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Case Series

Dentistry Section

Innovative Clinical Technique of Space Maintenance using Customised Functional Space Maintainer: A Case Series

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ABSTRACT

Space maintenance is of particular importance following the premature loss of deciduous molars to prevent development of malocclusion. The usage of fixed space maintainers is more common in clinical practice. Traditionally fixed unilateral space maintainers were advocated following the premature loss of primary molars but they have certain clinical disadvantages such as loss of arch length, improper eruption of permanent successors and primarily the loss of function of mastication which cannot be achieved with the available fixed unilateral space maintainers. The paper is about three cases with an interesting design of fixed functional space maintainers which might overcome the disadvantages in the existing strategies in space maintainers and space maintenance and restore the primary function of mastication. To incorporate functionality into the conventional space maintainers a stainless-steel crown or an acrylic tooth of customised adequate dimension is incorporated into the traditional design.

Keywords: Interceptive orthodontics, Preventive orthodontics, Space loss, Unilateral space maintainer

INTRODUCTION

The deciduous dentition has a significant role in the child's growth and development, not only in terms of speech, chewing, and appearance but also in the guidance and eruption of permanent teeth. The deciduous teeth may be prematurely lost due to extensive caries, trauma, or other causes, resulting in space loss and thus disturbances in the developing occlusion [1-3]. Therefore, concept of space maintenance is of paramount importance [4,5].

The premature loss of deciduous molars results in loss of space through mesial movement of teeth adjacent to the space into the edentulous area [6]. Therefore, space maintenance has to be stressed at the earliest to avoid developing malocclusion [5].

This case series introduces an innovative design of fixed unilateral customised functional space maintaining appliances proposed to overcome the drawbacks of the conventional space maintainers thereby allowing clinicians to use it in specific clinical situations.

CASE SERIES

Case 1

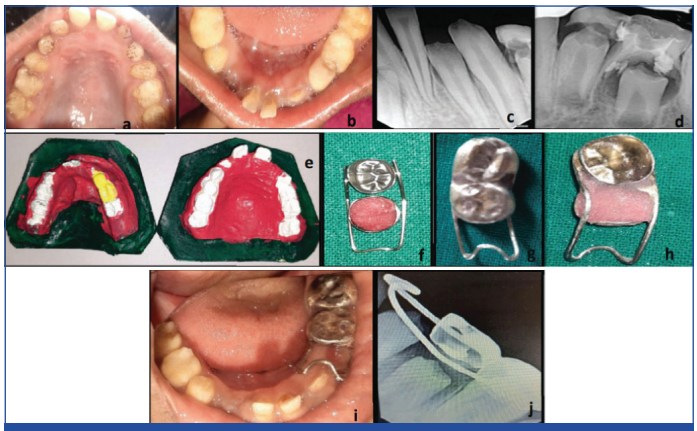
A nine-year-old female patient came to Department of Paediatric Dentistry with the chief complaint of pain in lower left back tooth region since three days. Pain was continuous, localised, throbbing type, aggravating on chewing and during night and intermittently relieved on intake of medication. She had a dental history of root canal treatment in lower left back tooth region five days back. There was no significant medical history. On intraoral examination there was furcation abscess in 74, 75 [Table/Fig-1a,b]. On radiographic examination [Table/Fig-1c,d], there was deep dentinal caries with completely resorbed roots and half of crown resorption in 74 and furcation radiolucency in relation to root canal treated tooth of 75. Final diagnosis was failed pulpectomy of 75. Authors planned to extract 74, 75 due to poor prognosis followed by space maintainer.

Details of patients were collected including extraoral and intraoral photographs, maxillary and mandibular models of the patient [Table/Fig-1e]. Tanaka Johnston and Moyer's mixed dentition analysis [7] was performed. Inference showed that space available was nearly equal to space required. Thus, space maintainer was advised to prevent space loss. On radiographic evaluation, succedaneous tooth with less than two-thirds of root formation was seen as an indication of space maintenance [Table/Fig-1c,d]. The primary molars 74, 75 were extracted under local anaesthesia. The patient was followed-up for one week for proper healing.

In second appointment a suitable sized stainless steel crown was chosen measuring the mesiodistal dimension of the molars to be an abutment in the space maintainer. The erupting premolar dimension was confirmed through the radiograph.

