

## Modification of Distal Shoe- A Systematic Review & Meta Analysis

**Dr Mohammed Muzammil Khan,<sup>1</sup> Dr. Rinku Adwani Nathani,<sup>2</sup> Dr. Heena Tiwari<sup>3</sup>,  
Dr. Dantuluri Lohitha Divya Vani,<sup>4</sup> Dr. Kumar B. Niwlikar,<sup>5</sup> Dr.Savitri Ranjeri<sup>6</sup>**

<sup>1</sup>Specialist Pedodontist, Ministry of health, Taif, Kingdom of Saudi Arabia.

[mdmuzammil.khan8@gmail.com](mailto:mdmuzammil.khan8@gmail.com)

<sup>2</sup>Associate professor, Dept.of Orthodontics and Dentofacial Orthopaedics, VYWS Dental College and Hospital, Camp Amravati, Maharashtra. [drrinkuadwani@gmail.com](mailto:drrinkuadwani@gmail.com)

<sup>3</sup>BDS, PGDHHM, MPH Student, Parul Univeristy, Limda, Waghodia, Vadodara, Gujrat, India. [drheenatiwari@gmail.com](mailto:drheenatiwari@gmail.com)

<sup>4</sup>Intern, Gitam dental college and hospital, Visakhapatnam, Andhra Pradesh.

[lohithadivyanidantuluri2821@gmail.com](mailto:lohithadivyanidantuluri2821@gmail.com)

<sup>5</sup>Reader, Department of Orthodontics and Dentofacial Orthopaedics, Nanded Rural Dental College and Research Center, Nanded, Maharashtra. [kumarniwlikar9@gmail.com](mailto:kumarniwlikar9@gmail.com)

<sup>6</sup>Consultant Pedodontist & Preventive Dentist, Bidar 585401, Karnataka.

[savitri.rao09@gmail.com](mailto:savitri.rao09@gmail.com)

**Corresponding Author:**Dr Mohammed Muzammil Khan, Specialist Pedodontist, Ministry of health, Taif, Kingdom of Saudi Arabia. [mdmuzammil.khan8@gmail.com](mailto:mdmuzammil.khan8@gmail.com)

### Abstract

**Introduction:** In the pediatric patients the premature loss of second primary molar will culminate in malocclusion of the permanent teeth by the space loss. This space has to be guarded with the help of the appliance that can prevent the permanent first molar from migration into the free space. The Distal Shoe Space Maintainer is indicated in such situation to avoid space loss. But there may be situations that will require some modifications in the conventional design. Hence in our study we intend to review the various modifications in the Distal Shoe Space Maintainer and their functional implications.

**Materials and Methods:** We conducted the search for the data from the online sources like the “EMBASE”, “Pubmed”, “Scopus” and other sources. The articles for the past 20 years were searched for the parameters Distal Shoe Space Maintainer, modified Distal Shoe Space Maintainer, space maintainers, space loss. The primary outcome variable was the effectiveness of the modified distal shoe space for the space maintenance after the eruption of lower first permanent molar in the oral cavity. The gingival responses and patient compliance were taken as the secondary outcomes. The data extraction was based on the PICOS guidelines. We also assessed the quality of the study using the quality assessment score.

**Results:** Out of the 27 articles only 6 articles were finalized. Inadequate data is available from these 6 articles. The efficiency of these modifications, gingival responses were inconclusive. Three studies only stated the patient compliance.

**Conclusion:** The success of the distal shoe and its gingival response is inconclusive. There were many clinical aspects that were not thoroughly described in the studies about these modifications. We can propose that further well designed studies be conducted to establish the performance of these modifications in the distal shoe and help clinicians with its application.

