



Comparison of the effect of different lingual arch space maintainers on oral health in children- A randomised clinical trial

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ABSTRACT

Background: Fixed functional space maintainers are found to be associated with increased plaque accumulation when compared to removable space maintainers or conventional fixed space maintainers.

Aim: To evaluate the effects of different lingual arch space maintainers on the oral health of children.

Materials & Methods: 20 patients selected between the ages 7-9 for whom fixed lingual arch space maintainers were indicated.

Group 1 (n=10)- Conventional lingual arch space maintainer, Group 2 (n=10)- Functional lingual arch space maintainer. The plaque index (PI), gingival index (GI), records were obtained at four time periods; T1: before insertion of appliance, T2: 3 months after insertion, T3: 6 months after insertion, T4: 12 months after insertion.

Results: The results depicted that in both functional and conventional lingual arch groups plaque index did not differ significantly during intergroup comparison but intragroup comparison for both groups at different time intervals showed increased plaque accumulation (p value-0.001), especially around the band region of both the appliances and beneath the acrylic resin in the functional group. The changes in the gingival index did not differ significantly between the conventional and functional group at any of the measurement periods (p > 0.05).

Conclusion: Fixed space maintainers lead to increased plaque accumulation around the banded molars in children. After a regular follow up of 1 year, increased plaque accumulation was seen in both groups especially after 6 months and 12 months. Proper maintenance and strict oral hygiene measures must be practised during the use of these appliances.

Keywords: *Functional lingual arch, space maintainer, space loss, premature loss, functional space maintainer*

INTRODUCTION

Space maintainers are used to maintain the edentulous space created by a premature loss of a tooth in children. These devices are important as the loss of a primary tooth often leads to impacted teeth, ectopic eruptions and other complex problems in the permanent dentition which would then require an orthodontic treatment. Creation and subsequent maintenance of adequate space might allow the succedaneous teeth to erupt normally into position without further treatment. Maintaining adequate space is possible with the help of space maintainers. Space maintainers can be broadly classified as removable and fixed (1). There are several types of fixed space maintainers, including lingual arch, band-and-loop, crown-and-loop, and distal shoe. Each type of space maintainer has its own design and may have a different effect on gingival health.

However, fixed space maintainers can have an increased impact on the gingival health of children (2). The lingual arch space maintainer is a type of fixed space maintainer used in pediatric dentistry. It is typically used to maintain space in the lower arch when one or more primary molars have been lost prematurely unilaterally or bilaterally. The lingual arch space maintainer is indicated only in children with completed erupted lower permanent incisors.

The lingual arch space maintainer is made of a 19 gauge wire that is shaped like an arch and is placed on the lingual side of the lower teeth. The wire is attached to bands that are cemented to the anchor teeth; permanent lower first molars. The wire extends across the arch, connecting the bands on the left and right sides of the arch (3).

The lingual arch space maintainer is designed to prevent the adjacent teeth on either side of the missing tooth from drifting towards the edentulous space. By maintaining the space, this space maintainer helps to prevent crowding and malocclusion in the future.

Recent modifications of lingual arch include functional lingual arch; that is, with an artificial pontic attached. The idea of using artificial pontics in edentulous span was to improve masticatory efficiency in children along with

space maintenance. The advantage of using wire framework underneath the artificial pontic was to give support to artificial pontics and also wire framework helps to distribute occlusal forces applied on pontics while mastication as it is soldered to the main component of conventional lingual arch space maintainer. This improves the masticatory efficiency and the child's oral health optimally (3).

Our team has extensive knowledge and research experience that has translated into high quality research (11-19). The aim of this study was to find out the effect of different fixed lingual arch space maintainers on oral health in children. This paper will also discuss strategies to minimise gingival problems associated with fixed space maintainers.

MATERIALS AND METHODS

Study Design

The study is a randomised study design clinical trial that followed the standards published by Consolidated Standards of Reporting Trials.

