

Clinical Technique: Space Maintenance Following the Premature Loss of Primary Molars using Innovative Fixed Unilateral Space Maintainers (Smart Appliances)

Research Article

Mohammed Zameer^{1*}, Tazeen Dawood², Syed Nahid Basheer³, Syed Wali Peeran⁴, Syed Ali Peeran⁵, Sameen Badiujjama Birajdar⁶, Arun Reddy⁷, Faisal Mohammad Alzahrani⁸

¹ Registrar Pedodontist, Armed Forces Hospital, Jizan, Saudi Arabia.

² Assistant Professor, Periodontics Division, Department of Preventive Dental science, College of Dentistry, Jazan University, KSA.

³ Assistant Professor, Department of Restorative Dental Sciences, Jazan University, Jazan, KSA.

⁴ Senior Registrar Periodontist, Armed Forces Hospital, Jazan, KSA.

⁵ Registrar Prosthodontist, Armed Forces Hospital, Jazan, KSA.

⁶ General Dentist, Sanjeevani Dental Clinic, Raichur, INDIA.

⁷ Associate Professor, Department of Oral & Maxillofacial Orthodontics, Navodaya Dental College, Raichur, INDIA.

⁸ Oral Maxillofacial Surgery Resident, Armed Forces Hospital, Jazan, KSA.

Abstract

Space maintenance has been of paramount significance following the premature loss of primary molars to prevent developing features of malocclusion. Numerous types of space maintainers (SM's) have been devised to guide the eruption of developing teeth and maintain the relationship of remaining teeth. Fixed unilateral SM's are more commonly used appliances in clinical practice. The traditional fixed unilateral SM's advocated following the premature loss of primary molars have certain disadvantages in their clinical use. Modifications in their designs are needed to meet the ideal requirements of a space maintainer. This paper aims to introduce an innovative design of fixed unilateral space maintaining appliances (Smart Appliances) that are intended to overcome the disadvantages of the conventional ones. The loop of a band-and-loop space maintainer is modified to allow physiological canine movement during the eruption of permanent incisors. A stainless-steel crown is accommodated to make it a functional appliance. A modification of non-pressure type distal shoe, fixed unilateral saddle appliance is designed to guide the eruption of the first permanent molar.

Keywords: Unilateral Fixed Space Maintainer; Functional Space Maintainer; Band and Loop Space Maintainer; Crown Band and Loop Space Maintainer; Fixed Unilateral Saddle Space Maintainer; Smart Appliances.

Introduction

The premature loss of primary molars due to caries, trauma, or other causes has shown to cause disturbances in the developing occlusion including space loss in the developing dentition [1-3]. Space maintenance has been of paramount significance following the premature loss of primary molars to prevent developing features of malocclusion [4, 5].

Space maintainers (SM's) advocated following the premature loss of primary molars are 1) Band-and-loop space maintainer(SM) following the loss of the first molar and crown-band-and-loop SM if the abutment tooth has extensive caries or vital thera-

py has been done earlier. 2) Distal-shoe SM following the loss of second molar, and the same can be modified as reverse band-and-loop SM after the eruption of first permanent molar before the eruption of permanent incisors [6]. These space maintaining appliances have been categorized by Code on Dental Procedures and Nomenclature (Code) CDT 2017 as fixed unilateral appliances [7]. They have been devised to guide the eruption of developing teeth and maintain the relationship of remaining teeth. All designs have certain advantages and disadvantages in their clinical use.

