Distal guide as a substitute for distal shoe space maintainer: a case series study

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Early loss of the primary second molar (DSM) before the eruption of the permanent first molar (PFM) may result in its mesial drift during the eruption. Traditionally, a distal shoe space maintainer is used in this situation to control the path of eruption and preserve the space. However, considering its disadvantages, an alternative appliance needs to be developed for guiding the unerupted PFM. The purpose of this article is to represent an innovative design for preserving space after the early loss of the DSM, describe the fabrication process, and present some data on the successful results of using the appliance in five cases.

Keywords: *Distal shoe, Space maintenance, Primary dentition, Distal guide*

INTRODUCTION

Severe caries of the primary second molars (DSMs) may lead to their loss prematurely. These teeth play an important role in preserving leeway space. An actively erupting permanent first molar (PFM) will mesially migrate if there is a missing DSM, causing the localized loss of space, along with a significant arch space/tooth size discrepancy [1–3]. In these situations, an effort should be made to regain the space; however, during repositioning the drifted PFM using an appliance, Reciprocal effects may influence the teeth anterior to the space loss. Also, any effort to reposition PFM may cause the impaction of the second permanent molar [4]. Furthermore, there are some contraindications for molar distalization, such as skeletal and dental open bite, because distalization of molars can lead to the bite opening [5]. Therefore, it is important to maintain the space of DSM before the eruption of PFM for a normal occlusion in the future.

Typically, a distal shoe space maintainer is used in this situation. Gerber first introduced the distal shoe appliance as a device guiding the eruption of PFM to its proper position in the dental arch [6]. There are, however, some disadvantages, including the need for local anesthesia, patient compliance to maintain optimal oral hygiene, and financial burden regarding the need to replace the distal shoe after the emergence of PFM. Also, incomplete epithelization around the intra-alveolar extension of the distal shoe and its associated-chronic inflammatory response [7] contraindicate it to be used in patients at risk for subacute bacterial endocarditis or immunocompromised patients [8]. Another contraindication to using this appliance is poor child/parent compliance [9].

Therefore, to address these shortcomings, in the present study, an alternative appliance was introduced based on a concept gained from years of experience (by the first author) in the use of removable functional space maintainers in the cases

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  doi: 10.22514/jocpd.2022.028

where DSM is lost before the emergence of PFM. In these situations, they have been led to a correct position of all PFM teeth despite the absence of subgingival appendage. Therefore, it seems that PFMs develop mesial tilt just after gingival penetration and during active eruption toward the occlusal plane.

The purpose of this research was to introduce an innovative design for a unilateral fixed space maintainer to overcome the disadvantages of the distal shoe device and encourage physicians to prescribe it instead of the distal shoe.

Appliance Fabrication

Appropriately selecting a band and taking an impression are similar to the band and loop space maintainer.

A 0.036 stainless steel wire is formed into a ring and designed in such a way that its "crib" remains in line with the shape of the residual alveolar ridge, and the "loop" is located on the distal surface of the second primary molar crown. As shown in Fig. 1, the loop is double-shaped to mimic the distal surface height of the second primary molar crown. Crib length is determined by a bitewing radiograph and the location of the PFM's bulge in the dental arch. Then, the wire is soldered to the band (Fig. 1).

This appliance is called the "distal guide."

This case series study has been approved by the vice of research and technology of Mashhad faculty of dentistry and the experts of pediatric dentistry in the Mashhad pedodontic department (date: August 11, 2021). Informed consent was obtained from all parents prior to the study.

Figure 1: Distal guide.

Case 1

A 43-month-old patient was referred to the Pediatric Dentistry Department of the School of Dentistry with a chief complaint of toothache. Tooth T had to be extracted due to severe caries and resorption of more than two-thirds of the mesial root (Fig. 2A). The distal guide was applied for the patient 7 days after extracting the tooth (Fig. 2B). During 13 months of follow-up, tooth 30 showed eruption without mesial drift (Fig. 2C).