Sample Size Calculation

The sample size for the present trial was based on the Using G*Power 3.1.9.2 software for power analysis indicated that we required a total of 20 participants requiring lingual arch space maintainer. With a power of 95%, the sample size was calculated to 10 per group.

Recruitment Of Participants

This randomized controlled trial was carried out on 20 children in the age group of 7-9 years old. The children were chosen for this study based on the predetermined inclusion and exclusion criteria. Prior to their enrollment, when the patient was found suitable for the study, a written informed consent was obtained from the parents or the accompanying guardians. The parents were also explained in detail regarding the nature of the study, treatments given and follow up period, advantages and risks that may present during the treatment. The parents or the guardians were also made aware that they were free to withdraw themselves from the study without any undue

effect of the course of the treatment required. Each step of the randomized trial was done and reported based on the ‘CONSORT’ guidelines framed for randomized clinical trials.

Inclusion Criteria

- Children aged 7-9 years with premature loss of primary molar or molars unilaterally or bilaterally.
- Children requiring space for a permanent tooth to be maintained for two years or longer.
- Children with permanent lower incisors and lower permanent first molars erupted.
- Extraction site with no space loss.
- Cooperative patient who had the behavioural rating of “positive” or “definitely positive” score according to the Frankl behaviour classification scale.
- Parents/Guardians with whom after explaining the full details of the treatment procedure and its possible outcomes, discomfort, risks, and benefits, gave their signed consent.
- Radiological criteria
- Presence of succedaneous tooth bud.
- Presence of more than 1mm bone overlying the succedaneous tooth germ.

Exclusion Criteria

- Children below 7 years whose lower permanent incisors have not erupted completely.
- Children whose lower permanent first molars have not erupted completely.
- Radiographs of the extraction region showing one third of the root of the succedaneous tooth already calcified.
- Space available is greater than the space needed for the permanent successor as indicated radiographically.
- When there is no bone observed roentgenographically overlying the erupting permanent tooth, which suggests that the tooth erupts in a few months.
- Parents not willing to give consent for placing a space maintainer in their child’s mouth.

Clinical Procedure

Dental plaque index

Dental plaque was measured using a sterile periodontal probe according to Silness and Loe (4) around the banded anchor teeth. It was evaluated at baseline (prior to placement of the space maintainer), at 3 months, 6 months and 12 months post insertion of the appliance. Scoring was from 0-3 and was based on the Silness and Loe plaque index where score 0 indicated absence of microbial plaque and Score 3 indicated large amount of plaque in the sulcus or pocket along the free gingival margin. (Figure 1)

Silness-Loe Plaque Index	Criteria
0	Absence of microbial plaque
1	Thin film of microbial plaque along the free gingival margin
2	Moderate accumulation with plaque in the sulcus
3	Large amount of plaque in sulcus or pocket along the free gingiva margin

FIG 1: Silness and Loe (1964) plaque index used to assess the amount of plaque accumulation around the banded teeth in both test and control groups.

Gingival index

Gingival index (GI) was used to assess the presence/absence and severity of gingivitis. The soft tissue surrounding the banded anchor tooth was divided into two areas of distal papilla and mesial papilla. The gingival color at these areas was assessed in the conventional lingual arch group and similarly in the functional lingual arch

group at baseline, 3 months, 6 months and 12 months follow up periods. The scoring was from 0-3 where score 0 indicated normal gingiva; natural coral pink gingiva with no evidence of inflammation and score 3 indicated severe inflammation; marked redness, edema or ulceration, tendency to bleed spontaneously. (Figure 2)

Scores	Gingival Status	Criteria
0	Normal gingiva	Natural coral pink gingival with no e/o inflammation
1	Mild inflammation	Slight changes in color, slight edema. No bleeding on probing
2	Moderate inflammation	Redness, edema and glazing. Bleeding upon probing
3	Severe inflammation	Marked redness and edema/ulceration/tendency to bleed spontaneously

FIG 2: Silness and Loe (1963) gingival index used to assess the amount of plaque accumulation around the banded teeth in both test and control groups.

