Qualitative evaluation of the adhesive interface between lithium disilicate, luting composite and natural tooth

Nicola Mobilio, DDS
Alberto Fasiol, DDS
Santo Catapano, MD, DDS

Department of Prosthodontics, Dental School, Dental Clinic, University of Ferrara, Ferrara, Italy

Corresponding author:

Alberto Fasiol
Department of Prosthodontics, Dental School, Dental Clinic, University of Ferrara
Corso Giovecca 203
44121 Ferrara, Italy
E-mail: albertofasiol@yahoo.it

Summary

Aim of this work was to qualitatively evaluate the interface between tooth, luting composite and lithium disilicate surface using a scanning electron microscope (SEM). An extracted restoration-free human molar was stored in physiological solution until it was embedded in an autopolymersing acrylic resin. A standard preparation for overlay was completed and after preparation an anatomic overlay was waxed on the tooth and then hot pressed using lithium disilicate ceramic. After cementation the sample was dissected and the section was analysed using an Automatic Micro-met (Remet s.a.s) and the section was analyzed using a scanning electron microscope (SEM). SEM evaluation of the tooth showed the three layers seamlessly; by increasing the enlargement the interface did not change.

Key words: adhesive, lithium disilicate, cementation, SEM.

Introduction

The use of lithium disilicate as ceramic material for fixed dental prosthesis combines good mechanical properties to excellent aesthetic results. This ceramic is indicated for single crowns, veneers and inlays, and compared with other glass-ceramics, it demonstrates very good performance (1).

Lithium disilicate represents a clinical option in both anterior and posterior region (2, 3), showing successful rates from 95.39 to 100% at 3 years (4).

It is generally assumed that clinical success of all-ce-

ramic restorations is influenced by the type of cementation (5, 6). A strong point claimed for using lithium disilicate is adhesive cementation. As glass-ceramic, the inner surface of lithium disilicate may be etched by fluoridric acid to increase the surface energy and consequently the bond strenght (7, 8). After etching and cleaning the surface, a silane coupling agent is used to establish a chemical bond between luting composite and ceramic surface.

A recent study investigated the retentive strength of lithium disilicate crowns cemented on natural teeth (9). Posterior teeth restored with adhesively-cemented disilicate crowns most often failed by fracturing the root, suggesting a real adhesion between dental structure and ceramic reconstruction rather than merely luting. Such an adhesive interface needs to be deeply investigated.

Aim of this work was to qualitatively evaluate the interface between tooth, luting composite and lithium disilicate surface using a scanning electron microscope (SEM).

Materials and methods

A restoration-free human molar, extracted for periodontal reason, was cleaned from dental plaque and periodontal tissues with ultrasonic instruments and curettes. The tooth was embedded in a self-curing acrylic resin block (ProBase Cold, Ivoclar Vivadent AG, Schaan, Liechtenstein) up to 2 mm below the cement-enamel junction (CEJ) and with its long axis perpendicular to the base of the block. The tooth was horizontally sectioned by using a diamond disk and 2 perpendicular grooves were made on the horizontal surface by using a spherical diamond bur, to facilitate the positioning of the restoration (Fig. 1).

Figure 1. Preparation and restoration.

An anatomic onlay was waxed and hot pressed using lithium disilicate (IPS e.max PRESS LT A1, Ivoclar Vivadent AG, Schaan, Liechtenstein).

The inner surface of ceramic was etched with 5% hydrofluoric acid (IPS Ceramic, Ivoclar Vivadent) for 20 second, then rinsed and cleaned in pure alcohol in ultrasonic bath for 10 minutes.

Therefore it was treated with universal primer (Monobond Plus, Ivoclar Vivadent AG, Schaan, Liechtenstein) and then dried with hot air.

The tooth was cleaned and dried, and then an adhesive (Multilink Primer, Ivoclar Vivadent AG, Schaan, Liechtenstein) was brushed on and dried. The cement (Multilink Automix, Ivoclar Vivadent AG, Schaan, Liechtenstein) was applied on the inner surface of the ceramic and then the onlay was seated on the prepared teeth until the end of polymerization (Fig. 2)

After cementation the tooth was sectioned along the vertical axis using a diamond disk and the section was analyzed using a scanning electron microscope (SEM).

Figure 2. Cementation.

Figure 3. SEM evaluation at 558 X.

Results

SEM evaluation of the tooth section at 558 X (i.e. 20 μ m) showed the three layers (tooth, luting composite and lithium disilicate) seamlessly (Fig. 3). With increasing enlargement at 800 X, 1.37 K X and until 3.67 K X, the interface did not change (Figs. 4-6).

Figure 4. SEM evaluation at 800 X.

Figure 5. SEM evaluation at 1.37K X.

Figure 6. SEM evaluation at 3.67K X.

Discussion

Traditionally, definitive cementation is considered a fundamental step among restorative procedures. The correct cement selection and correct cementation procedure are crucial for adequate marginal sealing and proper retention of the restoration in time (10). In restoring teeth by using metal-free restoration, the cementation step acquires an additional value. In this case, indeed, cementation is not just a luting procedure, but it realises a true adhesion between two different materials, i.e. dental tissue and ceramic restoration. Using an adhesive cementation has a large impact on clinical decisions and procedures. First of all, it is possible to prepare a tooth with insufficient retention form: it happens very often in case of partial reconstructions (veneers or onlays), that would not be possible with traditional, not adhesive procedures. Furthermore, the adhesive interface between tooth and ceramic has the ability to increase the mechanical properties of the latter, improving the fracture resistance of the whole system (11). For this reason it is possible to use all-ceramic restorations also in load-bearing areas (e.g. posterior region). Therefore, it is recognized that the success of an all-ceramic restoration greatly depends on the quality of the adhesive interface. For this reason in the present study such an interface has been evaluated by SEM. The SEM analysis revealed a continuous interface from dentine to luting composite to lithium disilicate. Such evidence was confirmed by increasing the enlargement. Such a perfect interface may be most likely responsible of the very good performance of all-ceramic crowns in a recent study (9). Teeth restored with adhesively-cemented lithium disilicate crowns most often failed by fracture of the tooth instead of decementation of the crown in a *in vitro* pull-out test. Where adhesive cementation was not used, the most of the teeth failed by decementation.

Among glass ceramics, lithium disilicate has the highest flexural strength and for this reason has many clinical indications, also in high stress areas or conditions. Furthermore, disilicate as a glass ceramic may be chemical etched and this is a clear advantage relative to more performing polycrystalline ceramics as zirconia. For this reason a true adhesion to the tooth is possible to achieve with lithium disilicate and not with zirconia. A

composite luting is mandatory to achieve adhesion both to the dental tissue and to inner ceramic layer (12, 13). In conclusion, within the limits of this qualitative SEM evaluation, the adhesive interface between tooth, luting composite and ceramic appeared to be with no interruption. Further quantitative *in vitro* studies are needed to better address this issue.

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