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Original Article

Failure Rates of Orthodontic Molar Bands and Buccal Tubes- A Comparative Study

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Abstract

Background: *The terminal attachments of fixed appliances placed on molar teeth can take the form of a cemented molar band or a bonded molar tube. Concerning the failure rates, whether to band molars or bond them during Orthodontic treatment has now become a dilemma to many Orthodontists.*
Objective: *The aim of this study is to further clinical evaluation of orthodontic molar banding and bonding buccal tube in regards of their failure rates.*
Material and methods: *This study was carried out at the Department of Orthodontics and Dentofacial Orthopedics, Dhaka Dental College & Hospital, Dhaka. 236 first molar teeth from 59 patients going to start fixed orthodontic treatment selected by inclusion and exclusion criteria were included in this Randomized Control Trail and were assigned with molar band and buccal tube randomly in the contra-lateral quadrants using cross-mouth technique. First time and subsequent failures of molar attachments were noted up to nine months from the starting of fixed orthodontic treatments.*
Results: *1st time failure rates for bonded molar tubes were 21.2% and molar bands were 16.9% (p = 0.483).*
Conclusion: Buccal molar tubes have more failure rates than molar bands.

Key wards: *Band / bond failure rates, Buccal tubes, Molar bands.*

Introduction

The terminal attachments of orthodontic fixed appliances are placed on molar teeth; most commonly the first permanent molars. These attachments can take the form of a cemented molar band or a bonded molar tube. After the introduction of acid etching of enamel by Bunnocare[1] in 1955, orthodontic brackets to incisors, canines, and premolars is now carried out routinely as part of fixed appliance treatment.[2-4] Bands, however, remain the most common means of attaching components to molars as it yields proper retention and resistance to orthodontic forces and bonding of brackets to molar teeth is a less frequently adopted practice,[5,6] as bonding molars was found to be problematic and technique sensitive.[7,8]
As adhesive systems evolved, bonding attachments to molars has become a routine procedure, reducing the duration of clinical care and facilitating oral hygiene.[9] Current data, however, indicate that routine bonding of first or second permanent molars has almost doubled in recent years.[10-12]
The bonded buccal tubes have higher failure rates than molar bands[13-20] causing emergency visits, lengthening of the treatment or patient dissatisfaction. Though another study shows there is no clinically significant difference in failure rates of banded and bonded appliances.[21] Because of lower failure rates and higher reliability, many orthodontists tend to favour molar bands.
However, the previous studies of molar bands and bonds are of short term and attachment failure rates are in conclusive which necessitates further studies.[22, 23]

Therefore, the aim of this study was to clinically compare the failure rates associated with molar banding and bonding teeth with buccal tubes during orthodontic treatment

Materials and Methods

This was a longitudinal, prospective study by Randomized Controlled Clinical Trial was done in the Department of Orthodontics and Dentofacial Orthopaedics., Dhaka Dental college and Hospital. Mirpur-14, Dhaka, Bangladesh. From January 2021 to September 2021. Ethical clearance was obtained from Dhaka Dental Collage Ethical Board.
Using the Simple random sampling, patients were selected from Department of Orthodontics and Dentofacial Orthopedics, Dhaka Dental College & Hospital to begin treatment with fixed orthodontic appliances. Sample was screened with the inclusion and exclusion criteria. No attempt was made to match the patients for age, sex or malocclusion to ensure a representative sample of patients. All the first molar teeth of the patients were included in the study and allocated molar bands and buccal tubes in contra-lateral quadrants with the cross-mouth technique using simple random sampling by lottery. The operator and patient remained blind to the attachment type until after the consent and registration procedures. 236 first molars teeth from fifty-nine patients, about to begin orthodontic treatment with fixed appliances were included in the study.
Sample size was determined using the formula, $n=(Z\alpha + Z\beta)^2 \times (\sigma 12 + \sigma 22)$

The inclusion criteria for the study were as following
1. Patients / parents giving informed written consent was included in this study.
2. Patients age group-13-25 years
3. Patient starting orthodontic treatment with upper and lower fixed appliances (pre-adjusted edgewise)
4. Patients with stable mental health condition and no significant physical problems.
5. Patients with clinically and radiological good periodontal tissues and good oral hygiene.

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Exclusion criteria

The exclusion criteria for the study were-

1. Lack of patient/parent's consent
2. Absence of or planned extraction of first permanent molars
3. First permanent molars with evidence of demineralization or hypoplastic enamel
4. Occlusion likely to deboned bonded attachments
5. Occlusions that require extra-oral or intra-oral anchorage reinforcement (headgear, palatal arch, lingual arch) or precluded the use of bands, e.g., use of a quad-helix appliance, trans palatal arch, Nance appliances etc.
6. Patients mentally unstable and non-co-operative.
7. Patient with systemic diseases
8. Pregnant women and lactating mother.

