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Comparative evaluation of longevity and clinical success rate of band and loop and crown and loop space maintainers in primary and mixed dentition-a clinical study.

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Abstract

Context: Loss of dental arch circumference due to premature loss of primary molars is a common presentation in primary and mixed dentitions. The premature loss of primary teeth can lead to undesirable mesial and distal movements of primary and permanent teeth, resulting in loss of arch length. The one such approach to maintain arch space and to prevent future malocclusion is to place a space maintainer.

Aims: (1) To assess the longevity and clinical success rate of band and loop compared to crown and loop space maintainer in primary and mixed dentition. (2) To check the significance of age, gender and dental arch on space maintainer failure rate and the factors responsible for it.

Methods and Material: A total of 34 children between age group of 4-8 years participated in the study. A prefabricated orthodontic band was selected for the abutment tooth for space maintainers. The patients were followed up at every 3 months at 3,6,9 and 12 months. The space maintainers were evaluated for mean survival time, failure rate and failure reasons.

Statistical analysis: Statistical analysis was performed in Excel format using SPSS version 20. The level of statistical significance was set at $p<0.05$.

Results: The mean survival rate of band and loop was 7.5 months whereas for crown and loop it was 10 months which was significantly higher. ($p=0.02$)

Conclusions: Survival time and success rates are better for crown and loop space maintainers. Space maintainer survival time and failure rate are unrelated to patient's age, gender, dental arch.

Keywords: Band and loop, Crown and loop, Space maintainer

Introduction

The primary dentition plays a very important role in child's growth and development not only in terms of speech, chewing, appearance and prevention of bad oral habits but also in the guidance of eruption of

succedaneous teeth.[1] Management of space problems associated with the transitional stages from primary to permanent dentition is a routine component of pedodontic practice.[2,3]

When a primary tooth is extracted or exfoliated prematurely, the teeth mesial and distal to the space tend to drift or be forced into it. This may result in the impaction of the succedaneous tooth, a shift of midline of the dental arch to the affected side, and over eruption of the opposing tooth, with subsequent impairment of function. Maintenance of the space may eliminate or reduce such consequences.[4]

The space maintainers are broadly classified as removable and fixed types which are further categorized as banded and bonded, active and passive, functional and non-functional. The goal of space maintenance is to preserve the arch length, width, and perimeter by maintaining the relative position of the existing dentition.[5]

It has been reported that a well-designed fixed space maintainer is more preferable than a removable appliance to both patient and dentist.[6] Also, fixed appliances, if properly designed, are less damaging to oral tissues and are of less irritation to patient as well as dentist because they are worn continuously for a longer period.[5]

The greatest amount of tooth displacement occurs within 6 months following the loss of teeth, so it is best to insert a space maintainer just after the loss of teeth.[7] The most commonly used unilateral space maintainer design for a single tooth loss in children is the band and loop space maintainer. The band and loop space maintainers are easy and economical to produce, requires little chair side time and adapts easily to accommodate changing dentition.[8]

A crown is used if the second primary molar has extensive caries or if the tooth has received pulp therapy.[9] As it is difficult to remove the crown (converted to a band) to make adjustments, adapting a band or one size larger crown over a cemented crown restoration and constructing a conventional band and loop appliance is another alternative to address unilateral crown and loop space maintainer. Cutting the space maintainer from the crown leaves a roughened surface, a nidus for plaque development hence it is recommended to use the band over crown.[10]