The traditional band-and loop space maintainer neither restores the chewing function nor restrict the supra-eruption of antagonist teeth [6]. Moreover, the adapted concavity following the distal

*Corresponding Author:

Mohammed Zameer,
Registrar Pedodontist, Armed Forces Hospital, Jizan, Saudi Arabia.
Tel: 00966531062563
E-mail: drmohammedzameer@gmail.com

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surface of the primary canine in the mesial arm of the loop has been shown to restrict the physiologic disto-labial canine movement during the eruption of permanent incisors [8]. The fabrication of distal shoe SM's is technique sensitive, and its usage is contraindicated in several conditions. Due to the cantilever design, it can replace only one tooth [6]. Histological studies have shown that complete epithelialization does not occur with the placement of intra-gingival extension and shows associated chronic inflammatory response [9]. Therefore, distal shoe space maintainer is contraindicated to be used in patients with a history of systemic illness such as congenital heart disease who need prophylactic antibiotic coverage, blood dyscrasias, immunosuppression, rheumatic fever, and juvenile diabetes [10].

This paper aims to introduce an innovative design of fixed unilateral space maintaining appliances (smart appliances) that are intended to overcome the disadvantages of the conventional ones and thus encourage the clinicians for their prescription in certain clinical situations.

The Technique for the Construction of Smart Appliances

Preparation

1. Collection of complimentary details that includes maxillary and mandibular models of the patient, model analysis, periapical radiographs of the primary molars indicative of extraction, and of the first permanent molar that needs eruption guidance.
2. Radiographic evaluation to evaluate the level of root formation and bone over the succedaneous tooth, the position of a first permanent molar, either extraosseous (that is the complete absence

- of bone over the occlusal surface of the molar) or intraosseous.
3. Determination of the size of stainless steel crowns by measuring the mesiodistal size of the molars to be replaced in SM. This can be done intraorally or using the models if the mesial and distal walls of molars are preserved. Otherwise, it must be measured from the contralateral molar and confirming it through a radiograph for appropriate measurement.
4. The primary molars are extracted and followed up for proper healing.

Fabrication

1. The operator must select an appropriate preformed band and place them to their ideal position on the abutment. This should be followed by an alginate impression of the band and edentulous area.
2. The band is gently removed with a band remover and stabilized in the impression in its correct position. The impression is poured using dental stone with the band in place. and the cast is separated after setting.
3. A 0.036 stainless steel wire is formed into a loop and contoured to fit the band and follow the alveolar ridge. The anterior portion of the loop should have a mild distal slope and contact the distal surface of the primary canine to allow its physiologic movements. The loop is then soldered to the band.
4. The selected stainless steel crown is reduced in height in order to accommodate over the loop based on the available space in occluso-cervical direction. it is then stabilized using a modeling wax. A layer of Type-II-gypsum is covered over the crown, leaving a slight window at the junction of distal surface of the crown and mesial surface of the band.
5. The solder material must be made to flow through the window

Figure 1. Pre and post - operative intraoral periapical radiographs.

A-D: Indicates non-restorable primary molars and reveals extraosseous position of permanent mandibular first molar
 E-H: At 12months of follow up, it shows progression in the level of eruption and reduction in the amount of bone over the succedene teeth and also reveals successful eruption of permanent left mandibular first molar.

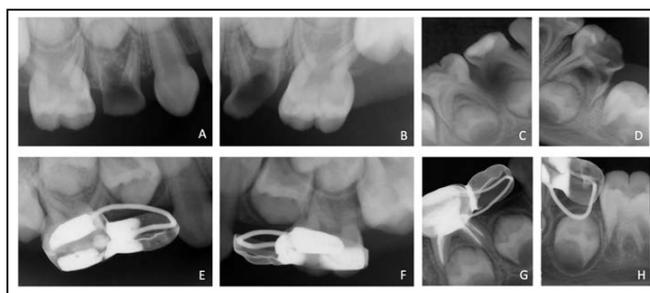


Figure 2 Banding and loop formation

- a,b : Banding on the abutment teeth of maxilla and mandible
- c : Cast separation with bands for maxillary teeth
- d : Formation of loop with disto-labial sloping for modified band-and-loop design
- e : Cast separation with bands for mandibular teeth
- f : Loop formation with the distal arm in approximation with the mesial surface of the first permanent molar under the eruption bulge and rest over the soft tissue.