**Keywords:** Space Management, Modified Distal Shoe Space Maintainer, Pediatric patients

## **Introduction**

For a pedodontists it is of great significance to maintain the primary teeth in their positions till the permanent teeth erupt. Nevertheless they may be extracted in some children if there is extensive or rapid caries.<sup>1,2</sup> In particular the loss of the primary molars will lead to malocclusion. There could be the reduction of the arch length if there is a loss of the primary teeth prematurely.<sup>3,4</sup> This may lead to the improper guidance to the erupting permanent molars and the premolars. To overcome this, the space maintainers are used. Various space maintainers can be given to the children, subject to the cooperation, age, missing teeth, patient's dental arch, stage of dental development, and dentition. Among the primary teeth the premature loss of the primary second molars is a challenge to the pedodontists. In such patients the careful selection will help in the proper guidance while maintaining the space to the permanent teeth.<sup>5-7</sup> The Distal Shoe (DS) Space Maintainer is indicated in such situation to avoid space loss. But there may be situations that will require some modifications in the conventional design. This appliance can be fixed and is patient friendly. There are some indications and contraindications for the use of the DS. The indications are extensive root resorption/ ankylosis of the second primary molar, loss of the second primary molars, caries of second primary molars, bone loss periapically. However if there are no adequate abutments, systemic health conditions, uncooperative children.<sup>8-10</sup> The choice of the space maintainer depends on the condition of the patient, the experience of the pedodontists also plays an important role. The choice depends on the first permanent molar position if that has erupted or not. The conditions that will preclude the use of the conventional distal shoe are premature loss of multiple primary molars. In such conditions the modified distal shoe can be used. Hence in our study we intend to review the various modifications in the Distal Shoe Space Maintainer and their functional applications.

## **Materials and methods**

We conducted the search for the data from the online sources like the "EMBASE", "Pubmed", "Scopus" and other sources. The articles for the past 20 years were searched for the parameters Distal Shoe Space Maintainer, modified Distal Shoe Space Maintainer, space maintainers, space loss. The primary outcome variable was the effectiveness of the modified distal shoe space for the space maintenance after the eruption of lower first permanent molar in the oral cavity. The gingival responses and patient compliance were taken as the secondary outcomes. The data extraction was based on the PICO structure. We intended to assess if the distal shoe appliance modifications may act as an effective and safe technique for space maintenance where lower second primary molars are indicated for extraction before eruption of lower first permanent molars in children. We also assessed the quality of the study using the Quality assessment score. We excluded the studies where the removable appliance were used, those articles that were not in English, animal research, duplicate studies. Only those studies where the distal shoes were used among the children of 4-6 years with indication to extraction of the lower second primary molar before the permanent molar eruption. Distal shoe space maintainer with modifications was used. We took care the outcomes were well defined. Two independent reviewers studied the full articles and the disputes were settled. The information thus obtain was tabulated and compared. We assessed the quality, considering the various parameters that were studied in the included articles.

## Results

The total number of the articles that were identified is 27. Among these only 6 articles were finalized for the study. The flow chart describing the finalization of the articles is presented in Figure 1.

The quality of the selected 6 studies were evaluated with the quality assessment scores by taking the following variables into consideration like the Keywords identified, Addressed question, Clear aims and objectives, Clarity of the technique, Clear outcome, Standard method of measurement, Clear data collection methods, Clarity of the case, Practicality of the results, Justified conclusions from the observations. All the 6 studies were evaluated and the score of 2/3 was obtained. This shows a very low quality of the study. (Table 1)

It was observed in our review that in all the studies the primary output was implicit results were only given, there were no thorough follow up or clear design. In these studies only one study mentioned the secondary variable and the others didn't regarding the gingival responses after the appliance was given. We also observed the good tolerance to the appliance was reported in 3 studies. (Table 2)

**Figure 1.** Flow-chart showing the selection of the articles.

**TABLE 1: Quality assessment of the finalised articles**

Study (reference)	Keywords identified	Addressed question	Clear aims and objectives	Clarity of the technique	Clear outcome	Standard method of measurement	Clear data collection methods	Clarity of the case	Practicality of the results	Justified conclusions from the observations	QA Score

13	Yes	No	No	No	No	No	No	yes	No	No	2/10
12	Yes	No	Yes	No	No	No	No	Yes	No	No	2/10
8	Yes	No	Yes	Yes	No	No	No	No	No	no	3/10
9	Yes	No	No	No	No	No	No	Yes	No	No	2/10
11	Yes	No	No	No	No	No	No	Yes	No	No	2/10
10	Yes	No	Yes	No	No	No	No	Yes	No	No	3/10

