



The distal shoe space maintainer: chairside fabrication and clinical performance

Warren A. Brill, DMD, MS(HYG)

*Dr. Brill is in private practice and a clinical associate professor of pediatric dentistry, School of Dentistry, University of Maryland, Baltimore, Md.
Correspond with Dr. Brill at wbrill@erols.com*

Abstract

The chairside-fabricated distal shoe appliance, with a stainless steel crown as the retainer, is an efficacious and cost-effective appliance for guiding the unerupted permanent first molar into position after premature loss or extraction of the second primary molar. The fabrication technique is illustrated in this case report and data is presented on the success rate of the appliance. (*Pediatr Dent.* 2002;24:561-565)

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The distal shoe space maintainer, as introduced by Gerber¹ and extended by Croll,^{2,3} is a valuable part of the pediatric dentist's armamentarium, because in those cases where the second primary molar is lost prematurely, it helps guide the first permanent molar into place. In 1973, Hicks outlined in detail the indications and contraindications for the distal shoe appliance, as well as the diagnostic and systemic considerations.⁴ The indications and contraindications as outlined by Hicks are listed in Table 1.

Hicks preferred fabrication of a cast gold appliance, although appliances with attachments soldered to stainless steel crowns or bands were clinically acceptable.⁴ Twenty years later, Gegenhiemer and Donly described the fabrication of a laboratory-processed distal shoe appliance soldered to a stainless steel crown that required 2 visits by the patient.⁵ The first was for preparation of the tooth serving as a retainer for the crown and transfer impression for appliance fabrication. Another crown was temporarily cemented and, when the appliance was fabricated and returned from the laboratory, a radiograph was exposed to verify position of the permanent molar before extraction of the nonrestorable primary second molar and immediate cementation of the appliance.

There are distal shoe appliance kits available (Dental Supply Co, Covina, Calif; Denovo, Arcadia, Calif) whereby the distal shoe can be fabricated and inserted immediately after extraction of the second primary molar while the patient is in the chair during one visit. These are the same as the design by Gerber, unchanged since their inception.¹

Neither Gegenhiemer and Donly nor Hicks reported on the survival rates of the distal shoe. Baroni et al,⁶ and Qudeimat et al,⁷ described survival rates for other fixed appliances. These were longitudinal studies of the band and loop and the lingual arch and utilized the life table method to calculate expected appliance longevity. This calculation allows for the pooling of information from cases followed for less than the entire period of observation, thus calculating an average survival rate for the entire sample.⁸⁻¹⁰ For this study, actual observations in a specific time period are reported rather than a statistical estimation of survival rates.

The purpose of this case report is to describe the chairside 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.

Clinical management/fabrication technique

Indications

Figure 1 shows a second primary molar that is nonrestorable and requires extraction. Clinically, the indications for extraction of the second primary molar were those described by Hicks (ie, irreversible pulpitis that was deemed not to be amenable to pulp therapy with a nonrestorable tooth). A radiograph should be taken to verify the clinical impression and ascertain the position of the first permanent molar.

Table 1. Indications and Contraindications for the Distal Shoe Appliance per Hicks, 1973⁴

Indications	Contraindications
Premature loss or extraction of the second primary molar prior to the eruption of the first permanent molar	Inadequate abutments due to multiple loss of teeth
Advanced root resorption and periapical bone destruction of the second primary molar prior to the eruption of the first permanent molar	Poor patient or parental cooperation
A primary second molar with advanced caries that is not restorable	Missing permanent first molar
Ectopic eruption of the permanent first molar	Systemic diseases that affect healing such as diabetes mellitus
Ankylosis of the primary second molar	Cardiac anomalies that require antibiotic prophylaxis prior to dental treatment

Table 2. Inventory Needed for Chairside Fabrication of the Distal Shoe Appliance

Stainless steel crown(s)
Extraction forceps
Distal shoe appliance kit*†
Electric spot welder
Heavy wire-cutting pliers
Heatless stone
Dental cement