Grouping

(A) Group A (Experimental group - After randomization by simple random sampling 118 molars were bonded with Buccal tube)-118

(B) Group B (Control group – and another 118 molars were banded with molar band)– 18

Materials and equipment used: Orthodontic Molar Bands, Orthodontic buccul tubes, Tooth polishing paste- Pumice, Dental Micromotor with polishing brush, Glass- Ionomer cement- GC Fuji, Etching gel (37% Orthophosphoric acid) , Orthodontic bonding Adhesive & Primer (Enlight), Height gauge, LED light curing unit ,Periodontal probe (UNC 15), Mouth mirror, Patient record book ,Data entry sheets, Scale, Rule.

Study procedure

A data collection sheet and a consent form were prepared, sample was selected on the basis of inclusion and exclusion criteria, relevant investigations were done.

Clinical sequence

A standardized procedure was followed for each patient as follows:

• Baseline variables recorded including patient age, gender, occupation and malocclusion type.

• All attachments were placed in their correct anatomical position on the tooth. Upper and lower fixed appliances (Edgewise prescription brackets) were then placed using standard technique and routine orthodontic treatment mechanics was followed.

• All patients were instructed to avoid hard and sticky foods. They were requested to maintain proper oral hygiene measures by regular tooth brushing, using of interdental brushes and mouthwash for the treatment duration.

Figure 1: Pre and post bonding and banding of molar attachment and prescription edgewise brackets

• At review appointments, outright bond or cement failure resulting in frank loss of the attachment or attachment loosening due to partial bond or cement failure, both were recorded as failure.

Methods of data collection, processing and statistical analysis: To avoid inter examiner variability, all the data were collected by a single operator. All the measured parameters were analyzed through Statistical Package for Social science software (SPSS). Comparison of 1st time Fracture of two groups of molar attachments was done by Fishers Exact test. The test of significance was calculated and p value <0.05 was accepted as level of significance.

Results

Two hundred thirty-six first molar teeth from fifty-nine patients were included in the study and after randomization experimental and control group received 118 molars in each group. There was no drop out or discontinuation of treatment within nine months of study that increased the ability to detect a clinically relevant difference between the two trial arms and also increased the power of the study. Baseline demographic and clinical characteristics are presented in **Table 3.1**

Table 1: Distribution of patient's characteristics and baseline variables (N=59)

Variable	Frequency	Percent (%)
Sex distribution of patients		
Male	10	16.9
Female	49	83.1
Age distribution of patients (in years)		
13-15	15	25.4
16-18	16	27.1
19-21	15	20.3
22-25	16	27.1
Occupation of the patients		
Student	51	86.4
Service	5	8.5
Housewife	3	5.1

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Types of malocclusions		
Class I with spacing	18	30.5
Class I with crowding	23	39.0
Class II Div 1	9	15.3
Class II Div 2	2	3.4
Class III	7	11.9

Data were expressed as Frequency & Percentage.

Failure rates & Survival of molar attachments

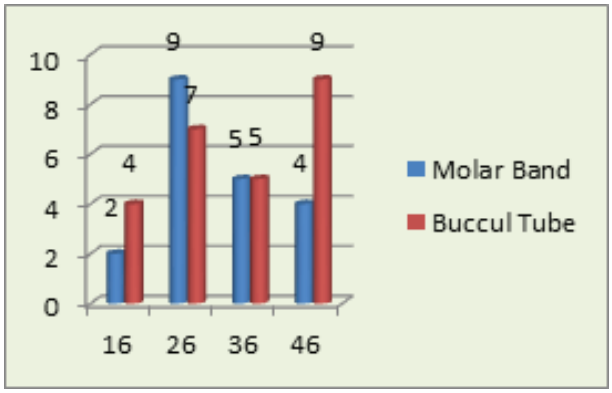

Figure 2: 1st time Failure of molar attachments at different 1st molar teeth(N=236)

During the nine months of follow-up, highest no of first-time failure for molar band group was observed at tooth no 26 (9 molars) followed by 36 (5 molars), 46 (4 molars) and 16 (2 molars) whereas in buccal tube groups highest no of failure occurred at tooth no 46 (9 molars) followed by 26 (7 molars), 36 (5 molars) and 16 (4 molars)

Table 2: Comparison of 1st time Fracture of two groups of molar attachments by Fishers Exact test (N=236)

Molar attachment	1st time Fracture of molar attachment			Total	Significance
	0-60	121-180	181 and above		
Molar band	10 50.0%	4 20.0%	6 30.0%	20 100.0 %	Fishers Exact test=1.580 df=2 p=0.483
Buccal Tube	17 68.0%	3 12.0%	5 20.0%	25 100.0 %	
Total	27 60.0%	7 15.6%	11 24.4%	45 100.0 %	

Data were expressed as frequency and percentage. Statistical analyses were done by Fishers Exact test. The p values < 0.05 was accepted as level of significance. df = Degree of freedom

During the nine months of follow-up, 20 out of 118 (16.9%) molar band showed failure compared to 25 out of 118 (21.2%) of bonded molars. Maximum occurrence of failure was observed within first 60 days - for bands 10 (50%) and bonds 17 (68%). Comparison by Fishers Exact test between two groups was not significant (P=0.483) .

