

# The use of Distal Shoe Space Maintainer in Pediatric Dentistry; A Systematic Review

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## Abstract

**Objectives:** Early loss of a second deciduous molar before the eruption of first permanent molar can lead to space deficiency in the dental arch. The Distal Shoe Space Maintainer (DSSM) is indicated in such situation to avoid space loss. We sought to assess the efficacy and safety of this appliance. **Methods/Statistical Analysis:** We performed a comprehensive search on PUBMED, Cochrane libraries, LILACS and EMBASE. Our primary outcome measure was the effectiveness of space maintenance. Other outcome measures were the gingival response and patient's tolerance to DSSM. We also assessed the design and quality of each study. **Findings:** Six articles which met our inclusion criteria were analyzed. Insufficient information was given in the studies regarding the efficacy in space maintenance or gingival response to the DSSM. The appliance was well tolerated by patients in 4 studies. **Application/Improvement:** Neither the efficacy of DSSM nor the gingival response to it has been investigated in the available studies. There is evidence that patients tolerate the DSSM well. The studies were shown to be of poor design and quality.

**Keywords:** Distal Shoe Space Maintainer, Space Management Malocclusion

## 1. Introduction

One of the most frustrating problems during the transition from primary to permanent dentition is the premature loss of the second primary molar, primarily due to caries<sup>1</sup>, prior to or during the eruption of the first permanent molar<sup>2</sup>. This may result in mesial migration of the first permanent molar occupying some or most of the future space of permanent second premolar and consequently its possible impaction<sup>3</sup>.

Therefore, it's crucial to place an appliance that holds this space and guide the eruption of the permanent first molar into the correct position. The traditional appliance of choice in such situation is the Distal Shoe Space Maintainer (DSSM)<sup>4</sup>.

The aim of this study was to systematically review the available that investigates the efficacy and safety of DSSM. When possible, the systematic review was undertaken in line with the recommendations of the guidelines

of the Cochrane Handbook for Systematic Reviews of Interventions and with particular reference to adverse events<sup>5</sup>.

### 2.1 Identifying the Review Question

The first step was the development of the research question using a PICO structure (Patient, Intervention, Comparators and Outcome) as follows:

In children where lower second primary molars are indicated for extraction before eruption of lower first permanent molars [patient], is the distal shoe appliance [intervention] an effective and safe technique for space maintenance [outcome]?

### 2.2 Search Strategy

We searched four databases in an attempt to locate any and all existing articles on distal shoe space maintainer (PUBMED, EMBASE, LILACS and Chocrane libraries).

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**Table 1.** Inclusion and exclusion criteria

| Inclusion criteria  | Exclusion criteria                                      |
|---|---|
| 1. [P] : Children from 4-6 years with lower second primary molar indicated for extraction or extracted before the eruption of the permanent molar | Studies using removable appliances for the same purpose |
| 2. [I] Distal shoe space maintainer was used  | Observational studies                                   |
| 3. [O] outcomes : studies with identifiable outcome(s)  | Animal studies  |
| 4. [S] Clinical trials, case reports or case series .   | Non English studies                                     |
| 5. Studies from 1990 to 2014  |   |

The search used combinations of the following search terms: ‘Deciduous molars’, ‘Primary molars’, ‘Premature or early’, ‘Loss or extraction or removal’, ‘Distal shoe’, ‘Distal extension’, ‘Intra-alveolar or intra-alveolar or intra-alveolar’, ‘Roche’, ‘willet’ and ‘space maintainer’. The MeSH term ‘Space maintenance’ was found in PUBMED and was used in searching (See Appendix (1) for the comprehensive search strategy). Screening the reference lists of relevant articles and citation searching were also employed.

### 2.3 Inclusion and Exclusion Criteria

Selection of studies was basically done according to the PI[C]OS elements; details of the inclusion and exclusion criteria are described in Table 1.