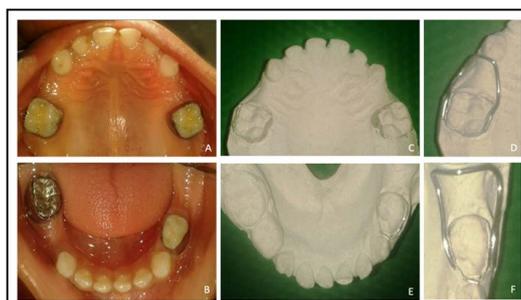


Figure 3. Insertion and follow up of the smart appliances after a year of time
 a : After finishing and polishing
 b : The undersurface of crown and loop sealed with acrylic
 c, d : Post insertion of Modified band-and-loop for the maxillary and mandibular teeth
 e : Post insertion of fixed unilateral saddle appliance
 f : Follow up of saddle appliance guided the eruption of permanent left mandibular first molar
 g-i : Post insertion views of smart appliances.



adjoining crown and the band. Followed by sealing the undersurface of crown and the loop with acrylic. Lastly, finishing and polishing are carried out.

Placement

1. The smart appliance is then trial fitted in the patient's mouth to see any soft tissue irritation or occlusal interferences. The final cementation should be carried out using Type-I Glass-ionomer cement with precautions for proper isolation, including rubber dam and use of high-volume suction.
2. No more than one week should lapse from the tooth extraction time to the placement of the appliance, just as with any other SM.

Management of Fixed Unilateral Saddle Appliance (Smart Appliance)

1. Fixed unilateral saddle appliance is indicated only if the erupting first permanent molar is extraosseous, which should be confirmed through radiograph.
2. An appropriate band is selected and placed on the first primary molar that acts as an abutment. The loop is formed to extend distally in approximation with the mesial surface of the first permanent molar under the eruption bulge and made to rest over the soft tissue.
3. The loop is soldered to the band, and a similar stainless steel crown adaptation was followed as described earlier. After finishing and polishing, the appliance is trial fitted to check any soft tissue irritation or occlusal interferences.
4. The final cementation should be carried out using type-I glass ionomer cement with proper precautions of isolation.

Follow up

1. The patient has to be recalled after a week to check the integrity of the appliances in the mouth and adjustments are made if necessary. The patient is kept on regular recall visits every two months.
2. Periodic clinical and radiographic re-evaluation with the removal of SM's is mandatory to closely supervise the appliance, the integrity of luting cement, the eruption status of the successor

and progress in the eruption of the first permanent molar. Thus, it requires frequent and long term follow-ups.

3. De-cementation of the band and breakage of the solder joint are possible complications as with any other SM's. The patient and the parents must be cautioned for the complications and asked to report if it happens.
4. When the succedaneous tooth starts to emerge or visible in the edentulous area, the fixed unilateral functional band-and-loop appliances can be removed, as it is the removal time of the appliance.
5. When the first permanent molar starts to emerge, the fixed unilateral saddle appliance is maintained and the clinician supervises that it does not make any interferences. After an adequate eruption of the permanent molar, a bilateral SM can be given for better stabilization.

Discussion

Premature loss of primary molars results in space closure by the movement of adjacent teeth into the edentulous area [3, 11]. It is also reported to have a negative impact on the quality of life of children concerning emotional well-being, oral symptoms, and functional limitations [12]. Space maintenance has been emphasized at the earliest to avoid developing features of malocclusion, and this can be achieved with different types of SM's [4, 5]. The traditional fixed unilateral SM's advocated following the premature loss of primary molars have certain disadvantages in their clinical use, and hence there is a need for innovative appliances to overcome their disadvantages.