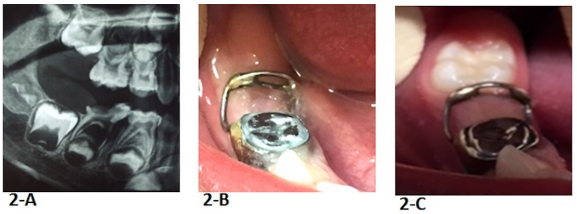


Figure 2: Clinical photos and radiograph of the first case. (A) Radiograph provided by the referring clinic. (B) After appliance cementation. (C) Two months after tooth 30 eruption.

Case 2

A 49-month-old patient was referred for extracting the remaining roots of deciduous teeth. Roots of tooth T had remained in the bone (Fig. 3A). Tooth S was covered with a stainless steel crown (SSC) after pulpectomy treatment due to severe caries (Fig. 3B). One week after extracting roots, the patient's distal guide was made and delivered (Fig. 3C). During 20 months of follow-up, tooth 30 erupted without mesial drift (Fig. 3D).

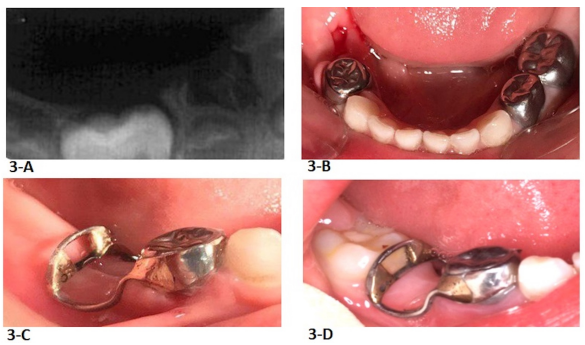


Figure 3: Clinical photos and radiograph of the second case. (A) Radiograph provided by the referring clinic. (B) Tooth S underwent pulpectomy and tooth T was extracted. (C) Distal Guide was delivered. (D) Photograph is taken two months after tooth 30 eruption.

Case 3

A 6-year-old patient was referred with a history of congenital heart disease and no history of dental visits. According to the results of the patient's clinical examination and radiography, all 8 deciduous molars had been decayed, crowns of teeth K and T had been completely destroyed, and tooth 30 had erupted but had a slightly mesial tilt. Tooth 19 was located just below the gingiva (Fig. 4A). Thus, teeth K and T were removed with antibiotic prophylaxis, and teeth L and S underwent pulpectomy and SSC. Model analysis was performed. There was no space deficiency. Therefore, it was

doi: 10.22514/jocpd.2022.028

planned to maintain the space. Nine days after tooth extraction, band and loop and distal guide were applied for teeth S and L, respectively (Fig. 4B).

During 9 months of follow-up, tooth 19 erupted without mesial drift (Fig. 4C). According to the radiographic finding, there was enough space for tooth 20 to grow (Fig. 4D). The patient's molar relationship was half-cusp Class II on the right side and Class I on the left side.

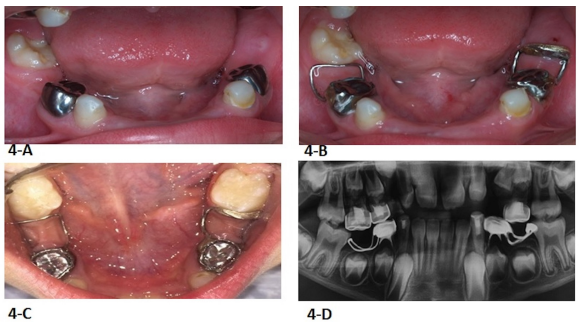


Figure 4: Clinical photos and radiograph of the third case. (A) Photograph taken in the first appointment. (B) Band & loop and distal guide were delivered. (C) Tooth 19 eruption in its normal path. (D) Radiograph shows no mesially migration of tooth 19.

Case 4

A patient aged 6 years 2 months old was referred for examination with the need for a space maintainer to be placed on the left side of the mandible. Tooth K had an irreparable crown due to caries, and tooth L underwent pulpectomy and SSC. There was no deficiency in overall arch length in the mandible based on the analysis of the patients' gypsum model space; thus, the space was maintained (Fig. 5A). Cusps of tooth 19 were located just below the gingiva. Tooth K was extracted, tooth L was immediately prepared, and the distal guide was made (Fig. 5B). Six months after delivery of the distal guide, tooth 19 erupted exactly at the right angle (Fig. 5C,D).