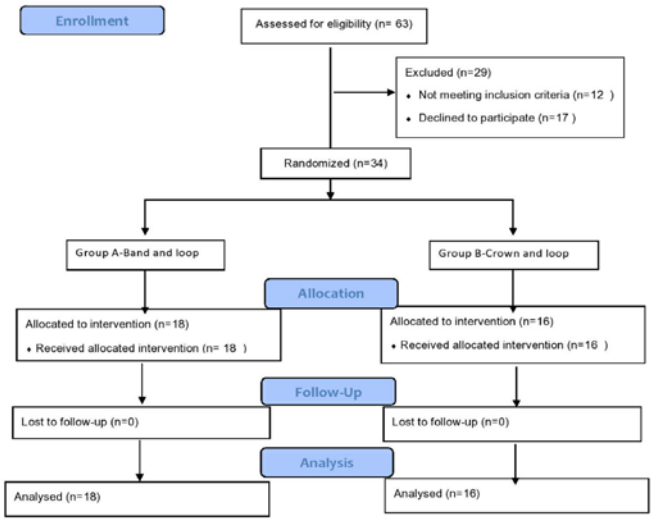
The most common causes of failure of space maintainer include high incidence of breakage in mandibular appliances, when compared with other appliances.[11] Others state that fixed space maintainers, if properly designed, are less damaging to the oral tissues than removable space maintainers, and more appropriate for longer periods of space maintenance.[12] Hence the aim of the present study was to evaluate the longevity of band and loop space maintainers compared to crown and loop space maintainers in primary and mixed dentition as well as to check the mean survival time and failure rate clinically. The objective of the study was to check the significance of age, gender and dental arch on space maintainer failure rate. The purpose of the present study was to test the null hypothesis, which was that the (i.e. Band and loop and Crown and loop space maintainers) would exhibit the same clinical success.

Subjects and Methods

The study was undertaken at Department of Pedodontics and Preventive dentistry, Karnavati School of dentistry, Uvarsad, Gandhinagar, Gujarat. Ethical approval for the study was taken from the ethical committee of the institution prior to start of the study. The patients as well as parents were explained about the whole procedure and written consent was taken from the parents. In our clinical study a sample size of 34 achieves 90% power to detect a difference of 5 between the null hypothesis that both group means are 35 and the alternative hypothesis that the mean of group 2 is 40 with group standard deviation of 6.9

with a significance level (alpha) of 0.050 using a two-sided two-sample t-test. Patient Recruitment and analysis is mentioned in CONSORT diagram. [Figure 1].

Figure 1: Consort flow diagram showing the patient allocation and analysis.



Inclusion criteria

Clinical criteria

- Child within age group of 4-8 years. Male/female; inclusive both
- Premature loss of primary first molars.
- Presence of angle's class I molar relationship in mixed dentition or flush terminal/mesial step in primary molar relationship.

Radiographic criteria

- Absence of periapical pathology
- Presence of succedaneous tooth bud
- Presence of more than 1 mm of bone overlying the succedaneous tooth germ/or less than 1/3rd of the root part formed.

Exclusion criteria

- Absence of teeth on mesial and distal side of edentulous area.
- The inability to return for follow-up appointments.

Each patient was seen for a mandatory three month recall during which the following procedures were performed:

- Appliance removal and oral prophylaxis
- Evaluation of the abutment teeth
- Cleaning and topical fluoride application before insertion of appliance

Method of placement of band and loop space maintainers: [Figure 2: a-d]

- For Band and loop procedure, grossly carious primary first molar or presence of deep caries which needed extraction were selected for the study. [Figure 2 -a]
- A prefabricated orthodontic band was selected for the abutment tooth by measuring the mesio-distal width of a tooth with Digital Vernier caliper and selecting a band with the same internal diameter.
- The band was fitted to the abutment tooth, and burnished against the grooves and contours of the tooth to ensure that it covered the tooth with a tight fit. The band could not easily be dislodged with a probe. [Figure 2-b].
- An alginate impression was taken, after which the band was removed from the patient's mouth, transferred in the impression and stabilized with fevikwik. Sodium hypochlorite 0.525% was used for 5 minutes to disinfect the alginate impression. Following disinfection of impression, working model was prepared with dental stone.
- Then a loop was constructed from 0.9 mm S.S wire and soldered to the band using silver solder and gas torch. All Band and loop SMs were constructed by the same operator.
- Prior to cementation, abutment teeth were cleaned and checked for any contact with the opposing tooth. Then Band and loop space maintainer was cemented using glass ionomer luting cement according to manufacturer's instructions. [Figure 2-c, d].

- After cementation of band and loop space maintainer interdental flossing was performed.
- Finally, it was ensured that the space maintainer made tight contact with the tooth to which the loop extended.

