Estimation of overall success rate of band and loop appliances

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Introduction

Both dental caries and trauma remain prevalent in young children in the United States. Such issues are the two primary reasons for premature loss of primary teeth.[2] While pediatric patients who lose teeth prematurely can remain functional, the loss of primary teeth can lead to space loss, midline shift and delayed or accelerated eruption of succedaneous teeth.[4,6,7] The ideal way to prevent space loss in pediatric patients is to prevent premature tooth loss but in cases where it is unavoidable, space maintainers can be an effective method for minimizing space loss.[3]

While there is poor evidence to recommended for or against the use of space maintainers[3], the consequences of not using space maintainers is well documented.[4,6,7] Space maintenance appliances include unilateral space maintainers such as band and loop and distal shoe appliances as well as bilateral space maintainers like a lower lingual holding arch or Nance appliance.[1] Appropriate treatment should be selected according to specific tooth lost, time elapsed since tooth loss, dental age, presence and amount of bone covering permanent successor, oral health and habits as well as clinical presentation and radiographs.[2]

Unilateral band and loop space maintainers are indicated when there is premature unilateral loss of a single primary first or second molar with more than 6 months before eruption of the succedaneous tooth and when there is bilateral loss prior to the eruption of mandibular permanent incisors.[3] Band and loop appliances can be fabricated in two ways: in office by a provider utilizing a chair side band and loop kit or by taking an impression and sending it to a lab to fabricate the appliance. Chairside band and loops can be placed during the same appointment as extraction, while lab fabricated appliances require 2 appointments as well as additional lab time and fees.[2]

There exists literature on the longevity of various space maintainers, primarily focused on comparing failure of unilateral versus fixed appliances.[5,8,9] Little literature exists comparing lab made versus chairside band and loops. It would be beneficial for providers to understand the differences in clinical successes and failures of lab fabricated and chairside band and loops to better inform treatment decisions and patient care.

Objectives

This study primarily aims to evaluate retrospectively overall clinical success of band and loops. The exploratory aim is to determine factors associated with success of band and loops such as type of fabrication, side/quadrant, type of tooth and treatment modality and patient behavior.

Primary aim:

- To estimate the overall success rate of band and loop appliances

Exploratory aim:

- Identity factors that are associated with success rate of band and loop appliances including type of fabrication, side/quadrant of placement, tooth that has been extracted, treatment modality and patient behavior.

Study Design and Methods

In a retrospective chart review clinical treatment notes, radiographs and completed treatment codes were reviewed. Inclusion criteria included a complete record of band and loop placement, completion of the D1510 CPT code and at least one follow up visit within a year of placement for post-placement evaluation. Study subjects were patients of the Division of Pediatric Dentistry at Montefiore Medical center who received at least one band and loop space maintainer between the time period of July 1, 2018 and June 30, 2022. Of the 853 patients that had the code D1510 completed, only 502 charts met inclusion criteria and were reviewed. The main reasons for not being included in the study were lack of follow up, lack of appliance delivery or completion of incorrect code.

Study Design and Methods

The following were collected for each subject: method of band and loop fabrication, quadrant of placement, tooth removed/missing, treatment modality, Frankl behavior score, patient age at time of cementation, survival time of the appliance and reason for band and loop removal (if removed). Patients were classified into 2 outcome groups: success and failure. Success was defined as patient is asymptomatic and space maintainer never needed to be recemented. Failure was defined as patient is symptomatic and/or, solder/band breakage and/or, soft tissue lesions, cement failure, complete loss of space maintainer, required recementation for another reason and/or not purposely removed by dentist.

A descriptive summary of patient characteristics is presented. A logistic regression model was employed in assessing the association between a priori selected patient characteristics and treatment success. Results are summarized as point estimate of effect of patient characteristics and associated 95% confidence interval (CI). Statistical significance is claimed at α=0.05 level.

Results

Four hundred and six band and loop space maintainers placed met the criteria for success and 96 were defined as having failed. Reasons for failure included those for premature removal and are summarized in Figure 1. The most common reason for failure was cement failure, 51 (53%), followed by impeding eruption of succedaneous tooth, 12 (13%), and broken appliance, 9 (10%). Overall success rate of treatment is 80.9% (95% CI: 77.2% , 84.1%). Treatment success rate among patient subgroups with tooth type D is 82.2% (95% CI: 78.2 % , 85.6%). Treatment success rate among patient subgroups with tooth type E is 75.3% (95% CI: 65.7 % , 82.8%). The patients included in the study ranged from 3-11 years old and the mean age was 6.4 years.

Most patients (175, 35%), were classified as a 3 on the Frankl Behavior Rating Scale. One hundred forty-two (28%) were classified as Frankl 2, 132 26%) were Frankl 4 and 53 (11%) were Frankl 1.

The majority of band and loop space maintainers, 385 (77%), were placed chairside using nitrous oxide-oxygen. Eighty-four (17%) were placed during oral conscious sedation, 15 (3.0%) were placed in the operating room with the patient being treated under general anesthesia, 15 (3.0 %) were place chairside without using nitrous oxide-oxygen, 2 were placed with patients in protective stabilization and 1 was placed with the patient in the knee-to-knee position.

Of the 502 charts reviewed, 370 (74%) space maintainers were fabricated by an outside dental lab. One hundred thirty-two (26%) were fabricated chairside using the Denovo chairside space maintainer system. All were cemented using GC Fuji I.

The most common tooth that needed to be replaced by a band and loop space maintainers was #S, followed by #L. All mandibular teeth were replaced more than their maxillary counterparts and 1st molars were replaced more than 2nd molars. A full summary of teeth replaced can be seen in Table 1.