After selection, the crown was placed in its ideal position on the abutment tooth by halls technique [8] on sound tooth of 36 (E6 stainless steel crown, 3M ESPE was selected). In this case, in third quadrant, only 31 and 36 were erupted and 33 were in erupting stage. As the lateral incisor 32 had not yet erupted there would be disto labial movement of 33 to allow eruption of 32. So, the loop was modified in this case to have a slight distal slope to allow the physiological movement of canine [9]. On radiographic examination, first premolar 34 had more than two thirds of root formation hence space maintenance was not indicated but 35 had less than two thirds of root formation indicative of requirement of space maintenance. As the tooth 35 takes time to erupt, to restore the masticatory function a stainless steel crown with adequate mesiodistal dimension (E5 stainless steel crown, 3M ESPE) taking care not to interrupt eruption of 34 was selected intraorally to function as a pontic. Trimming of the crown was done to prevent occlusal interruption. The pontic crown was removed from oral cavity. Keeping the abutment crown in position intraorally, an alginate impression was made for both arches and cast was poured. After completion of cast preparation, A long loop was fabricated with 21-gauge stainless steel wire to extend from 36 to 34 following the alveolar ridge of the edentulous area with an incorporated disto-labial slope and soldered to abutment crown. Then the selected pontic crown was placed in the region of 35 leaving a tiny window in between abutment and pontic crowns [Table/Fig-1f]. The solder material was allowed to flow through the window adjoining crowns, followed by sealing the under surface of pontic crown with acrylic [Table/Fig-1g,h]. The appliance was then tried in the patient's mouth. Soft tissue irritation or occlusal interferences was checked thoroughly. The appliance was cemented using type-I Glass ionomer cement with proper isolation [Table/Fig-1i]. Intraoral periapical radiograph was taken [Table/Fig-1j]. The patient was recalled after

one week to check the appliance integrity in the oral cavity. The patient was regularly followed-up every two months for 1 year.



[Table/Fig-1]: Case 1: Customised functional long double crown and loop space maintainer with stainless steel crown as pontic; a,b) Preoperative clinical intraoral photographs; c,d) Preoperative radiographs (31,32,33,74,75); e) Preoperative cast marking the extraction site in yellow colour; f) Appliance before soldering with tiny window between pontic and abutment crowns for solder to flow [acrylic filled inside pontic]- gingival view; g) Prepared appliance occlusal view; h) After finishing and polishing- gingival view; i) Postoperative clinical intraoral photographs mandible and long double crown and loop appliance with stainless steel crown as a pontic; j) Post insertion radiograph.

Case 2

A seven-year-old female patient came to Department of Paediatric Dentistry with the chief complaint of pain in lower left back tooth region since two months. She had history of pain in relation to decayed tooth which was continuous, localised throbbing type which aggravated during intake of cold fluid and during night. There was no significant medical and dental history. On intraoral examination there was gross decay in 75 and class II dental caries wrt 74. On radiographic examination gross destruction of crown and root structure with bone loss in 75 was seen. Diagnosis was chronic irreversible pulpitis with respect to 75 and extraction was advised for 75 followed by space maintainer due to poor prognosis and restoration was advised for 74.

Details of the patient were collected [Table/Fig-2a-e], radiographic evaluation and model analysis were done [Table/Fig-2f,g]. Extraction of 75 was done and one week recall visit was advised to ensure proper healing. In second appointment, 74 was restored with glass ionomer cement and an appropriate crown was selected for abutment tooth 74 (D5 stainless steel crown 3M ESPE). Stainless steel crowns of different sizes were tried to fit in the region of 75. But due to gross destruction of 75, opposing tooth 65 had supraerupted leading to inadequate space for stainless steel crown placement. So, an acrylic tooth was fabricated by using primary dentition mould and the acrylic tooth was trimmed to fit as a pontic in occlusion. Then alginate impressions were made after removing the pontic from oral cavity with abutment crown in place. Clear acrylic pontic was attached to the loop and the abutment crown with addition of extra amount of acrylic. Here clear acrylic was used for feasible assessment of the eruption status of permanent tooth 35 as the patient was from remote area and due to non-availability of transport for frequent visits. On cast, loop was fabricated and soldered to crown [Table/Fig-2h,i]. The appliance was cemented using type-I glass ionomer cement with proper isolation [Table/Fig-2j]. Intraoral periapical radiograph was taken [Table/Fig-2k]. The patient was regularly followed-up every four months for 1 year [Table/Fig-2l-n].

Case 3

A six-year-old female patient came to Department of Paediatric Dentistry with a chief complaint of pain in lower left back tooth region since three months. She had a history of pain in relation to decayed tooth in lower left back tooth region. Pain was intermittent, aggravated on eating and during night. Clinical evaluation revealed persistent infantile swallow pattern, tongue thrusting while swallowing

[Table/Fig-2]: Case 2: Customised functional reverse crown and loop space maintainer with custom made clear acrylic tooth as pontic. a,b,c) Extraoral photographs; d,e) Preoperative clinical intraoral photographs; f) Preoperative radiographs; g) Preoperative cast of maxilla and mandible marking the extraction site in yellow colour; h) Appliance prior to soldering- occlusal view; i) Appliance perior to soldering- gingival view; j) Postoperative clinical intraoral photograph- mandible with appliance [clear acrylic pontic]; k) Post insertion radiograph; l,m,n) two months follow-up intraoral photographs.

and difficulty in articulating specific words. Detailed history revealed that the child had been using the pacifier till a year ago. On intraoral examination, tongue assumed a lower posture at rest with the tip touching the cingulum/lingual fossae. Since other adverse oral habits were ruled out it can be concluded that the spacings between lower incisors was solely because of her abnormal tongue posture suggestive of tongue thrusting habit. On intraoral examination 74 was grossly decayed and radiographic examination showed gross destruction of crown and root structure of 74. Diagnosis was chronic irreversible pulpitis with respect to 74. Extraction of 74 followed by space maintainer was advised.