Figure 2: Method of Band and Loop Fabrication (Figure 2 – a to d)

Figure 2(a): Pre-operative picture

Figure 2(b): Fitted orthodontic band

Figure 2(c): Band and loop space maintainer

Figure 2(d): Post-operative occlusion

Method of placement of crown and loop space maintainers: [Figure 3: a-d]

- For Crown and loop space maintainers, second primary molars which needed or received pulp therapy were selected for the study. [Figure 3-a].
- Abutment tooth which received stainless steel crown after pulp therapy were selected and preformed band was selected for that abutment tooth by measuring the mesiodistal diameter of the SSC with a Digital Vernier caliper and then internal diameter of the prefabricated band was measured. The two were compared and the corresponding prefabricated band was then placed on the abutment tooth.
- The band was then seated on stainless steel crown and burnished against the grooves and contours of the crown to ensure that it covered the tooth with a tight fit. The band could not easily be dislodged with a probe. Impression was taken using alginate impression material. [Figure 3-b].
- Crown and loop space maintainer fitted and post op occlusion pictures are mentioned. [Figure 3-c, d]
- Further steps same as band and loop procedure

Figure 3: Method of Crown and Loop fabrication (Figure 3 - a to d)

Figure 3(a): Pre-operative picture

Figure 3(b): Fitted orthodontic band

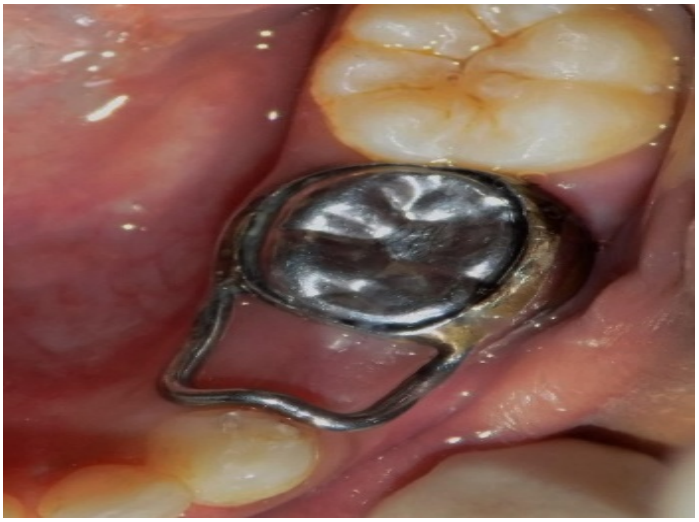


Figure 3(c): Crown and loop space maintainer

Figure 3(d): Post-operative occlusion

Data collection

A case number, the date of space maintainer placement, and various relevant demographic details were recorded for each participant. Results were collated by the researcher and verified by the supervisors of this study before being submitted to a statistician for analysis.

Follow up and Evaluation of Space maintainers

Patients were evaluated for follow up every 3,6,9 and 12 months interval. It is important that patients with space maintainers be monitored for complications arising from the device or from poor oral hygiene, and for the eventual eruption of the permanent tooth into the space. At the end of this study, parents were asked to report for 3 months check-up visits and to have their child's space maintainer removed as soon as the relevant permanent tooth erupted.

Gingival Index

A Gingival index, based on the Loe and Silness scoring criteria (1963),[13] was assessed for both types of space maintainers at each follow-up visit. Patients were evaluated for follow up procedure every 3, 6, 9 and 12 months interval.

Failure criteria for a space maintainer

Failure criteria were established from previous studies done by Qudeimat, Kirzioglu and Yilmaz which were modified as below. [14,15,16]

A space maintainer was classified as having failed when it presented with any of the following attributes:

- Distortion
- Cement loss
- Loop fracture/Solder breakage
- Caries
- Gingival inflammation

Statistical Analysis

All data were entered into an Excel format for statistical analysis, and all statistical analysis were performed using SPSS version 20. The level of statistical significance was set at $p<0.05$.