Statistical Analysis

To compare Plaque Index scores between test and control groups independent samples Mann Whitney U test is applied. To compare Plaque Index values between time points Related-Samples Friedman's Two-Way Analysis of Variance is used. To analyse the data SPSS (IBM SPSS Statistics for Windows, Version 26.0, Armonk, NY: IBM Corp. Released 2019) is used. Significance level is fixed as 5% ($\alpha = 0.05$).

RESULTS

This study is a double blinded randomized trial conducted from 2021 to 2022 in the Department of Pediatric and Preventive Dentistry, Saveetha Dental College and Hospitals, Chennai. The aim of this study was to compare the effect of different lingual arch space maintainers on oral health in children. The present study included an equal distribution of 10 boys and 10 girls between the age groups of 7-9 years. In each group, 10 children were included and all the outcomes were assessed at baseline, 3 months, 6 months and 12 months follow up.

Gingival Index

The changes in the gingival index did not differ significantly between the regions in the conventional and functional group at any of the measurement periods ($p > 0.05$), GI was score 0 in 9/10 participants before receiving the lingual arch space maintainer in group 1 and 2. In 3 months and 6 months after insertion of the appliance GI score was 1 in 8/10 participants in conventional lingual arch group and functional lingual arch group. 12 months after receiving the space maintainer GI was scored 1 in 9/10 participants in both groups.

Plaque Index

The inter-group comparisons showed no statistically significant difference between both the groups. (p value >0.05) Independent samples Mann Whitney U test is applied to compare plaque index scores between test and control groups. Pre op, 3 months, 6 months and 12 months evaluation shows no statistically significant difference between both groups. (Table 1) Whereas, the intra-group comparisons showed a statistically significant difference at

different time intervals, from baseline till 12 months. (p value-0.001) (Table 2)

This depicts that in both functional and conventional lingual arch gingival index and plaque index did not differ significantly but both

groups caused increased plaque accumulation seen at different time intervals, especially around the band region of both the appliances and sometimes beneath the acrylic base in the functional lingual arch group.

TABLE 1: Independent samples Mann Whitney U test is applied to compare plaque index scores between test and control groups. Pre op, 3 months, 6 months and 12 months evaluation shows no statistically significant difference between both groups. (p value= >0.05)

Plaque Index (Silness and Loe,1964)		Groups		
		Functional lingual arch	Conventional lingual arch	p value
Pre op Plaque Index	N	10	10	1.000
	Median	.00	.00	
	1st Quartile	.00	.00	
	3rd Quartile	.00	.00	
	Mean	.00	.00	
	Std Dev	.00	.00	
3 months Plaque Index	N	10	10	.739
	Median	1.00	1.00	
	1st Quartile	1.00	1.00	
	3rd Quartile	1.00	1.00	
	Mean	1.20	1.10	
	Std Dev	.42	.32	
6 months Plaque Index	N	10	10	.481
	Median	2.00	1.00	
	1st Quartile	1.00	1.00	
	3rd Quartile	2.00	2.00	
	Mean	1.60	1.40	
	Std Dev	.52	.52	
12 months Plaque Index	N	10	10	1.000
	Median	1.50	1.50	
	1st Quartile	1.00	1.00	
	3rd Quartile	2.00	2.00	
	Mean	1.50	1.50	
	Std Dev	.53	.53	

TABLE 2: Intra-group comparisons for plaque index from baseline, 3 months, 6 months and 12 months showing statistically significant difference in both groups at different time intervals. (p value <0.05)

Functional and Conventional lingual arch	Test Statistic	Sig.
Pre op Plaque Index-3 months Plaque Index	-1.650	.000
Pre op Plaque Index-6 months Plaque Index	-2.175	.000
Pre op Plaque Index-12 months Plaque Index	-2.175	.000

DISCUSSION

When primary teeth are lost prematurely due to various etiological factors such as dental caries

(5) and other causes such as trauma, ectopic eruption, congenital disorders, and arch length deficiencies causing resorption of primary teeth