Details of the patient were collected [Table/Fig-3a-h], radiographic evaluation and model analysis were done [Table/Fig-3i]. Extraction of 74 was done and patient was recalled after one week. In second appointment, on intraoral examination tongue occupied the extracted space due to complex tongue thrusting habit in the patient [Table/Fig-3h]. So, this case required modification of traditional space maintainer design. Banding was done for 75. stainless steel crown was chosen through trial-and-error method to fit in the region of 74. Gross decay of 74 resulted in decreased mesiodistal dimension and distal movement of deciduous canine making even size 2 (3M ESPE) crown larger to fit in the region of 74 and also tongue thrusting habit led to spacing in mandibular permanent incisors further distalising the deciduous canine. Hence, an acrylic tooth was fabricated similar to case 2 but a little amount of Zinc oxide eugenol (1/2 scoop with ZOE powder dispensing scoop) was added to the clear acrylic powder (5 scoops) for better aesthetics [Table/Fig-3j-l]. The acrylic tooth was trimmed and adjusted to normal occlusion. Alginate impression was made with band in position and cast pouring was done [Table/Fig-3j]. Loop was fabricated to fit the edentulous area and soldering of band and loop was done by stabilising with type-II gypsum [Table/Fig-3k,l]. The acrylic tooth was attached to band and loop with a pink coloured acrylic to simulate the gingiva. Lastly, finishing and polishing was carried out [Table/Fig-3m-p]. The appliance was cemented using type-I glass ionomer cement with proper isolation [Table/Fig-3q-t]. Intraoral periapical radiograph was taken [Table/Fig-3u]. The patient was recalled after one week to check the appliance integrity in the oral cavity. Periodic follow-up was done till a year.

Periodic clinical and radiographic re-evaluation [Table/Fig-1j,2k,3u] is mandatory to closely supervise the appliance, the eruption status of the successor, and the integrity of luting cement. Thus, it requires frequent follow-ups. Patients were advised to avoid sticky and hard foods as decementation and breakage of the solder joint are possible complications. Therefore, the patient and guardians were alerted about the complications and were asked to report if necessary.

[Table/Fig-3]: a,b,c) Extraoral photographs; d,e,f,g,h) Preoperative clinical intraoral photographs; i) Preoperative radiographs; j) Preoperative cast marking the extraction site; k) Stabillisation of band and loop with type- II gypsum; l) tooth coloured pontic prepararion by adding ZOE to clear acrylic powder and liquid in primary dentition mandibular mould; m,n,o) preparared appliance; p) Postoperative cast with appliance; q,r,s,t) Postoperative clinical intraoral photographs- mandible with appliance [tooth coloured acrylic pontic]; u) Post insertion radiograph.

Advantages
1. Aids in mastication and improves chewing efficiency.
2. Prevents supraeruption of opposing tooth.
3. Maintains mesio-distal width and prevents space loss.
4. Prevents development of abnormal tongue habits and alleviates established tongue habits as in case-3.
5. Equal distribution of occlusal forces on the pontic resulting in less chance of loop distortion/ slippage and impingement on gingiva.
6. Improves aesthetics and reduces psychological impact of tooth loss in patient.
Limitation(s) and possible solutions
1. Limitation: Direct visualisation of eruption of succedaneous tooth is not possible. Solution: Follow up intraoral periapical radiographs required. Parents should be informed that only pontic will be removed initially when the child approaches the eruption age of the successor or if there are radiographic signs of succedaneous tooth eruption or on development of clinical symptoms.
2. Limitation: Cement loss and failure of solder joint can be possible reasons for failure of the appliances. Solution: Hence appliances should be designed with good quality materials, close supervision and frequent follow-ups at atleast 2-4 months interval is imperative

[Table/Fig-4]: Pros and cons of the modified space maintainers.

Once the permanent successor is close to eruption, the fixed unilateral functional appliances can be removed.

