbalanced forces.

Contraindications Of Space Maintainers
(I)Pre-extraction radiograph revealing that the succedaneous tooth will erupt soon. (II) Radiograph of extraction region showing one third of the root of succedaneoustooth already calcified.

(III) Space left by the prematurely lost primary tooth is greater than space needed for permanent successor eruption.
(IV) Space shows no signs of closing.
(V) When the succedaneous tooth is absent.

Factors To Be Checked While Fabricating A Space Maintainer

According to **Owen**, the factors are as follows:

1. Incidence of Space loss
2. Time elapsed since tooth loss
3. Amount of Space Loss
4. Direction of space closure
5. Eruption status of the adjacent teeth
6. Amount of Bone Coverage Over the Tooth
7. Eruption status of the succedaneous tooth
8. Dental Age of the Patient; Sequence of Eruption
9. Available Space
10. Delayed eruption of the Permanent teeth
11. Arch length Adequacy
12. Curve of Spee
13. Abnormal Oral Habits
14. Interdigitation and its stability

These factors influence planning because they may be associated with either space gain or space loss. Some of these factors are the growth of the jaws, proximal caries, wear and attrition.

Space Analysis

Space analysis plays an indispensable role for the purpose of selecting a space maintainer.

➢**Space Discrepancy Analysis done by:**

1. Moyer's Mixed Dentition Analysis
2. Hixon And Old Father Method
3. Tanaka-johnston Analysis
4. Radiographic Method

Newer Generation Of Space Maintainers:

Ribbond- A biocompatible aesthetic material, manufactured from high strength polyethylene fibres. [1] It has got a number of advantages like ease of adhesion to the dental contours, fast technique of application and great strength.[2] It is well tolerated by the patient, aesthetic and less time consuming.[8]

EZ Space maintainer:

Cost effective, less time consuming than the traditional band and loop space maintainer. It does not require impression taking, time-consuming lab procedures, and they can be bonded directly during a single dental visit.[17]

Nikhil Appliance:

A tube and loop space maintainer, introduced by Srivastava et al. It is less time consuming. Like the conventional band and loop space maintainer, the lengthy lab procedures and soldering techniques are not necessary.

H-Appliance:

A simple bracket and hook space-maintainer, does not require the lengthy procedures of band making, welding and soldering like the conventional band and loop space maintainer.

Indirect bonded space maintainer:

One of the most commonest modern space maintainers. It is a newly designed and presented appliance, having brilliant properties. However this space maintainer can represent lower adjusting capacity than that of the "Cise" space maintainer.[10]

Fibre reinforced space maintainer:
Recently, fibre reinforced composite resins are being used for the fabrication of space maintainers. Consequently, this type of space maintainer application is found to be more successful than the conventional space maintainers in some aspects. This new approach possesses significantly higher patient acceptability and cost effectiveness. [24]

Digital Space maintainers:
They are quite modern and biocompatible; use the CAD-CAM Technique. They are fabricated by using polyetherketone, (PEEK), having a unique mix of strong mechanical properties. They are rigid, opaque, and biocompatible. Apart from that, the material also provides high chemical resistance, high- temperature stability, dimensional stability and a wide range of process in possibilities. It is highly recommended as the treatment options in patients suffering from severe allergy to metals.

Commonly Used Space Maintainers In Pediatric Dentistry:
Band And Loop Space Maintainer:
It is a unilateral, non-functional, passive, fixed appliance indicated for space maintenance in the posterior segments, when a single tooth is lost.[42]

➢**Indications:**
1. Usually for preserving the space, created by the premature loss of single, primary molar.
2. Bilateral loss of single primary molar before the eruption of permanent incisors. This is because the developing succedaneous tooth buds are placed lingually to the permanent incisors, hence the band and loop space maintainer is the most preferred one. The other space maintainers like the lingual arch may lead to obstruction of these teeth.[23]
3. Also indicated in the cases, where the second primary molar is lost after the eruption of the first permanent molar.

Contraindications:
1. High dental caries activity.[15]
2. Is contraindicated in cases, where an occlusion is extremely crowded or already exhibits marked space loss.
3. Replacement of primary anterior teeth.[12]
4. Replacement of the primary second molar in the primary dentition, without the partial clinical eruption of the permanent first molar.[17]
5. Replacement of the primary second molar in the primary dentition, without the partial clinical eruption of the permanent first molar.
6. Replacement of the primary second molars in the transitional dentition with banded permanent molar.
7. Cases, necessiating the guidance of eruption.

