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Research

Shear bond strength of orthodontic brackets to fluorosed enamel

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ABSTRACT

Objectives: To evaluate the influence of dental fluorosis and etching time on the shear bond strengths (SBSs) of orthodontic brackets to human enamel.
Methods: A total of 48 human maxillary central incisors, extracted for periodontal reasons were used. The sample was divided into three experimental groups ($n = 16$): group H30 with healthy teeth and group F30 and F60 with fluorosed teeth (Thylstrup and Fejerskov Index scores 3–4). After etching the dental enamel with 35% phosphoric acid for 30 s (groups H30 and F30) or for 60 s (group F60), metal orthodontic brackets were bonded with Transbond XT adhesive system and light cured (1200 mW/cm^2 for 10 s). The specimens were then thermocycled (5–55 °C, 500 cycles), stored in distilled water (37 °C/7 days), and tested in shear (Instron, 1KN, 1 mm/min). Failure mode was classified, with a stereomicroscope (20× magnification), according to the adhesive remnant index (ARI). SBS data were statistically analyzed with 1-way ANOVA, followed by Tukey post hoc tests ($\alpha = 0.05$). Kruskal–Wallis and Mann–Whitney nonparametric tests were used to analyze failure data ($\alpha = 0.05$).
Results: No statistically significant ($p = 0.763$) differences were found between F30 and F60, but these groups showed a statistically ($p < 0.05$) lower bond strength values than H30. The non-fluorosed group showed a significantly ($p < 0.05$) higher ARI score than the other groups.
Conclusion: Orthodontic brackets adhesion to enamel is negatively influenced by dental fluorosis. Doubling the etching time in fluorosed teeth was not enough to produce similar results to those observed in the healthy ones.

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Resistência adesiva a tensões de corte de brackets ortodônticos colados a esmalte de dentes com fluorose

Palavras-chave:
Fluorose dentária
Condicionamento ácido

RESUMO

Objetivos: Avaliar a influência da fluorose e do tempo de condicionamento ácido sobre a resistência adesiva ao corte de brackets ortodônticos colados ao esmalte.
Métodos: 48 incisivos centrais maxilares humanos, extraídos por razões periodontais, e divididos em três grupos experimentais (n=16): grupo H30 com dentes sem fluorose e grupos

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Brackets ortodônticos
Resistência ao corte
Adesão ao dente

F30 e F60 com dentes com fluorose (Índice de Thylstrup e Fejerskov, classificação 3–4). Após o condicionamento do esmalte com ácido fosfórico a 35% durante 30 segundos (H30 e F30) ou durante 60 segundos (F60), foram cimentados brackets metálicos com o sistema adesivo Transbond XT e fotopolimerizados (1200mW/cm^2 durante 10 segundos). Os espécimes foram termociclados (5–55°C, 500 ciclos), armazenados em água destilada (37°C/7 dias), e testados ao corte (Instron, 1KN, 1mm/min). A falha foi classificada, com um estereomicroscópio (ampliação 20x), de acordo com o Índice de Adesivo Remanescente (ARI). Os dados de resistência adesiva foram analisados com ANOVA e comparações múltiplas segundo Tukey (α=0,05). Os testes de Kruskal-Wallis e Mann-Whitney foram utilizados para analisar os dados da falha (α=0,05).

Resultados: Não foram encontradas diferenças estatisticamente significativas (p=0,763) entre F30 e F60, mas estes grupos apresentaram valores de resistência adesiva estatisticamente (p<0,05) mais baixos que os obtidos em H30. O grupo H30 apresentou uma classificação ARI estatisticamente (p<0,05) superior aos grupos F30 e F60.

Conclusões: A adesão de brackets ortodônticos ao esmalte é negativamente influenciada pela fluorose dentária. A duplicação do tempo de condicionamento ácido nos dentes com fluorose não foi suficiente para promover resultados similares aos observados nos dentes sem fluorose.

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Introduction

Due to the fluoride ion anticariogenic properties, a decrease in dental caries prevalence occurred, in the last decades.[1–3] When enamel remineralization cycles happen in the presence of fluoride ions, the hydroxyl groups of the hydroxyapatite are replaced by fluoride leading to a stronger and less soluble structure, the fluoroapatite.[4] However, as a result of its widespread use, there was also an exponential increase in fluorosis prevalence.[3,5–10]

Dental fluorosis is a developmental tooth enamel lesion resulting from a fluoride overdose and chronic ingestion during early childhood.[8,11] This condition leads to metabolic changes in ameloblasts, resulting in a poor matrix formation and tooth calcification.[11,12] The fluorosed enamel is characterized by a hypermineralized outer layer and a hipomineralized and porous sublayer.[13–16]

Etching the enamel surface with acids such as phosphoric acid is an important step to promote adhesion to dental enamel. The acid etching technique, introduced by Buonocore[17] in 1955, causes a selective decalcification of enamel, creating a rough surface and increasing the contact area and surface energy which provides the substrate for infiltration of the bonding agent making possible the micromechanical union between the adhesive/restorative materials and the enamel surface.[4] However, the adhesion to enamel of fluorosed teeth may be compromised, due to the etching procedure that has been proven to be less effective in these hypermineralized surfaces.[18–20] Some authors advocate the increase of etching time in order to overcome such limitation.[20–22]

Orthodontic treatment with fixed appliances requires an adequate bond between brackets and tooth enamel, and may be a clinical challenge in endemic fluorosis regions. If bond strength values are too low, earlier debonding of brackets may occur as a result of normal clinical stress, forcing a delay and increasing treatment costs.[23]

The available studies that assess the adhesion of orthodontic brackets to teeth with fluorosis are scarce and show different results.[20,22,24–27]

The aim of this study is to evaluate the influence of dental fluorosis and the etching time on the shear bond strength of metal orthodontic brackets to human enamel. The null hypotheses tested were that fluorosis does not decrease the bond strength and doubling the etching time does not increase the adhesion of orthodontic brackets to fluorosed enamel.

Materials and methods

The sample size ($n = 16$) was estimated with a power analysis to provide statistical significance alpha = 0.05 at an 80% power.

The sample consisted of 48 human upper central incisors extracted for periodontal reasons, and the study was approved by the Institutional Research Ethics Committee. Teeth were collected after receiving verbal consent and stored in 0.5% chloramine solution at 4 °C for a week followed by immersion in distilled water at 4 °C until bonding procedures. The criteria for study inclusion were absence of previous chemical treatment, caries and buccal surface cracks and restorations. Healthy teeth composed group H30. Mild to moderated fluorosed teeth were selected by consensus between two observers according to the Thylstrup and Fejerskov Index (ITF) scores 3–4, and randomly allocated to groups F30 and F60.[28]

Before bonding, buccal surfaces were cleaned with a mixture of water and non-fluoride pumice, thoroughly rinsed with water spray and air-dried.

The enamel of buccal surface specimens was etched with 37% phosphoric acid gel (Transbond™ XT Etching Gel, 3M Unitek, Monrovia, EUA), for 30 s for group H30 and F30, and 60 s for group F60. All teeth were rinsed with water spray for 15 s and dried with oil-free compressed air for 5 s, until characteristic frosty white enamel etched appearance was present.

Metal brackets (Victory Series™ Standart edgewise Bracket Univ U Central, 3M Unitek, Monrovia, USA) were bonded with

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