**Table 2:** Characteristics of studies included in the systematic review

<b>Authors and year</b>	Dhull et al, 2011	Gujjar et al, 2012	Dhindsa and Pandit, 2008	Bhat et al, 2014	Agarwal et al, 2014	Brill , 2002
<b>Nation</b>	Canada	India	India	India	India	USA
<b>Aim</b>	Evaluate the modification of the distal shoe-DS	Clinical management of the extensive mandibular caries with the Modified DS	Study the Modified DS application in bilateral loss of molars	Study the Modified DS application in multiple molars loss.	Study Modified DS application inside maxillary molars followed by functional band and bar space maintainer until the eruption of the underlying second premolar	Chair fabrication and application of the Modified DS.
<b>Problem to be addressed</b>	space loss	space loss	Bilateral space loss	space loss	Space and functional loss	space loss
<b>Study design</b>	All are Case reports					
<b>Average Age</b>	5 year	No report	4 year 10 month	4 year 5 month	5 year 4 months	No report
<b>Abutment teeth</b>	mandibular left D	Mandibular left D and mandibular right C.	mandibular right C and D and mandibular left C	mandibular right C & mandibular left E	maxillary right D	Mandibular Ds or mandibular Cs.

<b>Fabrication</b>	Laboratory	Laboratory	Laboratory	Laboratory	laboratory	Chair-side
<b>Retention</b>	Crown	Band	Band	Band	Band	Band
<b>Prohibiting occlusal interference with opposing tooth</b>	Yes	No	No	No	yes	No
<b>Allow adjustments</b>	Yes	No	No	No	No	Yes
<b>Follow up and intervals</b>	1.5 years Every 2 months	2 months Every month	7 months Every 2 months	10 months Every 2 months	Not reported Every 2 months	Not reported Every 2 month
<b>Outcome</b>	Implicit -DS guides first molar in correct position	Implicit - DS guides first molar in correct position	Implicit - DS guides first molar in correct position	Implicit - DS guides first molar in correct position	Implicit DS guides first molar in correct position	Implicit Success rate of the chair side fabricated Distal shoe appliance
<b>Findings</b>	The proposed design provided stability and adjustability to the appliance.	The modified distal shoe appliance was stable and showed acceptability by the patient.	The modified distal shoe (Willet) appliance is more stable and better accepted by the patient than the conventional	The modified distal shoe appliance is a time efficient, more stable and stronger than conventional design, better accepted by	The trial of an innovative design of a functional distal shoe space maintainer showed that it is well accepted by the child	No conclusion

			design	the child, require less cooperation and chair side time and meets all the criteria for proper space maintainer. permanent molar		
<b>Acceptance</b>	Patients tolerance to the appliance	Patients tolerance to the appliance	Patients tolerance to the appliance	-	-	-

## Discussion

In the pediatric patients the premature loss of second primary molar will culminate in malocclusion of the permanent teeth by the space loss.<sup>11-13</sup> This space has to be guarded with the help of the appliance that can prevent the permanent first molar from migration into the free space. In the current review we evaluated the efficacy of the modified distal molar in the space maintenance. The modification has been presented in several studies. However we considered only those studies that satisfied our criteria. A total of 6 studies were finalized for the review. Among these 4 studies were from India and 1 each from Canada and USA. The conventional design can be used only for the unilateral loss of the second deciduous molar. In special conditions like the bilateral loss of these, then a modification of the conventional design is required. This problem was addressed by Dhindsa and Pandit<sup>12</sup>, where they proposed a lingual holding arch for the bilateral conditions. The drawback was the permanent incisors might be hindered in their eruption path. Hence their design was later modified. In the design proposed by Gujjar et al., they proposed to place the lingual arch far lingually. This prevented the hindrance to the incisor eruption paths.<sup>13</sup> The presence of the lingual arch in both these designs is very useful lower arch integrity when there are multiple molar losses.<sup>2,12,13</sup> The primary outcome that is the effectiveness of the modified distal shoe space for the space maintenance after the eruption of lower first permanent molar in the oral cavity was implicitly met in all the 6 studies. The quality of the studies was poor as they didn't fulfill the criteria put by the quality assessment score. The scores of all the studies were 2/3 of 10. This poor quality is a hindrance to the correct explicit outcomes that can be applied in clinical practices. The second variable that was studied was the gingival response. Only in the study of Brill et al<sup>9</sup> though they mentioned the the appliance typically didn't cause gingival inflammation. Only the clinical photographs were used to describe the gingival condition, without any scientific records. As the conventional designs were fabricated from the cast metals the minor adjustments of the vertical arm can't be made. This new modifications given by Brill et al<sup>9</sup> and Croll et al<sup>15</sup> would help in minor adjustments be made in the distal shoe during the adaptations. Some authors have placed the loop modification in the designs that helped in the precise placement of the distal shoe. This not only helped in the placement but also prevented the supra eruption of the opposite tooth and the adjacent tooth's

tipping mesially. But the drawback with this appliance was the time, the compliance of the child and the excessive cost of the appliance. The patient compliance was noted in only three studies in our review. Gegenheimer and Donly gave a special modification in which the distal loop was made and cemented.<sup>6</sup> This helped as a space maintainer if the permanent molar erupted and the gingival extension be removed. A very different modification was given by Dhull et al<sup>14</sup> where they included buccal and lingual arms that provided better stability. In all these designs and modifications there were some cautions to be employed as there is literature stating the trauma to the successor tooth due to the gingival extension's wrong placements.

