ADHESIVE LUTING OF CERAMIC RESTORATIONS

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ABSTRACT

The adhesive luting of ceramic restorations bears direct correlation with the type of ceramic used. The great variety of ceramic systems, with different compositions, makes the choice of the superficial treatment to be used very difficult. Consequently, the understanding of the variables involved in this process comprises a vast area. The authors present a literature review about the steps required to the luting of different types of ceramic.

KEY WORDS: ceramic; adhesive luting

INTRODUCTION

Pure ceramic restoration were introduced in dentistry in 19th century England by John Muphy (DIETSCHI; SPREAFICO, 1997) but due to the unavailability of adequate cements for the

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binding of the ceramic to the dental structure, as well as technical innovation to the manufacture of more resistant ceramics; these showed high index of fracture and were abandoned (QUALTROUGH et al., 1990).

Various types of ceramic have been devised with the introduction of different strengthening elements suchs a leucite, alumina, magnesium, zirconium and litium fluoride (BLATZ; DENT, 2002; BROWN, 1998; McLEAN, 2001).

The main reason for the ceramic restoration failure is the fracture, which is usually associated to insufficient width of the ceramic, mode of the preparation, patient's occlusion, cementing agents and ceramic defects (KRÄMER et al., 1999; LEEVAILOJ et al., 1998).

The objective of the cement is to promote close binding of ceramic, enamel and dentin, forming an only body that allows the transfer of tensions from the restoration to the dental structure, enabling the ceramic to increase in resistence (BANKS, 1990). Besides that, by being insoluble, the resinous cement minimizes the problem of poor adaptation obtained by some ceramic systems due to the contraction during the synthesis process. A uniform width of cement up to 100 μm can be considered satisfactory (AUDENINO et al., 1999).

Contemporary types of ceramics show distinct constitution, resistance and manufacture. The ceramics based in silicium oxide (feldspathic), aliminium oxide and aliminium oxide strengthened with zirconium oxide are the most use dones (ANUSAVICE, 1997; ROULET; JANDA 2001).

Due to the variety of available ceramics with different compositions and properties and taking into consideration that their response to the surface treatments depends on their characteristics, a cementation protocol is needed that would consider the peculiarities of the material, which in turn would allow an effective interaction between the ceramic and the dental structure (GARBER; GOLDSTEIN, 1996; JENSEN et al., 1987).

Ceramic systems can be classified according to the technique of manufacture:

Conventional ceramic – a powder to which the technician add water or another vehicle to obtain a mass that will be used in the restoration in layers (Santos 2003), examples: Duceran Plus and LFC (Degussa); Optec HSP (Jeneric-Pentron); Fortune (Willians), etc.

Castable ceramic – ceramic pastilles that are used to construct the restoration by wax mold process and centrifuge casting.

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Since it is manufactured in only one color it should receive a layer of extrinsic painting or by feldspathic ceramic by conventional method in order to attain the final stage. Example: Dicor (Dentsply).

Machinable ceramic – several ceramic bars with different tonalities, tooled by the CAD-CAM CAD-CAM (Computer-aided-design – Computer-aided-manufacturing) system. Example: CEREC (Siemens).

In the Procera (Nobel-Biocare) system, a *copping* with high alumina content is produced through the synthetization of a piece that is refined through casting and than covered with feldspathic ceramic by the conventional method.

Pressable ceramic – it is characterized by the melting of ceramic, which is to injected in a mold obtained by the wax mold procedure (LUTHY et al., 1992).; for example, Optec OPC (Jeneric-Pentron); IPS Empress and IPS Empress 2 (Ivoclar-Vivadent).

Infiltrated ceramic - with 2 components, a powder rich in alumina, which is dry synthetized on the plaster torquel, and a lantanium glass, which is to be infiltrated in the porous substrate to form a coping that will later be covered with a conventional ceramic. Example: In Ceran (Vident).

Clinical procedure

Proof

After removing the provisory restoration, it must be placed in position so as to verify the adaptation and to make adjustments. The restoration should be assessed regarding marginal integrity, relation of proximal contact, occlusal relation to the opposite arch and color (SANTOS, 2003).

Premature contacts should be reduced with a diamond drill in low rotation in the straight specimen (DÉRAND; DÉRAND, 2000) and the worn facets should be polished with rubber for ceramic polishing (DIETSCHI et al., 1990).