### 2.4 Data Extraction

Articles which met our inclusion criteria were read in full then data was extracted by two independent reviewers. Information extracted from each article included the author, year of publication, country of occurrence, aims, ethical issues, recruitment context, mean age, problem to be addressed, study design, sampling, appliance design, follow up duration and intervals, outcomes, conclusions and recommendations. Disagreements between the two reviewers were resolved through discussion.

Our primary outcome measure was the effectiveness of space maintenance after the eruption of lower first permanent molar in the oral cavity. Our secondary outcome measure was the gingival response to the intra-alveolar part of the appliance. Our third outcome measure is the patient’s tolerance to the appliance.

### 2.5 Quality Assessment

we assessed the design and quality of each of the included studies, including whether a focused research question

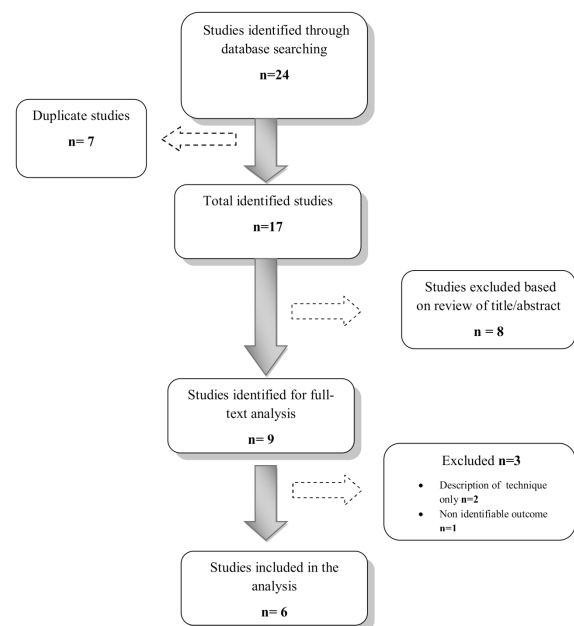
has been addressed, relevant key words have been used and also regarding the clarity and validity of the outcomes and results are shown in Table 2.

**Table 2.** Excluded articles and reasons for exclusion

| Excluded article | Reasons for exclusion         |
|------------------|-------------------------------|
| 5                | Description of technique only |
| 6                | Non identifiable outcome      |
| 7                | Description of technique only |

## 3. Results

We identified 17 studies in our search. Nine of these studies were potentially eligible for full text analysis are shown in Figure 1; 3 studies were excluded are shown in Table 3 and the remaining 6 studies were included in our study. We identified no randomized controlled trials or systematic reviews in our search.



**Figure 1.** Diagram of citations included and excluded during the systematic review.

Table 3. Quality assessment section

| Study | 1. Did the study include keywords that identify areas covered in this case report ? | 2. Did the study address a clearly focused question? | 3. Are the aims and purpose of the study clearly stated? | 4. Are the details of the technique sufficiently given to allow its transferability to other clinical settings? | 5. Are the outcomes of the study clearly stated? | 6. Are the outcomes measured using a defined method? | 7. Are the methods for collecting data clearly described? | 8. Is the case clearly described? | 9. Are the results credible and relevant for practice? | 10. Are the conclusions drawn justified by the results? | Quality assessment 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 4.** Characteristics of studies included in the systematic review

| Characteristics                            |   |  |  |   |  |  |
|--|---|--|--|---|--|--|
| Author/year of publication                 | Dhull et al, 2011   | Gujjar et al, 2012   | Brill , 2002   | Dhindsa and Pandit, 2008  | Bhat et al, 2014   | Agarwal et al, 2014  |
| Country                                    | Canada  | India  | USA  | India   | India  | India  |
| Aims:(explicit/Implicit/not mentioned)     | Implicit  | Explicit   | Explicit   | Implicit  | Implicit   | Explicit   |
| Aims                                       | To evaluate a modified design of the distal shoe appliance.                             | To describe the clinical management of extensively carious primary mandibular molars with a modified DSA | to describe the chair side fabrication of the distal shoe appliance with a stainless steel crown as the retainer and describe the clinical management of the appliance from insertion to removal, including problems requiring intervention and the effect they have on Clinical efficacy. | To evaluate a modified distal shoe appliance to overcome problems of the conventional design in cases of bilateral loss of second deciduous lower molars. | To evaluate a modified distal shoe appliance to overcome problems of the conventional design in cases of premature loss of multiple deciduous molars | To evaluate an innovative design of a functional distal shoe space maintainer to guide the eruption of the maxillary first permanent molar followed by a functional band and bar space maintainer until the eruption of the underlying second premolar |
| Ethics – how ethical issues were addressed | The procedure was explained to the patient’s parents, and informed consent was obtained | informed consent was obtained from his parents   | Not reported   | The procedure was explained to the patient’s parents, and informed consent was obtained   | The procedure was explained to the patient’s parents, and informed consent was obtained  | The procedure was explained to the patient’s parents, and informed consent was obtained  |