Results:

There were total of 34 number of patients with the mean age of 6.02+_1.48 years consisting of 2 groups individually as Band and loop and Crown and loop. Two different types of space maintainers viz., Band and loop and crown and loop space maintainers were evaluated for:

Age

Gender

Dental arch

Follow up in months

Cause of failure of space maintainer

For the 34 evaluated SMs, descriptive statistics for mean of survival and distribution of space maintainers according to age, gender, dental arches were calculated. Cumulative survival rates of SMs were estimated via Kaplan-Meier method. Distribution of space maintainers according to age, gender and dental arch are presented in [Table 1].

Table 1: Distribution of Space Maintainers According to Age, Gender, Dental Arch

SM Type	Gender	Dental arch		Age				
		Maxillary	Mandibular	4	5	6	7	8
Band and loop(n=18)	Male	05	07	03	03	04	03	00
	Female	03	03	00	01	03	01	00
Crown and loop (n=16)	Male	01	07	00	02	03	02	01
	Female	00	08	00	00	02	04	02
Total (n=34)		09	25	03	06	12	10	03

Failure rate for band and loop space maintainers noticed in this study was 27.7%. In comparison, failure rate for crown and loop space maintainers was 12.5%. The reasons summarized in [Table 2 and 3].

Table2: Band and Loop Space Maintainer Failures and Reasons for Failure

Causes of failure	Time				Total (100%)
	3 months	6 months	9 months	12 months	
Distortion	0	0	0	0	-
Cement loss	0	0	0	0	-
*Loop fracture#Solder breakage	*1	#2	0	0	3(16.6%)
Caries	0	0	0	0	-

for space maintainer failures recorded during this study are

Soft tissue lesion	0	0	0	0	-
Gingival inflammation	0	0	2	0	2(11.1%)
Total	1(5.5%)	2(11.1%)	2(11.1%)	(0%)	5(27.7%)

Table 3: Crown and Loop Space Maintainer Failures and Reasons for Failure

Causes of failure	Time				Total (100%)
	3 months	6 months	9 months	12 months	
Distortion	0	0	0	0	-
Cement loss	0	0	2	0	2(12.5%)
*Loop fracture/ #Solder breakage	0	0	0	0	-
Caries	0	0	0	0	-
Soft tissue lesion	0	0	0	0	-
Gingival inflammation	0	0	0	0	-
Total	(0%)	(0%)	2(12.5%)	(0%)	2(12.5%)

Out of 18 Band and loop space maintainers 1 failure noted at 3 months due to loop fracture and 2 failures at 6 months which were due to solder breakage. [Figure 4-a, b]. Another 2 failures were noticed at 9 months which were due to Gingival inflammation. [Table 2] Out of 14 crown and loop space maintainers 2 failures were noticed at 9 months follow up period which were due to cement loss. [Figure 4-c].