*Dental Supply Company, DSC Dental (Covina, Calif)

†DENOVO (Arcadia, Calif)



Fig 1. Nonrestorable second primary molar

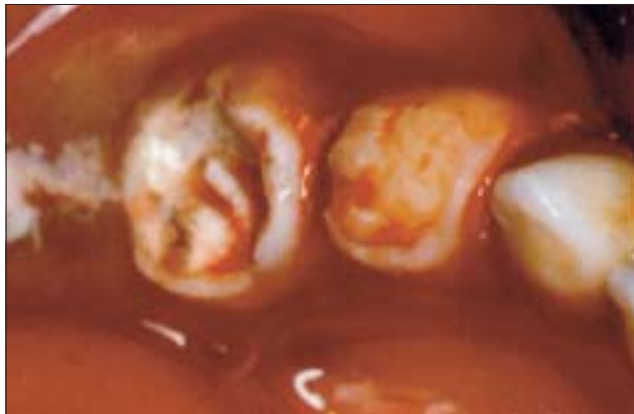


Fig 2. First primary molar prepared for a stainless steel crown

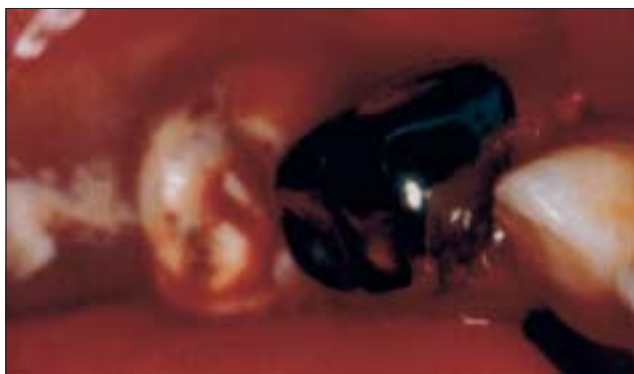


Fig 3. Test fit of a stainless steel crown on the first primary molar

Fabrication

The inventory needed for the fabrication of the appliance is shown in Table 2. The first primary molar is prepared for a stainless steel crown (Fig 2) and the crown is fitted in the usual manner (Fig 3). The primary second molar is extracted and, while hemostasis is being achieved, the female attachment of the appliance is welded, using an electric spot welder, to the distal of the crown (Fig 4). The legs of the male attachment are shortened, with the cut ends smoothed off, and the male attachment is inserted into the tube of the female attachment (Figs 5-7). The crown is seated and the male attachment extended to the most distal aspect of the extraction socket (Fig 8). A radiograph is taken to verify the position of the distal shoe blade with respect to the first permanent molar (Fig 9). The appliance is removed and the legs are welded immobile (Fig 10) prior to being cemented into place (Fig 11). If additional hemostasis is needed, medications to aid clotting can be inserted into the socket.

Figure 12 shows the cemented appliance with the hemostatic agent and Figure 13 shows the erupted first permanent molar at the successful conclusion of therapy. After the molar erupts, the blade can be removed—converting the appliance to a crown and loop—or the attachment can be disengaged from the crown and either a unilateral or bilateral space maintainer can be placed.

Methods

Beginning May 31, 1995 through September 26, 2001, there were 127 children who had 1 or more distal shoe appliances, with a stainless steel crown as the retainer, inserted to protect the eruption position of the first permanent molar, included in this study. There was 1 child who had a distal shoe placed to protect the eruption position of an unerupted second primary molar and one to protect the eruption position of a second permanent molar. Children were recalled for observation every other month and any adjustments, corrections, or repairs were noted in the patient's chart. Parents and/or guardians were given unequivocal instructions to call the office immediately if the appliance broke. If both the first and second primary molars required extraction, the appliance was