|   |   |   |  |  |  |   |
|---|---|---|--|--|--|---|
| Recruitment Context (e.g. where people were recruited from)                             | Department of Pedodontics and Preventive Dentistry, JSS Dental College and Hospital, JSS University, Mysore, Karnataka, India.              | Department of Pediatric Dentistry, S.D.M College of Dental Sciences, Dharwad, India | Not reported   | Department of Pedodontics and Preventive Dentistry.                                    | Department of Pedodontics and Preventive Dentistry                                     | Department of Pedodontics and Preventive Dentistry  |
| Problem to be addressed   | Possibility of space loss following extraction of lower primary second molar, when the opposing upper second primary molar has over erupted | Possibility of space loss following extraction of lower primary second molar        | Possibility of space loss following extraction of lower primary second molar | Possibility of space loss following bilateral extraction of lower primary second molar | Possibility of space loss following extraction of lower primary first and second molar | Loss of function and Possibility of space loss following extraction of lower primary second molar |
| Study design  | Case report   | Case report   | Case series  | Case report  | Case report  | Case report   |
| Sampling: a. Number of cases at start of the study                                      | 1   | 1   | 190  | 1  | 1  | 1   |
| b. Number of cases with appliance in place at the eruption of the permanent first molar | 1   | 1   | 86   | 1  | 1  | 1   |
| c. Randomization (Y/N)  | N   | N   | N  | N  | N  | N   |
| Mean Age  | 5 years   | Not reported  | Not reported   | 4 years 10 months  | 4 years 5 months   | 5 years 4 months  |

| Appliance design   | Lower left D | Lower left D and lower right C. | Lower Ds or lower Cs. | Lower right C and D and on lower left C | Lower right C & lower left E | Upper right D |
|--|--------------|---------------------------------|-----------------------|---|------------------------------|---------------|
| Abutment tooth (teeth)   |              |                                 |                       |   |                              |               |
| Chair side or laboratory fabricated  | Laboratory   | Laboratory                      | Chairside             | Laboratory                              | Laboratory                   | laboratory    |
| Appliance retention (Band/Crown)   | Crown        | Band                            | Band                  | Band                                    | Band                         | Band          |
| d. Features to avoid possibility of occlusal interference with opposing molar (Yes/No)?  | Yes          | No                              | No                    | No<br>No                                | No                           | yes           |
| The appliances have features to allow adjustment of the distal extension (Yes/No)?   | Yes          | No                              | Yes                   | No                                      | No                           | No            |
| f. The technique take into consideration any magnification or horizontal overlap in the x-ray during planning of the distal extension position? (Yes/No) | No           | No                              | No                    |   | No                           | No            |