Figure 4: Pictures showing failures of space maintainer

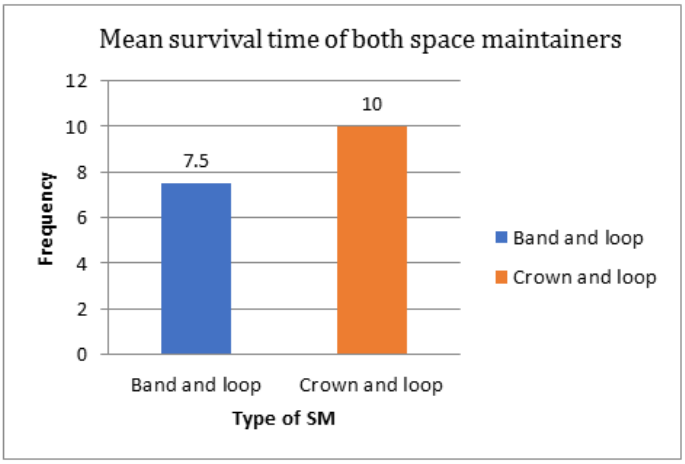
Figure 4(a): Loop fracture

Figure 4(b): Solder breakage

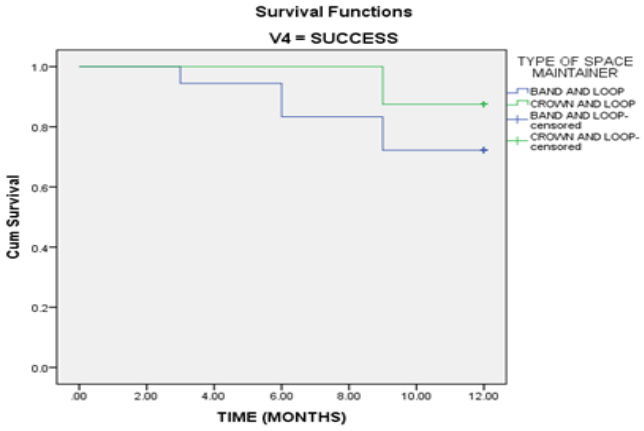
Figure 4(c): Decementation

This suggests that it had high success ratio compare to band and loop space maintainer even after 12 months. [Table 3]. The Mean survival time for band and loop and crown and loop space maintainers was 7.5 months and 10 months respectively. [Graph 1]. Cumulative survival rates of SMs estimated via Kaplan-Meier method is given in [Graph 2].

Graph 1: Mean Survival Time of Both Space Maintainers



Graph 2: Survival Curves By Kaplan-Meier Method And Treatment Comparison Using Log-Rank Test



The fate of both space maintainers used in this study are presented in [Table 4]. When comparing the success rate of band and loop and crown and loop space maintainers the crown and loop space maintainers showed significantly higher success rate of 87.5% at 12 months follow up evaluation period. [Table 4]. Distribution of space maintainer failure rates for different age groups are given in [Table 5].

Table 4: Comparison of Band and Loop & Crown and Loop Space Maintainers Success & Failure Rates

SM TYPE	Status		Total(N=34)
	Success	Failure	
Band and loop	13(72.2%)	5(27.8%)	18(100%)
Crown and loop	14(87.5%)	2(12.5%)	16(100%)
Total	27(79.4%)	7(20.6%)	34(100%)

Table 5: Distribution of Space Maintainer Failure Rates for Different Age Groups

Age	Status		Total	P Value
	Success	Failure		
4	3(8.8%)	0(0%)	3(8.8%)	0.103
5	5(14.7%)	1(2.94%)	6(17.64%)	
6	9(26.4%)	3(8.82%)	12(35.29%)	
7	8(23.5%)	1(2.94%)	9(26.4%)	
8	2(5.8%)	2(5.8%)	4(11.7%)	
Total	27(79.41%)	7(20.5%)	34(100%)	

It was observed that space maintainers placed for male patients failed sooner than those placed for female patients. The two-sample t-test showed this to not be statistically significant (p = 0.25). The results of this analysis are summarized in [Table 6]. By statistically comparing the failure rates of space maintainers placed in the maxilla with those of space maintainers placed in the mandible, it was found that the means for these two groups was statistically not significant (p=0.705). [Table 7]. The results of analysis using Cox proportional Hazards model are shown in [Table 8].

Table 6: Comparison of Space Maintainer Failures for Male and Female Patients

Gender	No. of failures	Mean (+_SD)	P value
Male	5	7.2(2.68)	0.257
Female	2	7.5(2.12)	

Table 7: Comparison of Space Maintainer Failures in Maxilla and Mandible

Dental Arch	No. of failures	Mean (+_SD)	P value
Maxilla	3	5(1.73)	0.705
Mandible	4	9(0.00)	

Table 8: Cox Regression Model for Co-Variables (Age, Gender, Dental Arch)

Risk indicator SMs loss	Exponent (B)	95% Confidence interval for exponent (B)	P -value
Age	1.879	0.880-4.016	0.103
Gender	0.399	0.072-2.205	0.292
Dental arch	3.551	0.748-16.852	0.111

All P values for various predictor variables were insignificant. For age p=0.103, for gender p=0.292, for dental arch p=0.111. It was observed that the patients who did not follow the oral hygiene instructions, their Gingival indices increased over a period of time which was clinically significant but statistically non-significant. Oral hygiene reinforcement was done for those patients who showed the signs of gingival inflammation at follow up evaluation period.