Modifications :
1. Crown and Loop- It resembles the same as that of the band and loop, but here instead of the band, stainless steel crown is used.
2. Crown Band and loop- At first, the stainless steel crown is placed, after which it is banded.
3. Mayne's Space maintainer- It resembles somewhat that of the band and loop space maintainer, but the loop is halved with the elimination of the buccal loop, thereby giving the lingual extensions only.
4. Reverse Band and Loop: It is typically used in the cases, where there is premature loss of the primary second molars and the permanent molars have not erupted fully, as to support a band. In such cases, primary first molar is banded and a loop is made; that touches just below the marginal ridge of the permanent molars.
5. Long Band and Loop- It is used in the cases, where there is multiple loss of teeth in one segment and an arch stabilizing space maintainer like the lingual arch cannot be given due to the eruption status or if a removable appliance is contraindicated.
6. Bonded band and loop space maintainer: : With the use of acid etch technique, the light curing composite systems, simple space maintainers can be more readily made. The chief advantages include the ease of adhesion to the dental contours, fast technique of application, good strength.
7. Band and Loop Space Maintainer with NIMS modification- Prajapati et al in 2013, proposed that in some cases like long-standing loss of the upper first primary molars, the primary canine occludes with the primary molar of the opposite arch, such that the cusps of the molar impede in the space created by the loss of teeth.[33] In these cases, the loop has to be modified and one arm has to be removed as to create space and therefore to

8. allow proper occlusion.
9. Band and loop space maintainer with unilateral band and bent wire design which was presented by Pushpalatha et al, in some cases, with space loss.

Lingual Arch Space Maintainer:
1. It is a bilateral, non-functional, passive/active, mandibular fixed appliance.
2. It is the most effective appliance of space maintenance and minor tooth movement in the lower arch.[5]

Indications:
1. This appliance is usually indicated to preserve the space created by the multiple loss of the primary molars, when there is no loss of space in the arch. The use of the lingual arch is a mentionable preventive measure, since it helps in maintaining the arch perimeter by preventing both the mesial drifting and the lingual movement of the molar teeth and also the lingual collapse of the anterior teeth.[12]
2. Bilateral loss of the primary molars after eruption of the lower lateral incisors.
3. Unilateral loss of the primary molars after the eruption of lower, lateral incisors.
4. Minor space regaining.

Contraindications:
•It is not used before the eruption of the permanent incisors because the permanent incisor tooth buds develop somewhat erupt lingually to their primary precursors and the design of conventional mandibular lingual arch might interfere with the eruption.[11]

Modifications:
1. Hotz Lingual Arch: With U- loop, used for space regaining .
2. Removable Lingual Arch: The removable lingual arch wire has precision fitting shafts that fit into corresponding sheaths on the molar bands. It is used as an active appliance or as a device to maintain the arch perimeter.
3. Omega bands: It is found in the canine region, in order to prevent interference.[48]

Nance Palatal Arch Space Maintainer:
Having been discovered by Nance in 1947; it is a bilateral, non-functional, passive, maxillary fixed appliance that does not contact the anterior teeth, but approximates the anterior palate via an acrylic button, contacting the palatal tissue, therefore resistance to the anterior movement of the posterior teeth in a horizontal direction.

➢**Indications:**
1. Nance palatal arch may be used in maintaining the maxillary first permanent molar positioning.
2. When there is bilateral premature loss of primary teeth, with no loss of space in the arch and a favourable mixed dentition analysis.[31]

Modifications:
1. Modified Nance Appliance for unilateral molar distallization.[42]
2. Esthetic Nance Palatal Arch: Appliance modified with the attachment of the teeth in the anterior region, to serve as a space maintainer and also for anterior esthetics.[42]

Transpalatal Arch
It is an unilateral, non-functional, passive, maxillary fixed appliance, that has been recommended for stabilizing the maxillary first permanent molars when the primary molars require extraction.

•Was eventually reported and described by Goshgarian (1972), Hill and Tsamtsouries (1977).[48]

➢**Indications:**
The best indication stands; when one side of the arch is intact and several primary teeth on the other side are missing.
•Also indicated when primary molars are lost bilaterally.[45]
It is designed to prevent the molars from rotation.

➢ **Design Of The Wire Loop:**

- The transpalatal arch runs directly across the palatal vault, thereby avoiding contact with the soft tissues.[30]
- It has a U-shaped bend, which is given to the wire in the middle of the palate.[47]
- As the wire approaches the mesial part of the palatal surface of the band, it should be bent to the distal part of the band to assure a better joint.

➢ ADVANTAGES:

- Used in unilateral or multiple loss of molars
- Can be used for expansion.[48]

➢ DISADVANTAGES:

- Rotation of the molars.
  - Both the molars may tip together.