|   |  |  |   |  |  |  |
|---|--|--|---|--|--|--|
| Follow up :<br>Duration of follow up<br>Follow up intervals   | 1.5 years<br>Every 2 months  | 2 months<br>Every month  | Not reported<br>Every 2 month   | 7 months<br>Every 2 months   | 10 months<br>Every 2 months  | Not reported<br>Every 2 months   |
| Outcome:<br>Outcome of research (Implicit/Explicit/Not clear):<br>Outcome (S)   | Implicit<br><br>-Eruption of lower first permanent molars in correct position, guided by the distal shoe appliance | Implicit<br><br>-Eruption of lower first permanent molars in correct position, guided by the distal shoe appliance | Implicit<br><br>Success rate of the chair side fabricated Distal shoe appliance | Implicit<br><br>-Eruption of lower first permanent molars in correct position, guided by the distal shoe appliance | Implicit<br><br>-Eruption of lower first permanent molars in correct position, guided by the distal shoe appliance | Implicit<br><br>Eruption of lower first permanent molar in its correct position, guided by the distal shoe appliance |
| Did the study include the assessment of: Amount of space loss in the dental arch (Yes/No)?<br><br>if Yes: Method of measurement: Amount of space loss in mms                | No   | No   | No  | No   | No   | No   |
| The gingival response to the distal extension (Yes/No )   | No   | No   | No  | No   | No   | No   |
| If yes: i) Method of measurement<br>ii) Gingival inflammation present? (Yes/No)<br>Patient's tolerance to the appliance (Y/N)<br>If yes, was the appliance tolerated (Y/N)? | No   | Yes<br><br>Yes   | No  | Yes<br><br>Yes   | Yes<br><br>Yes   | Yes<br><br>Yes   |

|                                       |  |  |    |  |   |   |
|---------------------------------------|--|--|----|--|---|---|
| Conclusions included?<br>(Yes/No)     | Yes  | Yes  | No | Yes  | Yes   | Yes   |
| <u>If Yes</u> , Mention               | The proposed design provided stability and adjustability to the appliance. | The modified distal shoe appliance was stable and showed acceptability by the patient. |    | 1. The modified distal shoe (Willet)appliance is more stable and better accepted by the patient than the conventional all design<br><br>2. Further clinical studies are needed to establish its feasibility and usefulness in pediatric dentistry. | 1. The modified distal shoe appliance is time efficient, more stable and strong than conventional design, better accepted by the child, require less cooperation and chair side time and meets all the criteria for proper space maintainer when primary first and second molar needs extraction prior to the eruption of first permanent molar<br><br>2. Further clinical studies are needed to establish its feasibility and usefulness in pediatric dentistry. | The trial of an innovative design of a functional distal shoe space maintainer showed that it is well accepted by the child |
| Recommendations included?<br>(Yes/No) | No   | No   | No | No   | No  | No  |
| <u>If yes</u> , Mention               |  |  |    |  |   |   |



- **Primary outcome measures:** Insufficient information was given in the studies for us to assess the effectiveness of the techniques in maintaining the space of the extracted molar till the eruption of the lower first permanent molar in the oral cavity is shown in Table 4.
- **Secondary outcome measures:** No specific data were collected relative to gingival response to the intra-alveolar part of the appliance. Brill<sup>6</sup> noted that the appliance typically didn't cause gingival inflammation and used a clinical photograph to demonstrate that, without using any scientific recording method.
- **Third outcome measures:** Four studies (9-12) reported good tolerance of the patient to the appliance.

## 4. Interpretation

Our review suggests that neither the effectiveness of the distal shoe appliance nor the gingival response to it has been investigated in the available studies. The studies that investigated the patient's tolerance to the DSSM showed good acceptance to the appliance.

Regarding the quality of the investigated studies are shown in Table 3, the quality assessment score ranged from 2 to 3 out of 10 for all studies, suggesting their poor quality.

Regarding the description of the techniques used in the studies are shown in Table 4, a series of questions has been asked regarding the steps of fabrication and design. None of the techniques described was able to fulfill all the clinical criteria suggested.

## 5. Conclusion

Based on our review, we concluded the following:

- There is no evidence for either the space maintaining effectiveness or safety of the DSSM on gingival tissues, to help clinicians to confirm or refute its use in children.
- There is weak evidence that the child can tolerate the presence of this appliance in his mouth.
- None of the described techniques was able to cover adequately all the technical aspects of fabrication that ensure successful installation of this appliance in the child's mouth.
- It's strongly recommended to conduct a high quality primary study to assess more patient-

centered outcomes in addition to space maintenance effectiveness of DSSM

## 6. References

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