Case 5

A patient aged 6 years 10 months old was presented with bilateral caries in teeth A and J. Tooth J had to be extracted for an unrestorable crown. Space analysis of the model showed sufficient space in the patient's maxillary arch. Three days after extracting tooth J, the distal guide was placed on tooth I (Fig. 6A). After 7 months of follow-up, tooth 14 erupted in its natural path (Fig. 6B).

DISCUSSION

The purpose of this study was to provide an alternative device for the distal shoe so that it can be effective in maintaining space without tissue invasion and is easily accepted by the patient and his/her parents.

In order to evaluate the position of PFM in relation to DSM in different developmental stages, in a pilot study, we assessed 505 radiographs of children aged 2–16 years old and compared

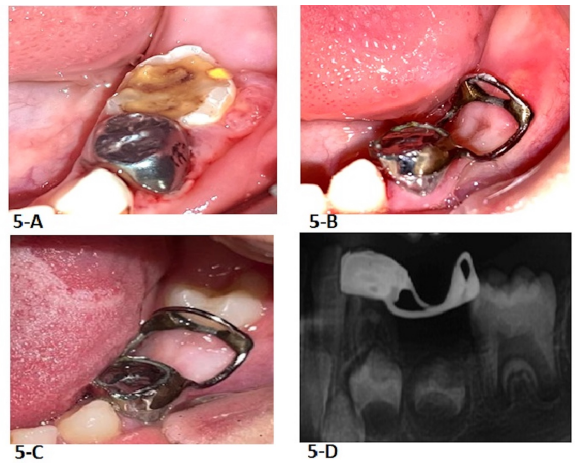


Figure 5: Clinical photos and radiograph of the fourth case. (A) Photograph taken in the first appointment. (B) Distal guide was delivered. (C) Tooth 19 eruption in its normal path. (D) Radiograph shows no mesially migration of tooth 19.

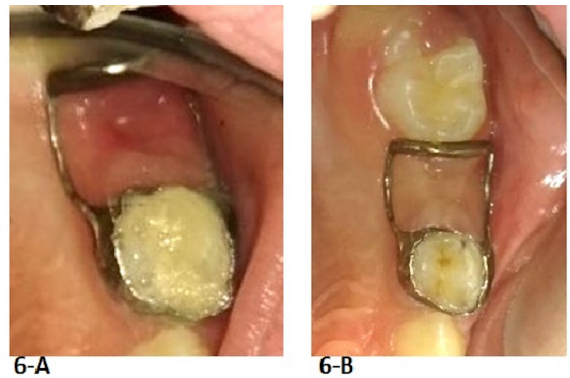
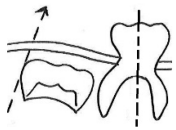
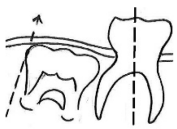
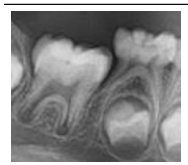
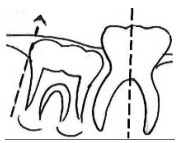
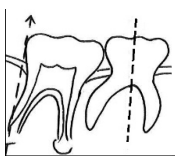
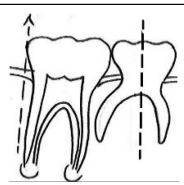
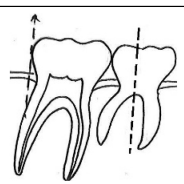


Figure 6: Clinical photos of the fifth case. (A) Distal Guide was delivered 3 days after tooth J extraction. (B) tooth 14 erupted in normal direction.

the results with some common dental age estimation methods, such as Nolla[10], Demirjian[11], and Moorrees[12] methods (Table 1; The complete results of the study will be published in the near future). According to previous studies, when PFM is in the basal bone in children aged 2–5 years old, the loss of DSM will not cause loss of space[13]. As shown in Table 1 (eruption stages I and II), the tooth is surrounded by a bone crypt during this period. After the crown of the tooth is completed, during the pre-emergent eruptive spurt, it moves bodily toward the occlusal plane. At this stage, usually, his longitudinal axis runs angular to DSM so that the mesial marginal ridge of PFM will be finally placed under the height of contour (HoC) of DSM after rupture of the crypt and gingival emergence (eruption stage III).

