Original Article

Comparison of Shear Bond Strength of Different Methods of Orthodontic Bonding

Iqra Gaffar and Zubair Hassan Awaisi

ABSTRACT

Objective: The study objectives to assess the impact of deproteinization with 5.25% sodium hypochlorite (NaOCl) before acid etching on the shear bond strength of orthodontic brackets adhered to fluorosed teeth.

Study Design: Randomized clinical trial study

Place and Duration of Study: This study was conducted at the Orthodontic Department of the Nishtar Institute of dentistry, Multan from June 2020 to Dec 2020.

Methods: The included 60 fluorosed teeth were collected in 6 months. These premolars were extracted for orthodontic purposes from patients seeking fixed orthodontic treatment at the Department of Orthodontics. Upon completion of the required sample, the 60 teeth were divided into two groups consisting of 30 teeth each. In the control group (Group I), brackets were bonded to 20 teeth using composite resin without prior deproteinization, and the bonding process involved etching the teeth with 37% phosphoric acid. In the experimental group (Group II), brackets and fluorosed teeth were bonded after 5.25% NaOCl deproteinization using composite resin.

Results: The mean megapascals (MPa) in Group I and Group II was 9.59±1.06 and 13.34±2.58, respectively. MPa was higher in Group II than the Group I, and this difference was statistically significant, ($p<0.001$). (Table. I).The modified ARI score 3 was most common in Group II and Group I, 9 (60.0%) and 6 (40.0%), respectively.($p=0.748$).

Conclusion: Prior to acid etching, the use of 5.25% NaOCl for deproteinization significantly enhances the shear bond strength of brackets adhered to fluorosed teeth, offering a convenient and effective option in orthodontic bonding procedures for such cases.

Key Words: Shear Bond Strength, Orthodontic Bonding, NaOC, deproteinization, Brackets

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INTRODUCTION

The shear bond strength (SBS) of orthodontic bonding refers to the resistance of the adhesive bond between the orthodontic bracket and the tooth surface to shear forces[1]. Various methods and materials are used in orthodontic bonding, and researchers often conduct studies to compare their shear bond strength[2]. Light-cured adhesives are commonly used in orthodontics. They are applied to the tooth surface, and the orthodontic bracket is then positioned and cured with a light source. Similarly, chemically cured adhesives are cured through a chemical reaction without the need for a light source[3,4].

Department of Orthodontics, Nishtar Institute of Dentistry, Multan.

Correspondence: Dr. Iqra Gaffar, Post Graduate Resident (PGR) of Orthodontics, Nishtar Institute of Dentistry, Multan.
Contact No: 0345 0356084
Email: iqraghaffar1@gmail.com

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The importance of bond strength in fix appliance at active orthodontic treatment was emphasizing the need for successful bonding to ensure good treatment progress[5]. The typical duration of active orthodontic treatment with fixed appliances is mentioned as 2.5–3 years. Efforts are continuously made to improve bond strength, particularly in challenging situations such as bonding to different materials like gold, porcelain, and amalgam[6]. In orthodontic treatments, brackets are often bonded to the tooth surface using an adhesive that requires proper etching of the enamel to ensure a strong bond[7]. However, in the case of fluorosed teeth, the hypermineralized and acid-resistant nature of the enamel makes it challenging to achieve effective etching. Acid etching is an important step as it creates a microscopically rough surface on the enamel, providing better adhesion for the bonding material[8].

Micromechanical retention is important in orthodontics for ensuring the stability and effectiveness of orthodontic appliances like braces. Several methods like adhesion promoters, enamel conditioning with phosphoric acid, air abrasion and microetching are in practice in these days[9]. These methods have been traditionally used, it's worth noting that advancements in orthodontic technology and materials continue to evolve. Researchers and practitioners are exploring alternative techniques that may be less invasive or more

efficient. Some of these alternatives may include the use of laser technology for enamel conditioning or the development of new adhesive materials with improved properties[10].

METHODS

Study conducted in the Orthodontic Department of the Nishtar Institute of dentistry, Multan from June 2020 to Dec 2020. Study was started after ethical approval from board of ethics and informed consent was obtained from patients. Simple convenient sampling technique was used. The included 60 fluorosed teeth were collected in 6 months. These premolars were extracted for orthodontic purposes from patients seeking fixed orthodontic treatment at the Department of Orthodontics. The study excluded individuals outside the age range of 14 to 25 years, as well as teeth exhibiting visible defects, caries, apparent damage cracks, abrasion resulting from forceps extraction, surface defects, malformed teeth, restored teeth, teeth with root canal, dentinogenesis imperfect and those previously subjected to chemical treatment.

The teeth were removed, possibly for various reasons such as decay, damage, or other dental issues. The teeth after extraction were washed thoroughly in tap water. This step aims to remove any blood, debris, and tissues that might be still attached to the teeth. Following the cleaning process, the surface of the teeth was dried. This is likely done to prepare the teeth for further examination or analysis. Classification of fluorosed teeth were made according to the Thylstrup and Fejerskov index (TFI) as category 4[11]. The Thylstrup and Fejerskov index is a system used to assess the severity of dental fluorosis, which a cosmetic issue is caused by excessive fluoride intake during tooth development. Category 4 of the TFI likely represents a specific level of severity in fluorosis, and the classification provides a standardized way to describe the condition.