The understanding of developing anterior occlusion indicates physiologic canine movements that take place in the mandibular arch during the eruption of the permanent lateral incisors, whereas, in the maxillary arch during the eruption of the permanent central incisors. Restriction of primary canine movement by a space maintainer may have a negative impact on the erupting mandibular permanent lateral incisor and maxillary primary lateral incisor. The adapted concavity following distal surface of primary canine in the mesial arm of the loop of conventional band and loop SM restricts physiologic disto-labial canine movement during the eruption of permanent incisors [8]. In the present design, the disadvantage of the conventional band-and-loop

SM was overcome by following the recommended modification of the loop that incorporates a distal-abial slope in the mesial arm of the loop. This revised design of the loop allows the physiologic canine movement to take place, simultaneously it preserves the arch length required for the unerupted first premolar and enhances alignment of permanent labial incisors [8].

The literature indicates a fixed unilateral SM using fiber-reinforced composite resin as an alternative to conventional band-and-loop appliances. Although they have been reported to be better in terms of patient acceptance, the time required to complete the appliance, and clinical efficiency [13], they do have certain disadvantages like the possibility of supra eruption of opposing teeth and does not allow physiologic canine movement during the eruption of permanent incisors. Another modification has been reported to overcome the disadvantage of the nonfunctional design of conventional band-and-loop. It has a similar metal framework as of the conventional design along with an acrylic tooth as a pontic that is attached to the loop using cold cure acrylic [14]. In our design, the stainless steel crown is soldered to the band over the abutment and allowed it to rest over the loop. Hence, it can stand strong enough to distribute the masticatory forces and prevents loop slippage or distortion and impingement in the gingiva. This design, along with restoring masticatory function and restricting antagonist teeth movement, also allows the physiologic canine movement to occur during the eruption of the permanent incisors.

It has been reported that extra-alveolar designs of the distal shoe SM's are pressure-type appliances [10, 15, 16]. It is stated that free end SM's that are removable, extra-alveolar, pressure type appliances can be employed in both the extraosseous and intraosseous position of the first permanent molar. But they start their role of maintaining space and guiding the eruption only when the molar becomes extraosseous. Theoretically, the terminal end of these appliances exerts pressure received by the neuromuscular spindles in the area (also called proprioceptive receptors), which absorb directional information concerning the eruptive movement of the tooth, hypothetically allowing tooth eruption without mesial migration [10]. Contrarily, it has also been reported when the molar is situated slightly occlusal and distal to the distal extension of the removable appliance, clinical approximation without pressure exerting ridges be sufficient to allow and guide the erupting permanent first molar [17]. However, more research needs to be done to support either technique. In the present case, an innovative extra-alveolar, non-pressure-type, fixed unilateral saddle appliance was used that had approximation with the mesial surface of the permanent first molar under the eruption bulge and successfully served to maintain the space and guide the erupting permanent first molar.

After the first permanent molar has been guided into position, continued vertical development may result in the tipping of the molar over the blade extension in a conventional distal shoe appliance. The possible suggested option is to remove the intra-gingival extension and replace it with a reverse band and loop. It has an occlusally directed extension that prevents tipping of the molar over the distal end [6]. In our design of fixed unilateral saddle appliance (smart appliance), the loop is extended distally in approximation with the mesial surface of the first permanent molar under the eruption bulge and rests over the soft tissue. The stainless steel crown is adapted over the loop and is soldered to the

band. This serves to guide the unerupted first permanent molar in both sagittal and vertical direction, simultaneously preventing the supra-eruption of the opposing teeth. Therefore, the same appliance can be employed before the eruption of extraosseous first permanent molar and after the adequate eruption to be banded in the use of bilateral SM. The need for bilateral SM is because of the exfoliation time of primary first molar as an abutment which may occur before the eruption of second premolar [6].

This innovative design has led to the development of modified fixed unilateral functional SM's (Smart Appliances). They include; band-and-loop, crown band-and-loop, and non-pressure-type fixed unilateral saddle SM's. The success of these appliances is determined by the efficiency in terms of maintaining space, allowing masticatory function, and preventing the extrusion of the opposing tooth. The fixed unilateral saddle appliance furthermore acts as a guide for the eruption of the extraosseous first permanent molar.

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