doi: 10.22514/jocpd.2022.028

Table 1: Different stages of PFM eruption; comparison with developmental stages of tooth, and some common dental age estimation methods.

longitudinal axis of PFM* in relation to DSM**		PFM eruption staging	Moorrees staging #	Demirjian Staging #	Nolla # Staging	Developmental stages of tooth	Chronological age	Eruption stages
		(I) covered by a thick bone	Cr_c	D	6	Crown formation is complete	3	follicular growth
		(II) covered by bone (partially or completely)	$R_{1/4}$	E	7	The root length is less than the crown height	3–5	pre-emergent eruptive spurt
		(III) covered by mucosa	$R_{1/2}$	F	7.5	The root length is equal to the crown height	6–7	pre-emergent eruptive spurt
		(IV) emerges in the oral cavity	$R_{2/3}$	F	8	The root length is greater than the crown height	6–7	Post-emergent eruptive spurt
		(V) at occlusion (Open apex)	R_c ($A_{1/2}$)	G	9	Root almost completed (open apex)	8–9	juvenile occlusal equilibrium
		(VI) at occlusion (Closed apex)	R_c (A_c)	H	10	Apical end of root completed	9–10	juvenile occlusal equilibrium

** PFM = permanent first molar; ** DSM = deciduous second molar. # For more details, please refer to the relevant references.*

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After that, at the post-emergent eruptive spurt, as the tooth erupts, it follows the distal surface of DSM (eruption stage IV), and finally, his long axis will be parallel to that of DSM (eruption stages V and VI). Therefore, it can be inferred that the space loss, most likely, occurs after bone emergence (eruption stage III) if DSM has already been lost. Accordingly, eruption guidance of PFM can be performed by placing a device that simulates the distal surface of the DSM.

Among our patients, 2 were less than 5 years old, and PFMs were unerupted according to Figs. 2A and 3A (eruption stage II). Implementing the distal guide led to the eruption of PFMs in a correct position. The other 3 cases were 6 years old, and the position of PFM was above the bone at the time of extraction. The distal guide was effective in them too.

Interestingly, more than 50 cases received the distal guide by the first author and her colleagues over the past 5 years have been successful, among which 5 cases are presented. There was just one case in which the cement failure and patient reluctant of visiting dental school due to fear of contracting the coronavirus led to space loss.

Traditionally, there are 2 theories for eruption guidance of PFM. The first theory holds that the crown of DSM is the guide, while the second theory accepts the distal root of DSM as eruption guidance [1]. Based on the second theory, to provide guidance, it has been recommended to design a distal shoe inserted into tissue. However, according to the first theory, there is no need to use a device to guide PFM before emergence from the gingiva [1].

According to the pilot study and the cases reported here, it seems that the first theory is more credible, and the distal guide appliance is based on it.

Active eruption of the PFM tooth after the DSM loss in the maxillary arch causes more space loss than the mandibular arch. In addition, the movement of the first permanent maxillary molars is more bodily in this condition, while in the mandibular arch, the tooth moves more in the form of tipping [10]. Cases 1–4 belonged to the mandibular arch, and case 5 belonged to the maxillary arch. In case 5, despite being older and having a higher probability of bodily movement of PFM in the alveolar bone, the tooth erupted in its normal eruption path, and the molar relationship on both sides was the same.

It is important to note that in all cases, the distal guide devices were reserved to maintain the space after erupting the PFMs, thus reducing the financial burden. Also, unlike the distal shoe, there is no need to take a radiograph prior to cementation.

CONCLUSION

According to the cases reported herein, the distal guide is an easy-to-fabricate, well-tolerated, and cost-effective space maintainer with no contraindication, which could be used to maintain the space of DSM before the eruption of PFM.

However, to provide more accurate clinical data, further research is necessary.

ACKNOWLEDGMENT

The authors would like to thank Dr Iarbakht M., Dr. Gifani M., Dr. abbasi M., Dr. Emrani N. and Dr. Ghanbari F. for providing the clinical pictures of the cases presented in this article.

CONFLICT OF INTEREST

None

FUNDING

This research received no external funding.

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