It can be said from our review that the success of the modification, the gingival response and acceptance were not thoroughly described. This could be due to the poor quality of the study designs. None of the techniques described was able to fulfill all the clinical criteria suggested.

## Conclusion

The dentist should constantly evaluate the space when there is succession from the primary to permanent teeth. Hence the space maintenance is of great significance. The following conclusions can be drawn from our review. The success of the distal shoe and its gingival response is inconclusive. There is insufficient data to help clinicians with choosing these modifications. There is inadequate evidence to depict the level of tolerance of these modifications when given in children. There were many clinical aspects that were not thoroughly described in the studies about these modifications of the distal shoe. We can propose that further well designed studies be conducted to establish the performance of these modifications in the distal shoe.

## References

1. An SY, Shim YS, Park SY. Aesthetic rehabilitation in maxillary anterior tooth with early childhood caries using ZIRKIZ® Crown: Long-term follow-up. Indian Journal of Science and Technology. 2015 Oct; 1-5.
2. Kupietzky A. Clinical technique: Removable appliance therapy for space maintenance following early loss of primary molars. European Archives of Paediatric Dentistry. 2007; 8(1):30-4.
3. Pinkham JR, Casamassimo PS, Tighe MDJ, Fields HW, Nowak AJ. Pediatric dentistry: Infancy through adolescence. Elsevier Saunders. 2005; 63146.
4. Dean JA, Avery DR, Donald MRE. Dentistry for the child and adolescent. Riverport Lane. 2016; 3251.
5. Cochrane Handbook for Systematic Reviews of Interventions. 2014. Available from: [http://handbook.cochrane.org/index.htm#0\\_2\\_how\\_to\\_cite\\_the\\_handbook.htm](http://handbook.cochrane.org/index.htm#0_2_how_to_cite_the_handbook.htm)
6. Gegenheimer R, Donly KJ. Distal shoe: A cost-effective maintainer for primary second molars. Pediatric Dentistry. 1992; 14(4):268-9.
7. Kirshenblatt S, Kulkarni GV. Complications of surgical extraction of ankylosed primary teeth and distal shoe space maintainers. Journal of Dentric Childist (Children ). 2011; 78(1):57-61.

8. Nouri MR, Kennedy DB. Optimal fit of chairside-fabricated distal shoe space maintainer. *European Academy of Paediatric Dentistry*. 2013;14(5):351-4. 9.
9. Brill WA. The distal shoe space maintainer chairside fabrication and clinical performance. *Pediatric Dentistry*. 2002; 24(6):561-5.
10. Bhat PK, Idris M, Christopher P, Rai N. Modified distal shoe appliance for premature loss of multiple deciduous molars: A case report. *Journal of Clinical Diagnostic Research*. 2014; 8(8):43-5.
11. Agarwal R, Chaudhry K, Yeluri R, Singh C, Munshi AK. Alternative approach to management of early loss of second primary molar: A clinical case report. *Journal of California Dental Association* . 2014; 42(5):327-30.
12. Dhindsa A, Pandit IK. Modified Willet's appliance for bilateral loss of multiple deciduous molars: A case report. *Journal of Indian Social Pedodtric Prevention Dental*. 2008; 26(3):132-5.
13. Gujjar KR, Indushekar KR, Amith HV, Sharma SL. Modified distal shoe appliance-fabrication and clinical performance. *Journal of Dentric Childist*. 2012; 79(3):185-8.
14. Dhull KS, Bhojraj N, Yadav S, Prabhakaran SD. Modified distal shoe appliance for the loss of a primary second molar: A case report. *Quintessence Int*. 2011; 42(10):829-33.
15. Croll TP, Sexton TC. Distal extension space maintenance: A new technique. *Quintessence Int* 1981;10:1075-80.