Table 3: 2nd time Fracture of molar attachments. (N=236)

Molar attachment	2nd time Fracture of molar attachment			Total
	0-60	121-180	181 and above	
Molar band	-	-	-	-
Buccal Tube	0	1	1	2
	0%	50.00 %	50.0%	100.0 %
Total	0	1	1	2
	0%	50.0%	50.0%	100.0 %

There were only two occasions of second time failure in the buccal tube groups and no subsequent failure observed within nine months period. In molar bands group no second time failure was reported.

Table 4: Means for Survival time of molar attachments (N=236)

Molar_att	Mean[a]			
	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Molar band	206.500	32.452	142.893	270.107
Buccul Tube	137.720	17.641	103.144	172.296
Overall	184.289	20.532	144.046	224.532

The estimates were done in the no. of days. This demonstrates molar band were less likely to fail during fixed appliance treatment with mean survival time about 206 days. Buccal tubes were more likely to fail with mean survival time about 137 days which was much less than that of molar bands.

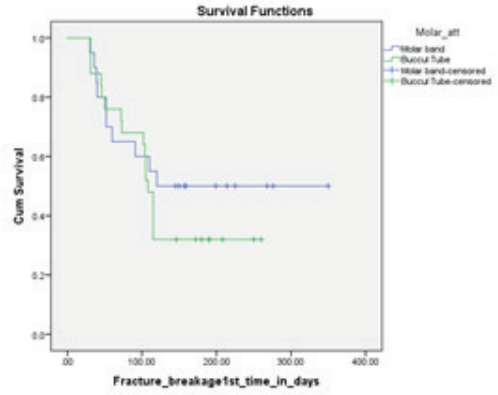

Figure 3: Survival analysis of molar band and buccal tubes (N=236)

Survival functions for the two attachment types were done by Cox proportional hazards survival analysis

The total study time for each patient was 9 months. The minimum time to attachment failure for molar band was 30 days and the maximum time was 268 days.

For buccal tube minimum attachment failure was reported on 31 days and maximum was on 260 days.

The graph shows more survivability of molar bands than buccal tubes.

Discussion

General Discussion

The success of every orthodontic therapy still relies on four old-fashioned key components: the diagnostic and clinical skills of the orthodontist, favorable biologic characteristics of the patient (bone turnover, craniofacial morphology, stage of growth, etc.), patients' willingness to cooperate during treatment and to follow all treatment recommendations (i.e., patient compliance), and the use of an appropriate and effective orthodontic appliance.[24] In other words, factors such as optimizing clinical (chair) time and patient comfort, as well as preserving the integrity of dental structures, are paramount to ensure the effectiveness of orthodontic treatment

Orthodontic pain influences patient compliance. In order to possibly reduce the painful response to orthodontic treatment, and in the attempt to enhance patient compliance, clinicians should take into consideration a set of procedures that can be easily and safely performed and incorporated to routine clinical settings other than simply always resorting to the prescription of pain medications.[24]

Plaque retention surrounding orthodontic appliances leads to enamel decalcification and periodontal disease,[25] therefore, the employment of mechanics that facilitate oral hygiene measures performed by the patients to reduce plaque accumulation is important. Orthodontists have been examining the need for bonding molar attachments. The advantages are plenty: it has been theorized in the literature that the very act of placing separators tends to sensitize the periodontal ligament, setting in motion the cellular processes responsible for orthodontic tooth movement and possibly compromising anchorage, even before loading in extraction treatment. The initial pain on placement of separators requires medication and, in cases of anticipated bacteraemia, antibiotic cover may be necessary. Economy of space in non- extraction treatment is also crucial.

Loose attachments lower morale, reduce profitability and wreak havoc with scheduling.[26] As regards the duration of treatment; a recent study[27] showed that about 30% of the variation in treatment time in adult patients was related to orthodontic appliance failure. Frequent rebonding and/or recementation of attachments often interferes with orthodontic mechanics, eventually increasing treatment time.[18,27] Given the advantages of bonding attachments for posterior teeth, such as reduced clinical time, esthetics, and lower risk of periodontal problems and bacteremia, most scientific research has been conducted to assess the efficiency of bonding of buccal tubes in the molar region; but there were differences in opinions.

