FRACTURE STRENGTH OF INDIRECT COMPOSITE LAMINATES CEMENTED ON EXISTING RESTORATIONS

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Introduction and Objectives

When a laminate is indicated for a tooth that contains multi discoloured resin restorations, with a history of several restoration cycles, the replacement of underlying pre-existing resin composite restorations require removal action by drilling. This could result in unavoidable reduction of sound enamel and dentin tissues. Clinical evidence indicates that failures related to adhesively bonded ceramic laminates are more frequent on existing composite restorations.[1] In general, adhesion between two composite layers is achieved in the presence of an oxygen-inhibited layer of unpolymerized resin. Pre-polymerized or aged resin restorations contains no or less unreacted monomers on the surface layer. Although several surface conditioning methods have been proposed to facilitate composite-composite adhesion,[2,3] such studies were conducted on specimens with standard geometries, disclosing the effect of enamel or dentin surrounding them. When a laminate is to be bonded to a tooth with existing composite restorations, clinicians are challenged with conditioning of three main substrates, namely the resin composite, enamel and/or dentin.[4] The objectives of this study were: a) to compare the fracture strength of indirect composite laminates on teeth containing differently conditioned, aged resin composites and b) to evaluate the failure types after fracture strength test.

Materials and Methods

Specimens

Sound human maxillary central incisors (N=60, 10/per group)

Standard Class III box preparations in 50 teeth using ultrasonic burs (Groups 1 to 5) (Fig. 1)

Acid-etching with 35% H_3PO_4 (Ultra-etch) for 30 s + Rinsing with water and air-drying

Primer (Quadrant Unibond Primer, Cavex) and bonding agent* (Quadrant Unibond Sealer)

[*due to possible exposure of dentin]

Composite restorations (Quadrant Anterior Shine, Cavex)

Light-polymerization: for 40 s ech layer (Demetron LC, 500 mW/cm^2)

Finishing and polishing

Thermocycling (6000 cycles between 5°C and 55°C)

Preparation and Production of the Laminates

Taking impression from each tooth, obtaining molds

Window type of tooth preparations without incisal overlap (Depth cutting bur, Intensiv SA)

Indirect laminate veneers (Estenia)+ Light polymerization + light and heat polymerization (Technomedica)

Finishing and polishing (Swiss Dental Products)

Surface Conditioning Protocols

Group 1: Air-abrasion of Class III composite (CoJet®-Sand, 30 μm SiO_2 particles, 3M ESPE, chairside air-abrasion (Dento-Prep)

Group 2: Air-abrasion of Class III composite (50 μm Al_2O_3 particles)

Group 3: 9.5% HF acid gel on the Class III composite for 90 s

Tooth: 35% H_3PO_4 (Ultra-etch) for 30 s+Rinsing with water, air-drying

Composite: Silane (ESPE-Sil) for 5 min

Tooth+composite: Primer (Quadrant Unibond Primer) for 30 s+Bonding agent (Quadrant Unibond Sealer)+Light polymerization for 20 s

Group 4: 40% H_3PO_4 (K-etchant) overall for 10 s+ Rinsing with water, air-drying+ Primer (Clearfil SE Bond Primer+Clearfil Porcelain Bond Activator, Kuraray) for 20 s+ bonding agent (Clearfil SE Bond) to the tooth surface and the composite+Light-polymerization for 10 s

Group 5: Primer (Quadrant Unibond Primer) on both the Class III composite and the surrounding enamel/dentin+ bonding agent (Quadrant Unibond Sealer)

Group 6: Control group-unrestored teeth

Cementation of the Laminates

Conditioning the inner surfaces of the laminates+silanization

Ultrasonic Cementation (Panavia F2.0, Kuraray)

Light polymerization (40 s) from four directions

Fracture Strength Test

Embedding the teeth with the cemented laminates in PMMA

Water storage at 37°C for 1m

Load application at 137° (crosshead speed: 1 mm/min) from the incisal direction to the laminate-tooth interface (Fig. 2)

Failure Analysis

Digital photos, two calibrated operators (x20)

Failure types:

Cohesive failure within the composite laminate (Type A)

Adhesive failure between the tooth and the laminate (Type B)

Chipping of the laminate with enamel exposure (Type C)

Statistical Analysis

ANOVA, Tukey's test, $\alpha=0.05$

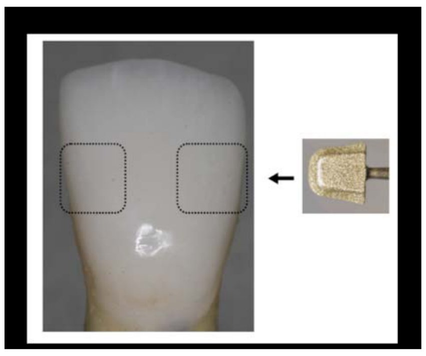

Fig. 1 Box preparations for Class III resin composite restorations using ultrasonic burs.

Results

Significant difference was observed in fracture strength values between the groups (ANOVA, p = 0.0261). The only significant difference was between Group 2 (299±103 N) and Group 3 (471±126 N) (p = 0.0239) (Tukey's). The mean fracture strength values in the descending order were 471±125, 416±146, 363±118, 352±117, 339±96 and 299±103N for Groups 3,5,4,6,1 and 2, respectively (Fig. 2).

. The majority of the failure type experienced in all groups was mixed failure type (Type C) where chipping of the laminate was seen together with enamel exposure (35/60). This type of failure was followed by Type B (21/60) (Table 1).

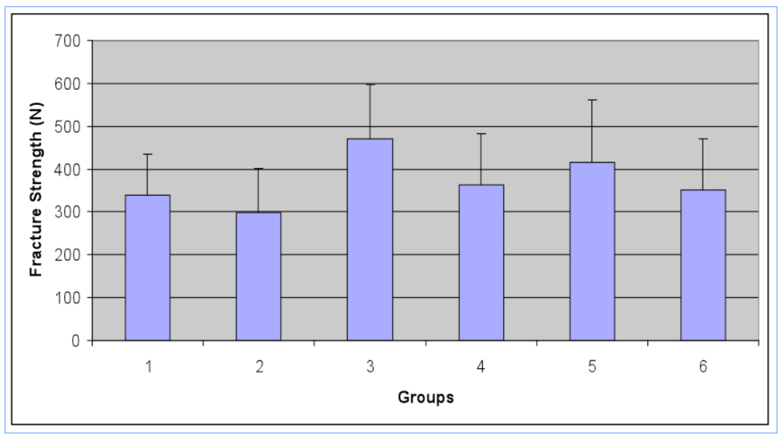

Fig. 2 The mean fracture strength (N) values for the experimental groups. See Materials and Methods for groups descriptions.

	Type A	Type B	Type C
Group 1	1 / 10	6 / 10	3 / 10
Group 2	2 / 10	0 / 10	8 / 10
Group 3	0 / 10	2 / 10	8 / 10
Group 4	0 / 10	6 / 10	4 / 10
Group 5	0 / 10	6 / 10	4 / 10
Group 6	1 / 10	3 / 10	6 / 10
Total	4 / 60	21 / 60	35 / 60

Table 1. Distribution of failure types. Type A: Complete adhesive failure between the tooth and the laminate; Type B: Cohesive failure within the composite laminate; Type C: Mixed failure; chipping of the laminate with enamel.

Conclusions

- Fracture strength of laminates tested, did not show a significant difference when they were bonded to teeth with aged Class III composite restorations or to intact teeth only but the failure types varied between the groups.
- The lowest results were obtained from air-particle abraded (50 μm, Al_2O_3) and silanized group.

References:

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