Fig 4. Spot welding the female attachment to the stainless steel crown

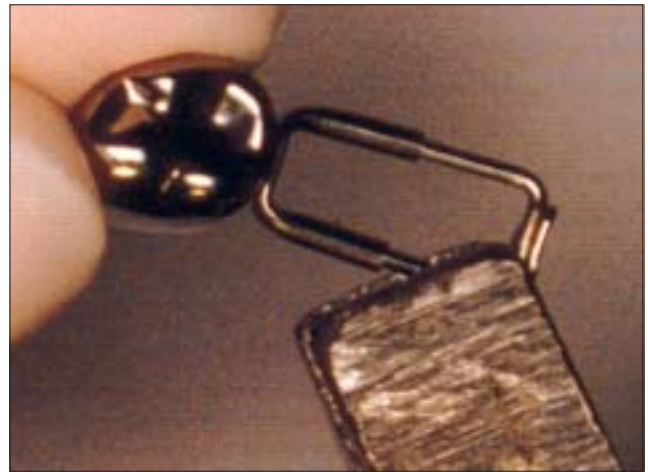


Fig 7. Inserting the male attachment



Fig 5. Cutting the legs of the male attachment



Fig 8. Extending the male attachment to the most distal aspect of the extraction side



Fig 6. Smoothing the cut legs of the male attachment

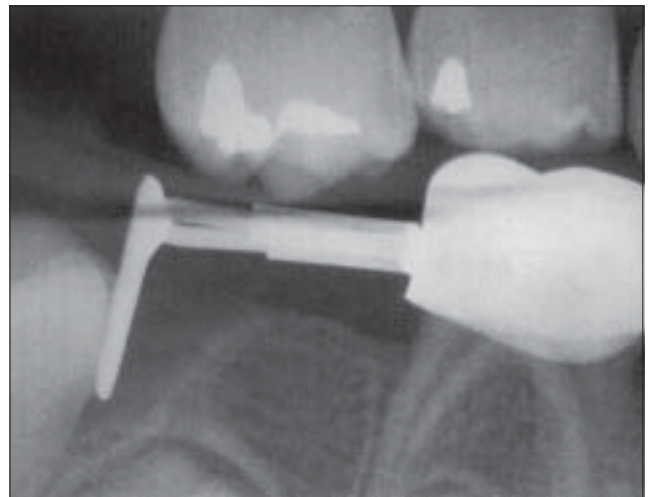


Fig 9. Radiograph of the appliance prior to cementation to verify position



Fig 10. Welding the legs of the appliance immobile



Fig 11. Cementing the appliance in place



Fig 12. Cemented appliance

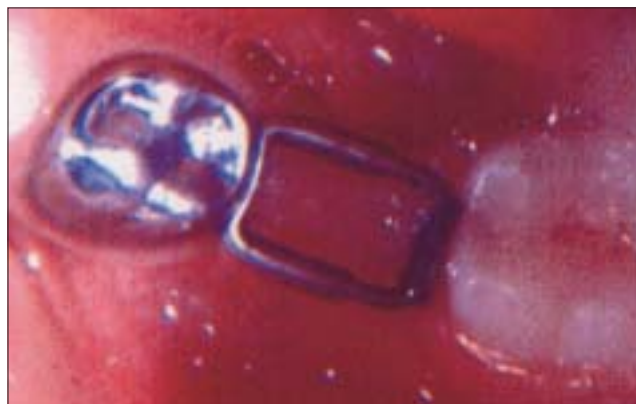


Fig 13. First permanent molar guided into position

attached to a stainless steel crown cemented on the primary canine.

When an appliance broke, a stainless steel band was fitted over the crown, and the appliance was remade within 2 days as a distal shoe attached to a band and inserted without any loss of space. If this occurred, the treatment sequence using the stainless steel crown/distal shoe was considered complete, albeit a failure for this specific appliance. The observation was also considered complete when the permanent first molar erupted and a noninvasive appliance was placed to succeed the distal shoe.

Clinical notes from patient charts were transferred to a computer database program for storage and analysis. All parents/guardians gave written informed consent for the treatment regimen.