(6) they cause space loss. To prevent this space loss from occurring, space maintainers are utilised to preserve the space needed for the eruption of permanent successors. These space maintainers can be broadly classified as fixed space maintainers (FSM) and removable space maintainers (RSM) (1). The lingual arch space maintainer is one such example of a fixed space maintainer, it is not only an appliance for maintaining space for the eruption of the permanent teeth, but also an important way to resolve marginal crowding, by maintaining arch length, width and perimeter in the mandibular arch (7) (8)

Lingual arch is helpful for preserving lower arch dimensions, tooth position, and is efficient enough to preserve the space of lost primary teeth. But In spite of its widespread use, the major drawback is it is unsuccessful to restore masticatory function in place of lost primary teeth. Hence, new modifications in the lingual arch designs were introduced and in this study a novel functional lingual arch is used (3)

The purpose of utilising artificial pontics in edentulous spans was to increase children's masticatory effectiveness and space maintenance. The advantage of using wire framework underneath the artificial pontic was to provide support for the artificial pontics. In addition, wire framework aids in dispersing occlusal forces applied to the pontics during mastication because the bands are soldered, much like the banded teeth of conventional lingual arch space maintainers.

All fixed space maintainers such as lingual arch, band and loop, often include placement of a band; custom made or prefabricated around the abutment tooth. The band may be welded with wires of various shapes, depending on the type of space maintainer. The band and wires of these appliances frequently lead to plaque buildup.

Due to poor oral hygiene habits and subsequent plaque buildup after the insertion of these appliances, the usage of FSMs might potentially result in some periodontal alterations and the possibility of gingival irritation. Therefore, in this study we assessed the gingival and plaque

index only in fixed lingual arch space maintainers.

Plaque index

Space maintainers are known to cause increased plaque accumulation in children leading to poor gingival health (2) especially around the bands in the conventional lingual arch design. In this novel functional lingual arch design plaque accumulation was noticed even beneath the artificial pontic region. Although the results showed no statistically significant difference in plaque accumulation from baseline to 12 months in both groups but in the intra-group multivariate analysis there was a statistically significant difference found at different time intervals. (Table 2)

Gingival index

The GI uses the following scoring system: 0 = normal gingiva;

1 = mild inflammation: slight change in colour, slight edema, no bleeding on probing;

2 = moderate inflammation: redness, edema, and glazing, or bleeding on probing;

3 = severe inflammation: marked redness and edema, tendency toward spontaneous bleeding, ulceration based on the scoring given by Silness and Loe in 1963. In this study no significant difference in gingival index scores was found in both the groups as the banding process was similar; prefabricated bands used for molars in both groups. No gingival inflammation was seen around the edentulous span where the artificial pontic with acrylic base was attached. Score 1 GI was seen in 8/10 participants in both groups and similar score 1 was seen in 9/10 participants after 12 months in both groups.

Studies with findings similar to our study included findings of which suggest that the presence of, and increase in microbial population in the oral environment represents a potential risk for periodontal pathologies during the usage of fixed space maintainers (2) .

Souto et al, 2008 (9) also found significant correlation between *E.faecalis* & plaque

accumulation leading to gingivitis in children with space maintainers.

Boyd and Baumrind, 1992 (10) compared the periodontal status of bonded and banded molars before, during and after treatment with fixed orthodontic appliances and found more plaque accumulation around banded molars.

In this study, it was found that plaque accumulation was seen in both groups, especially after 3 months. Mainly around the bands and beneath the acrylic resin of the functional space maintainer group.

The effects of removable and fixed space maintainer appliances on periodontal health have been studied previously but considering the recent advances and modifications with lingual arch space maintainers, the effect of different lingual arch space maintainers on gingival health has not been studied before thus highlighting the novelty of this study.

Future scope

Various different removable & fixed space maintainers & their effect on oral health in children can be studied.

CONCLUSION

Fixed space maintainers lead to increased plaque accumulation around the banded molars in children. After a regular follow up of 1 year, increased plaque accumulation was seen in both groups especially after 6 months and 12 months. Proper maintenance and strict oral hygiene measures must be practised during the use of these appliances.

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