Discussion

The premature loss of teeth is an unfortunate occurrence; each situation needs to be assessed thoroughly to provide the best treatment. The knowledge of using the appropriate appliance at right time is an important aspect of space maintenance treatment planning.[17] In cases of premature loss of a single posterior tooth the most commonly used space maintainer reported to be the band and loop or crown and loop space maintainer.[18] Hence the present study was conducted to evaluate the longevity of band and loop space maintainers compared to crown and loop space maintainers in primary and mixed dentition as well as to check the mean survival time and failure rate clinically over 12 months period.

Unlike previous retrospective studies, [19-22] in the current study, the decision to provide or remove the space maintainer, use of prefabricated band, the impression taking and the cementation of space maintainer were all made by the same pediatric dentist. Also, this study is unique with respect to the follow up visits, where examination of each space maintainer was carried out by the same clinician and over a known recall interval. Thus, the main investigator was the only clinician involved in the decision of withdrawing space maintainer from the study according to previously determined criteria.

Failure criteria were established from previous studies by Qudeimat, Kirzioglu, and yilmaz. [14,15,16] Christensen and Fields advise that the crown and loop is not a recommended technique. [23] Fields states that it is no longer considered advisable to use the crown-loop appliance because it precludes simple appliance removal and replacement.[23] He recommends that teeth with SSC should be banded like natural teeth. Hence in present study, band over crown and loop was used as another technique of placing crown and loop. Roughening the band interior with a coarse diamond bur is advocated to aid cement adherence to the stainless steel while cementing band over crown and loop space maintainer.[24]

Breakage of loop can occur at the solder joint or within the loop. Approximately 17% of the band and loop space maintainers placed in the present study showed loop fracture at 3 and solder breakage 6 months respectively. Previous studies on band and loop space maintainers over a six-month period attributed to failures due to loop fracture/solder breakage.[14,23,25] Such a high rate of mechanical failure in present study could have been due to poor construction quality, i.e., overheating of the wire during soldering, wire thinned by polishing, remnant of flux on the wire, and failure to encase the wire in the solder.[8,26]

In present study, the major cause of failure of crown and loop space maintainer was reported to be decementation which accounted for (12.5%) of the total cases. This rate was lower than the cement failure rates reported in fixed space maintainers by previous studies.[8,19,21,22] It has been shown in the literature that loss of cement around a SM band and later decementation of an appliance, constitute a cause of failure of SMs,[20] this come in agreement with our study which demonstrated decementation. However, failure could also reflect difficulties in keeping a dry field during cementation. The thickness of the cement between the tooth and the band could influence the band's vulnerability. Thus, the high number of cement loss failures reported in other studies may have been significantly influenced by placement technique and operator skill. [27,28]

When comparing the mean survival time of both space maintainers in our study, band and loop space maintainer showed survival time of 7.5 months whereas for crown and loop it was 10 months (p=0.023). However, the difference was statistically significant. The failure rate of band and loop space maintainer found in this study was relatively high as compared to crown and loop space maintainer. The reason for such high failure rate of band and loop space maintainer can be attributed to poor construction quality. [14,21] Whereas in case of crown and loop the probable cause for failure can be due to loss of cement around a space maintainer. [20, 29]

In our study, the age and gender of children, and arch type had no significant association with performance of the space maintainer, in agreement with several previous studies, where they used the life table method to measure the median survival time of various space maintainers.[7,8,20,21] This perhaps reflects that adequate pre-treatment evaluation may ensure that the use of a space maintainer is appropriate, but does not influence appropriate design selection and construction.

Limitations

It is acknowledged that present study had following limitations:

1. Although post-study care maintenance instructions were given to all parents/patients, these instructions may not have been diligently followed by all. This may have led to the premature failure of certain space maintainers.

2. Because of the limited sample size in this study, all results should be interpreted as descriptive and provisional, and not as conclusive.

Conclusions

1. Mean survival rate of crown and loop was 10 months whereas for band and loop 7.5 months which was significantly higher.
2. Solder Breakage/loop fracture was the most commonly recorded cause of space maintainer failure, followed by loss of cement and gingival inflammation.
3. Age, Gender, Dental arch in which the appliance was placed, had no significant effect on longevity of the space maintainer.

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