The average survival for all space maintainers was 28.8 months. The mean time for failed space maintainers was 16.4 months and the mean time for successful space maintainers was 37.3 months, including those that are still in use.

A summary of the overall distribution of selected patient characteristics can be seen in Table 2.

Among the a priori selected patient characteristics, only survival time (> median) is significantly associated with higher treatment success rate ($p < 0.001$, see table 3). In addition, older age (> median) approached significance ($p < 0.046$). Chairside method of fabrication trended for higher odds of success but did not reach statistical significance (p=0.2). The wide CI associated with the effect of length of use is a reflection of study size limitation, i.e., the number of parameters in the model shown in Table 3 is almost the maximum that the data can reasonably support.

Results

Figure 1: Reason for band and loop failure

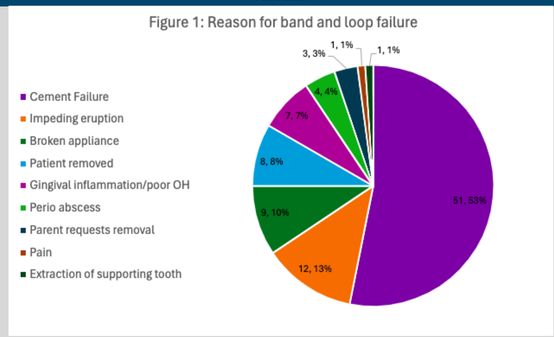

Table 1: Description of teeth replaced by band and loop space maintainers

Tooth # replaced	N	Total per quadrant
A	20	119
B	99	
I	85	99
J	14	
K	34	143
L	109	
S	112	141
T	29	

Table 3. Association between selected patient characteristics and treatment success

Variable	OR[1]	95% CI[1]	p-value
Method of Fabrication			
Lab fabricated	—	—	
Chairside	1.51	(0.82, 2.83)	0.2
Quadrant of Placement			
Upper right	—	—	
Upper left	1.96	(0.89, 4.52)	0.10
Left lower	1.08	(0.55, 2.13)	0.8
Lower right	0.87	(0.45, 1.68)	0.7
Frankl Score at time of placement			
Frankl 1	—	—	
Frankl 2	2.23	(0.86, 5.74)	0.10
Frankl 3	2.06	(0.80, 5.22)	0.13
Frankl 4	1.74	(0.66, 4.58)	0.3
Tooth Type			
First primary molar	—	—	
Second primary molar	0.80	(0.44, 1.47)	0.5
Patient age			
≤ 6	—	—	
> 6	1.65	(0.96, 2.86)	0.071
Survival time			
≤ 28	—	—	
> 28	17.4	(8.57, 40.6)	<0.001

[1]OR = Odds Ratio, CI = Confidence Interval

Table 2. Overall distribution of selected patient characteristics

Variable	N = 502
Method of fabrication	
Lab fabricated	370 (74%)
Chairside	132 (26%)
Quadrant	
Upper right	119 (24%)
Upper left	99 (20%)
Left lower	143 (28%)
Lower right	141 (28%)
Frankl score	
Frankl 1	53 (11%)
Frankl 2	142 (28%)
Frankl 3	175 (35%)
Frankl 4	132 (26%)
Tooth type	
First primary molar	405 (81%)
Second primary molar	97 (19%)
Treatment modality	
Chair with N2O	385 (77%)
Sedation	84 (17%)
General anesthesia	15 (3.0%)
Chair without N2O	15 (3.0%)
Papoose	2 (0.4%)
Knee to knee	1 (0.2%)
Outcome	
Failure	96 (19%)
Success	406 (81%)
Patient age	
Median (IQR)	6 (5, 7)
Survival time	
Median (IQR)	28 (17, 38)

Discussion

The data revealed that the overall treatment success rate is high and there was a trend of even higher success rates among patients that had a first primary molar replaced with a band and loop. The odds of treatment success increased by 1.5 with chairside band and loops, but this difference was not found to be statistically significant.

The most common reason for treatment failure was failure of the cement, or the band and loop becoming dislodged. This could be due to a variety of factors, including incorrect band size, poor isolation during cementation and improper placement. While the reasons for treatment failure were similar to previous studies of band and loop space maintainers, the frequency was different. This study found that cement failure occurred in 53% of failures. Previous studies found it occurred in 32.8% of failures. This study revealed that 10% of failures were due to broken appliances, where others found 49.6% of failed appliances broke.[8] These differences could be due to newer materials as previous studies were completed in 1998. The success rate for this study was very high, with 81% of space maintainers lasting their expected lifetimes or being removed due to normal eruption of succedaneous teeth. Previous studies show survival rates much lower, 63% .[5] This could be due to differences in studied patient populations and materials used. Survival times for this study were higher than previous studies as well. Previous studies had a mean survival time of 13 months and this study shows a median survival of 28 months.[8] In all previous studies, only lab fabricated band and loops were analyzed. Analyzing chairside and lab fabricated band and loops could have contributed to the higher survival time and success rates, however this analysis is exploratory and more research needs to be done to assess how fabrication method affects survival and success.

Conclusion

The main limitation in this study is the low sample size and all findings are specific to the population studied and cannot be generalized to the general pediatric population. We are not able to definitively state which method of fabrication is better, chairside or lab fabricated. However, it can be concluded that success rates for all band and loops is high and complication rate is low. Band and loop space maintainers continue to be the gold standard for maintaining space of premature lost primary teeth. Practioners can opt to use either method according to other factors such as desired number of treatment appointments and ability of patient to tolerate treatment.

More research needs to be completed to analyze the effects of fabrication methods on success rates of band and loop space maintainers.

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