Discussion on the Result

Failure rates of molar attachment

During the nine months of follow-up, 20 molar band out of 118 (16.9%) failure for 1st time compared to 25 bonded molar tubes out of 118 (21.2%). There was no special discrimination observed regarding upper arch and lower arch failure. Maximum occurrence of failure was observed within first 60 days - for bands 10 (50%) and bonds 17 (68%). Though the attachment failures were more for the buccal tube groups analysis using the Fishers Exact test to compare molar band and buccal tube groups showed no statistically significant differences for the first time (P=0.483) There were only two occasions of second time failure in the buccal tube groups and no subsequent failure observed within nine months period. In molar bands group there was no second time failure reported.

The multicenter retrospective study of Millett DT et al[8] found the median survival time of 1190 tubes bonded to first permanent molars in 483 patients were 699 days with an overall failure rate of 21%. The failure rate is similar for the bonded tubes in present study.

Randomized Control Trail by Carlos Flores-Mir et al[9] shown that the failure of molar tubes bonded with either a chemically-cured or light-cured adhesive was considerably higher than that of molar bands cemented with glass ionomer cement which doesn't commensurate with present study.

A Multi-center randomized clinical trial by Mariyah Nazir et al[13] found that the first-time failure rate for molar bonds was 18.4% which is closer to the study result and 2.6% for molar bands which is much less from present study and comparison was highly significant (P=0.0002) in present study which is not. Survival analysis demonstrated molar bonds were more likely to fail compared with molar bands.

In a Cochrane review of Millett DT et al[18] from the two well-designed and low risk of bias trials also shown that the failure of molar tubes bonded with either a chemically-cured or light-cured adhesive was considerably higher than that of molar bands cemented with glass ionomer cement which is also dissimilar to the study.

Another randomized controlled clinical trial by Philip Banks et al[19] revealed first-time failures of bands=18.8% which is nearer to present study but the bonds failure was much higher 33.7 % and the comparison between the groups were significant which is not in the study.

In a Cohort study conducted on 178 orthodontic patients by Rahul Gupta et al[20] recorded fifty-six bond failures with a mean of 0.62 failure rate and tubes breakages were comparatively more than bands failure which is dissimilar to the study.

Another split-mouth randomized clinical trial of 32 adult patients by Valйria Jacques Oeiras et al [21] found that survival rate of bonded molars was not statistically different from that of banded molars (log-rank test, p = 0.97). Bonded upper molars yielded a survival rate of 81.25% (26 out of 32) compared to 71.87% (23 out of 32) for banded upper molars. The survival rate was 66.66% (18 out of 27) for banded lower molars and 59.25% for bonded lower molars (16 out of 27). This result is commensurate and similar to the findings of present study.

In the present study molar band failure is comparatively more than other previous studies and the comparison is non-significant. The reason may be as to moisture control during banding which is vital for the manipulation of glass ionomer cements, poor manufacturing of molar band with poor welded tubes. Insignificant comparison results may due to fact that the biomechanics applied in the treatment procedures like -use of sliding mechanics for space closure, use of mini-screws and careful use of distal end cutter at buccal tube that enables less failure of bonded tubes. In addition, orthodontic resident usually works without a chairside assistant, which impairs moisture control during banding and bonding procedures. Previous studies have also shown that the operator affects the bond strength of molar tubes.[13,27]

More failures with tubes could be possibly because of moisture contamination, poor adaptation on the buccal surface of the tooth, heavy occlusal force or occlusal interference of the opposing tooth. Other reasons for bracket bond failure of posterior teeth may be different etching patterns produced on different teeth by acid conditioning[28] and inadequate adaptation of the bracket to the tooth surface due to attrition by malocclusion and the diverse morphology of buccal grooves.[29]

Findings of this research will be helpful for the clinicians in orthodontics for their daily practices to decide proper molar attachments in fixed labial orthodontic treatment as well as for the researchers who will conduct future longitudinal studies to assess the uses of either molar bands or buccal tubes in orthodontic treatment modalities.

Limitations of the Study

Attachment failure depends on material factors (bonding technique, bonding material, etching technique, adhesives type, types of molar band and tubes & their manufacturer quality, bracket base design and size etc.) and tooth related factors (enamel morphology, fluorosis) and environment factors like moisture control, masticatory force, occlusal clearance & other miscellaneous factors. But in this study, all the material related and other factors was not strictly adhered which may have influence on attachment failure results. Nevertheless, the designated clinical procedure followed in the study reflects the results almost similar to previous studies.

The study is of nine months clinical periods which may not depict complete failure behavior of molar attachment.

Conclusions

• Buccal molar tubes have more failure rates than molar bands during nine months of orthodontic treatment

• The uses of properly fitted molar bands with proper cementation are recommended when molar bands are selected.

Finally, based on the findings of this present study Buccal molar tubes have lesser patient pain and discomfort, reduced periodontal deterioration but little higher failure rates.

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