Storage of specimens was made at room temperature in a 0.1% thymol and distilled water solution for disinfection and inhibiting growth of bacteria. Thymol is a natural compound with antiseptic properties, and it is commonly used for its antimicrobial effects. Upon completion of the required sample, the 60 teeth were divided into two groups consisting of 30 teeth each. Subsequently, the teeth underwent a cleansing and polishing procedure for 10 seconds using a rubber prophylactic cup and a non fluoride pumice, followed by thorough washing with water and drying. Following the cleaning process, all teeth were bonded. Treated teeth were embedded in acrylic resin block after bonding with the aid of a jig, ensuring that the buccal surface of each tooth was aligned parallel to the cylinder base. In the control group (Group I), brackets were bonded to 20 teeth using composite resin without prior deproteinization, and the bonding process involved etching the teeth with 37% phosphoric acid. In the experimental group (Group II), brackets and fluorosed teeth were bonded after 5.25% NaOCl deproteinization using composite resin. After the bracket bonding process, the teeth underwent distilled water storage at room temperature until they were subjected to a shear test for debonding. The shear test was conducted using a universal test machine equipped with a 500 N load cell.

After debonding, the study assessed whether any adhesive material remained on the surface of the teeth. The evaluation of adhesive remnants was done using the Adhesive Remnant Index (ARI). The ARI is a scoring system, and the modified version from) was likely used. This index helps quantify and categorize the amount of adhesive left on the tooth surface after bracket removal. SPSS version 23 was used for data analysis. After basic analysis of numerical and categorical values student t test used in table I variables and chi-square was used in table 2.

RESULTS

Overall, 60 teeth were included in this study and divided into two equal groups, Group I and Group II, 30 (50.0%) in each. The mean bond strength value megapascals (MPa) in Group I and Group II was 9.59±1.06 and 13.34±2.58, respectively. MPa was higher in Group II than the Group I (Table. 1).The modified ARI score 3 was most common in Group II and Group I, 9 (60.0%) and 6 (40.0%), respectively. (p=0.748). (Table. 2).

Table No. 1: Megapascals distribution among the study groups

Variable	Group I	Group II	p-value
Mean bond strength value (MPa)	9.59±1.06	13.34±2.58	<0.001

Table No. 2: Distribution of modified ARI scores among the study groups

Modified ARI scores	Group I	Group II	p-value
1	3 (20.0%)	1 (6.7%)	0.748
2	3 (20.0%)	3 (20.0%)	
3	6 (40.0%)	9 (60.0%)	
4	1 (6.7%)	1 (6.7%)	
5	2 (13.3%)	1 (6.7%)	

DISCUSSION

Bond strength is a critical factor in orthodontic treatment success and efficiency. The ability of orthodontic brackets to effectively adhere to teeth influences the overall outcome of the treatment[12]. Orthodontists in this area are reportedly dealing with

frequent bracket failures. This can lead to prolonged treatment durations and inconvenience for both the orthodontic practitioner and the patient[13]. In this study mean MPa in Group I and Group II was 9.59±1.06 and 13.34±2.58, respectively. MPa was higher in Group II than the Group I, and this difference was statistically significant, ($p<0.001$). A study was conducted by Sharma et al[14] on this topic and reported that shear bond strength of Group II (11.75 ± 2.83 MPa) was measured, and it was found to be higher than that of Group I (7.44 ± 2.43 MPa). SEM was used to examine the etching pattern. The statement "the etching pattern was more of type 1 and 2 in Group II" suggests that the microscopic surface features or patterns resulting from the etching process were different between the two groups.

In a study Espinosa et al[15]demonstrated that pre-treatment with NaOCl (deproteinization) prior to etching effectively removes organic substances from the surface of enamel. This process theoretically enhances orthodontic bond strength by increasing the total etched area and promoting predominantly Type 1 and Type 2 etching patterns. In a study conducted by Nazari et al[16] reported that reducing the etching time to 10 and 5 seconds on intact enamel yielded some beneficial effects. This is noteworthy, especially considering the previous lack of a definitive factor that determines the bonding ability of self-etch (SE) and total-etch adhesives on enamel, whether it's ground or unground. Similar findings were reported by Pivetta et al[17] that reduction in etching time suggests that the altered treatment duration has a positive impact on the bonding capabilities of the adhesives. Some contrast studies are also in practice as in this study MPa was 13.34±2.58 was not considered suitable. In a study conducted by Scougall Vilchis et al[18] reported that exceeding the fracture strength of enamel (approximately 14 MPa) in bracket shear bond strengths is considered undesirable, as it may compromise the structural integrity of the enamel. Similar findings were also reported that Lamper et al[19] and Boruziniat et al[20] that Orthodontic practitioners often aim for a balance in bond strength. Sufficient bond strength is necessary to ensure that the brackets remain attached during the course of treatment, but it should not be excessively high to the extent that it causes enamel damage during bracket removal.

In contrast to the findings of the present study, another investigation by Shafiei et al[21] assessing various resin removal techniques for bracket bond strength observed notably lower MPa is more beneficial as compared to higher MPa methods.

CONCLUSION

Prior to acid etching, the use of 5.25% NaOCl for deproteinization significantly enhances the shear bond strength of brackets adhered to fluorosed teeth, offering a convenient and effective option in orthodontic bonding procedures for such cases.

Author's Contribution:

Concept & Design of Study:	Iqra Gaffar
Drafting:	Zubair Hassan Awaisi
Data Analysis:	Zubair Hassan Awaisi
Revisiting Critically:	Iqra Gaffar,
Final Approval of version:	Iqra Gaffar

Conflict of Interest: The study has no conflict of interest to declare by any author.

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