Table 3. Placement of Distal Shoe Appliance by Span and Abutment (N=190)

No. of appliances	Span	Abutment
36	3-B	B
3	3-C	C
1	A-C	C*
29	14-I	I
47	19-L	L
13	19-M	M
54	30-S	S
6	30-R	R
1	31-S	S

*Tooth B was extracted before tooth A erupted

Results

There were 127 patients who had 190 appliances inserted during the period of observation. Table 3 shows the distribution of appliances by abutment tooth. The end point of the observation was either the eruption of the first permanent molar or conversion to a distal shoe appliance attached to a band after the appliance separated from the crown.

Table 4. Successful and Unsuccessful Distal Shoe Appliances During the Observation Period: May 31, 1995–September 26, 2001

Span	DS inserted	DS successful	DS converted to DSB*	DS under observation
3-B	36	15	4	17
3-C	3	N/A	N/A	3
A-C	1	1	N/A	N/A
14-I	29	18	5	6
19-L	47	24	4	19
19-M	13	7	3	3
30-S	54	17	3	34
30-R	6	3	3	N/A
31-S	1	1	N/A	N/A
Total	190	86 (45%)	22(12%)	82 (43%)

DS=Distal shoe appliance with stainless steel crown as abutment
 DSB=Distal shoe appliance with orthodontic band as abutment
 N/A=Not applicable
 *Unsuccessful DS

During the period of observation, 86 appliances were successful in guiding the permanent molar into its proper arch position, while 22 failed and were converted to a distal shoe appliance with an orthodontic band as the retainer, as seen in Table 4. The remaining patients/appliances were still under clinical supervision at the completion of the period of observation. While no specific data were collected relative to gingival response to a foreign object embedded in the tissue, Figure 13 shows the typical clinical observation of the appliance in situ with no chronic inflammation or clinically observable periodontal pathology.

Discussion

The success criterion of a distal shoe space maintainer, as defined by Baroni et al and Qudeimat et al, is the successful guidance of the unerupted permanent tooth into the arch with no problems associated with the appliance.^{7,8} This eliminates a clinically valid definition of success (ie, did the appliance do what it was designed to do for the patient, even though it needed service or repair during the course of treatment?). Since the treatment of a child by a pediatric dentist is a dynamic rather than a static relationship, it is the end point of therapy that should be used as the marker for success. Accepting this dynamic definition rather than a static one, the chairside-fabricated distal shoe appliance with a stainless steel crown as the retainer can be considered a successful appliance, albeit one that needs careful supervision and occasional service.

The position of the molar when it erupts may not always be favorable: no data were collected as to the frequency of occurrence, but as seen in Figure 12, perfect arch position is not always achieved when the tooth erupts. This is a minor problem compared to correction of position of a molar that has erupted mesioangularly when no guiding appliance is placed, and is easily handled by adjustment of a lingual arch.

Since the appliance can be fabricated during the same visit as the extraction of the hopeless primary second molar, it is a very cost-effective treatment. The cost savings are associated with the lack of laboratory expenses and elimination of a second visit for insertion of the appliance.

As seen, appliances do break and need replacement, but this only happened to 12% of the appliances followed during the course of the study. Conversion to a band retainer required just 15 minutes of chair time. In addition, when converting a distal shoe to a band retainer, administration of a local anesthetic is not necessary as long as the insertion

site of the blade has not been fused with granulation tissue. Since parents were given unequivocal instructions to contact the emergency service of the practice immediately upon breakage, insertion of the band retainer replacement appliance was always done atraumatically and without local anesthesia.

The chairside-fabricated distal shoe appliance, with a stainless steel crown as the retainer, is a valuable asset to the pediatric dentist faced with the decision that a primary second molar must be extracted before eruption of the first permanent molar. It can be delivered at the same visit as the extraction and, with the cooperation of the parent, has a high success rate. After eruption of the permanent molar, it can be converted easily to either a crown and loop or band and loop. If the clinician prefers, a bilateral fixed appliance can also follow the distal shoe appliance for maintenance of the permanent molar in its position in the arch.

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