Distal Shoe Space Maintainer:

It is also known as the **intra alveolar appliance**.

- The most earliest design of the "Distal Shoe space maintainer" is the "Willet's Distal Shoe space maintainer .[40]
- The appliance recently popular as the "Roche's Distal Shoe Space Maintainer" having a distal intragingival extension.[7]
- Offers a V-shaped end, offering a broader surface, which helps to prevent rotations.
- The broader surface also holds a greater chance of success, if the unerupted tooth is positioned buccally or lingually in the dental arch.[47]
- When the second primary molar is removed, prior to the eruption of the first permanent molar, the intra-alveolar appliance provides greater control of the path of eruption of the unerupted tooth and prevents undesirable mesial migration.[23]

➢**Indications:**

When the second primary molar is extracted or lost before the eruption of the first permanent molar.

➢**Contraindications:**

- Inadequate abutments due to multiple losses of teeth.
- Poor oral hygiene.
- Lack of parent and patient cooperation.[48]
- Medically compromised patients like patients with congenital heart disease, kidney problems, juvenile diabetes, history of rheumatic fever, hemophiliacs.[47]
- Congenitally missing first permanent molar.

Various Modifications:

- A combination of lingual arch and distal shoe appliance was suggested for use in patients, in whom both the primary molars are lost. The patient's strong gag reflex prevented the use of a removable appliance.[18]
- Placing loops in the horizontal arm of the space maintainer. These loops will permit the precise adjustments needed for the accurate placement of the molars.
- Gingival saddle appliance: This is a combination of reverse band and loop and distal shoe; where the loop is placed on the gingiva and the molar on eruption, comes in direct contact with this loop.[19]
- Levit showed an alternative method for construction of the distal shoe space maintainer, whereby, the second deciduous molars are extracted, the tooth is placed on the previously taken impression.[48]
- Bhat et al modified the design of the distal shoe space maintainer, therefore fusing it with the lingual arch in case of early loss of both primary first and second molars unilaterally.[28]

Recent Advancements In Space Maintainers:

▪Digital Space Maintainers:

Space maintainers using CAD-CAM or 3D print technology with modern and biocompatible materials are called the "Digital space maintainers." The various drawbacks and challenges of the traditional space maintainers can be overcome by using this technology.[9]

Types of **Digital Space Maintainers**:

Peek Polymer:

- These are the materials made from polyethereketone, having a unique mix of strong mechanical properties.
- They are rigid, opaque and biocompatible in nature.[9]
- Apart from the different mechanical properties, the material substantiates for numerous characteristics like chemical resistance, high-temperature stability, and a wide range of processing possibilities, which deserves a special mention.
- Patients, who are duly allergic to metals like Nickel or somehow dislike the unpleasant metallic taste can easily use this, as it has a natural tooth-coloured appearance.[9]
- It is hence used as a potential candidate for the usage as aesthetically pleasing metalfree orthodontic wire.

➢ **BRUXZIR**:[10]

- It is three to five times more fracture-tough than standard zirconia; having a flexural strength of up to 1,465 MPa, imparting the material an excellent impact resistance to the masticatory forces in the mouth.
- This gives the material an excellent impact resistance to the masticatory forces in the mouth,
- The material is capable of staying in the mouth; without getting shifted or becoming loose in the mouth, because of its minimal thermal expansion.[10]
- It also accounts for better appliance retention, thereby preventing the tooth tipping.
- The masticatory forces are distributed equally across the extracted tooth's region.

- **TRILOR**:
- It is an extremely compatible CAD-CAM processed FRC resin.
- Metal and zirconia are heavy materials; this metal free, biocompatible alternative weighs 3-5 times less.[13]
- Durability, elastic property, low weight, biocompatibility and repairability are some of the chief benefits
- Beretta and Cirulli developed a metal-free CAD-CAM device, intending to produce safe appliances for special needs patients, who require regular magnetic resonance imaging (MRI).

Conclusion:-

▪One of the important functions of primary teeth is to occupy the physiological space and guide the eruption of the replacement teeth. Primary teeth exfoliation followed by successor teeth eruption is a normal physiological process; interrupting which, may lead to mesial migration of the permanent teeth, crowding, impacted permanent teeth, formation of cross-bites, differences in the median line of teeth, and the supra-eruption of the antagonistic teeth. It is also reported to impact negatively on the children's quality of life regarding the emotional well-being; therefore; space maintenance at the primary stage is a major factor in preventive orthodontics. An early intervention with a space maintainer may prevent undesirable space loss; thereby, this very effort, is hence extremely significant; in preventing the need of any future complicated orthodontic treatment.

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