DISCUSSION

Deciduous teeth play a pivotal role in proper alignment of permanent dentition. Dental arch integrity is the key requisite for proper occlusion. Transition of deciduous to permanent dentition is always a critical determinant, and the timely management of developing malocclusion becomes need of the hour. Premature loss of deciduous tooth leads to loss of arch circumference, drifting of the adjacent tooth [10]. Crowding, impaction of the succedaneous tooth, midline shift, and subsequent impairment of function [11]. Early loss of primary molars can result in reduced arch length thereby increasing the propensity malocclusion. So, every effort should be made to maintain the leeway space of Nance. Unilateral loss of a deciduous canine or first molar commonly leads to midline discrepancy, [11] mesial migration of the posterior segment and distal migration of anterior hence it is vital to maintain the space carefully [12]. Unilateral loss of primary molars can be managed spatially through a number of clinical modalities. The ultimate decision depends largely on the dental health and restorative needs of the abutment teeth [13].

The traditional fixed unilateral space maintainers following the premature loss of primary molars have shown good success rates but had certain disadvantages like supraeruption of opposing teeth, does not aid in mastication and does not improve chewing efficiency in their clinical use [13]. To overcome the disadvantages, innovative appliances which are simple to fabricate, having noninterference with normal occlusal adjustments and those which do not restrict normal growth and development has been designed [14].

A new technique of customised fabrication of functional long band and loop, crown and loop, reverse crown and loop space maintainer was described in this case series. [Table/Fig-4] enlists the pros and cons of these customised functional space maintainers compared to traditional versions of these space maintainers [9].

The understanding of developing occlusion in the anterior segment indicates physiologic canine movements during the eruption of the permanent lateral incisors in the mandibular arch, whereas in the maxillary arch during the eruption of the permanent central incisors. Therefore, restriction of primary canine movement by a space maintainer has a negative impact on the maxillary primary lateral incisor and erupting mandibular permanent lateral incisor [9].

During the eruption of permanent incisors there will be disto-labial movement of deciduous canine. The loop in traditional band-and loop space has the disadvantage of limiting the physiologic disto-labial canine movement during the eruption of permanent incisors [10]. To prevent restriction of physiological movement of deciduous canine disto-labially, the conventional space maintainer loop was modified to incorporate an adapted concavity in the mesial arm of the loop following the disto-labial surface of the deciduous canine [15].

All the three cases required unilateral fixed space maintainer. Unilateral space maintainers indicated following the premature loss of deciduous molars are:

1) Band-and-loop space maintainer or crown-and-loop space maintainer if the abutment tooth has extensive caries. Band/crown-and-loop space maintainer can be used with permanent molar when there is unilateral loss of a deciduous molars. However, the first permanent molar can tip mesially resulting in loss of space in mandibular arch which does not occur as much with maxillary arch as they are fixed to two posterior teeth across the arch [13].

2) Distal-shoe space maintainer is indicated following the loss of the second molar, and can be modified as reverse crown-and-loop space maintainer if the first permanent molar had erupted before the eruption of permanent incisors [16].

In case 1, the design is a modification of conventional crown and loop. A stainless steel crown is soldered to the crown over the abutment. Thus, it can rest over the loop to withstand the masticatory forces and thereby preventing distortion and impingement of the gingiva. This design, along with restricting antagonist teeth movement also restores masticatory function [15]. the disadvantage of the conventional crown-and-loop space maintainer had been overcome by following the recommended modification of the loop through incorporation of disto-labial slope in the mesial arm of the loop to allow the physiologic canine movement to occur. In addition, it enhances the alignment of permanent labial incisors, simultaneously preserving the arch length required for the unerupted first premolar [16].

In the case 2, the loop was extended distally to approximate with the mesial surface of the first permanent molar and rests over the soft tissue. It has a similar metal framework as the traditional design, along with a clear acrylic tooth as a pontic attached to the loop using cold cure acrylic. It is another modification to nullify the disadvantage of the non functional design of reverse crown-and-loop.

In the case 3, the modification of conventional band and loop space maintainer was to alleviate the tongue thrusting habit. The movement of tongue into the extraction space restricted by giving functional customised acrylic tooth. It also improved aesthetics and the base connection of acrylic tooth to band and loop is made with pink coloured acrylic to simulate gingiva.

The three children reported satisfaction with the modified space maintainers and found that it is comfortable for eating. All the children were recalled for follow-up. The appliance designs did not interfere with oral hygiene maintenance neither caused any soft

tissue irritation, nor discomfort or food lodgement. Fracture of the appliances was not observed. However, it should be noted that the maximum follow-up was only one year. Hence, long-term follow-up is needed to evaluate the appliances.

CONCLUSION(S)

These innovative designs have led to a modified fixed unilateral functional crown and loop and band and loop space maintainers. The success of these appliances is determined by allowing masticatory function, maintaining space and preventing the extrusion of the opposing tooth. An appliance should not dictate the clinical scenario instead customise an appliance which suits the clinical scenario and requirement of the patient.

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