In cases of severe adaptation failure of the restoration it is mandatory to repeat the molding in order to get a new specimen, molded.

Before cementing the restoration with adhesive system, whenever possible, absolute isolation of the operative filed to prevent contamination with saliva should be attained.

Pre-treatment tooth

The tooth needs to be cleaned with pome stone paste and water in a rubber cup or with a Robinson brush. Then, the dentin and the enamel are treated according to the type of cementation agent, following instructions of the manufacturer.

For use of resinous cement the preparation should be conditioned with 37% phosphoric acid for 15 seconds and rinsed with a spray of water for 20 seconds (GROTEN; PRÖBSTER, 1997) and in case of glass ionomer cement it should be used the primer of the selected system.

Pre-treatment restoration

Although similar, the ceramic restoration can be treated in different ways previous to the use of resinous cement. The treatment is dependent on the ceramic type and can undergo alterations (DELLA BONA et al., 2002).

Etching

Etching with 50 µm aliminnium oxice particles, under a pressure of 80 lb/inch ^{2}, aiming to promote micro-retention is indicated to increase resistance in the union between the ceramic restoration and the cementation resins (SANTOS, 2003). Usually, it is done by technicians in the laboratory but can be done just before the cementation with an special device (Microetcher – Optblast, USA). This procedure creates irregularities in the surface of the ceramic favoring the flow and the interaction of the cement.

Fluorid acid

The external surface has to be protected in advance with utility wax to prevent its conditioning during the application of the floride acid, which would make the removal of the remains of the resinous cement difficult. This protection should be removed only after the sinalization (NEIVA et al., 1998).

The conditioning of the internal surfaces with 10% fluoride acid usually takes 2 minutes. However, some variation can be expected because of composition of the ceramic type; litium-silicate strengthened ceramics, such as the Empreess II system, should be conditioned for no more than one minute to prevent weak-

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ening due to silica removal; in systems with high content of alumina (Procera), due to the low content of vitreous phase and of silica, the conditioning has no effect and can even cause, as reported in some studies, reduction in the bond force to the resinous cement (KERN; THOMPSON, 1995; AWLIYA et al., 1998); the glass infiltrated ceramics (in-Ceram) undergo degradation of the vitreous matrix by the fluoride acid and should not be conditioned (ÖZCAN et al., 2001; HULS, 1995).

After conditioning, the fluoride acid must be removed by thourough rinsing with water or spraying for at least 30 seconds since their remains may interfere in the signalizing process; than, the surface is to be air-flow dried until it becomes whitish.

Silanization

Silane is a bi-functional molecule that reacts with the vitreous components of ceramic (SIO2) through a silicofunctional inorganic radical and with the organic matrix of the resinous cement (Bis-GMA) through an organofunctinal radical (PEUTZFELDT, 2001). The application of the silane agent will be made with a disposable paint brush and letting it take effect in the surface for one minute followed by drying the silane with air with a triple syringe for 5 seconds. At this moment the adhesive system must be applied.

Cementation

After tooth treatment and restoration, the cement will be handled on an impermeable paper plaque. Then, the cement is applied in the inside of the restoration, which is placed in the cavity under light pressure to allow the outpouring of the exceeding cement.

Its removal should be done in the free facet with absorbent paper before complete polymerization, keeping the pressure for 10 minutes to avoid displacement of the piece. When a photopolimerizable cement or cement with double initialization is used, the photoactivation can be done for 5 seconds to facilitate the removal of residues of cement in the proximal areas with a dental floss. Then, each facet of the restoration should be photopolimerized for 60 seconds (DIETSCHI et at., 1992).

After removing the isolation and assessing the occlusal contacts with a carbon ribbon (AccuFilm II), adjustments must be made with a diamond drill of fine granulation in high rotation under air/water refrigeration. The finishing is done with abrasive rubber point for ceramic and the polishing with a diamond past in felt disk

(DONOVAN; CHE, 1993).

Factors to cementation

During cementation of a ceramic restoration the characteristics of the involved materials in the different present interfaces should be kept in mind. In order to obtain an effective adhesion the resinous cement-ceramic, adhesive-cement and tooth adhesive interfaces must be carefully worked on.

The interface between the ceramic and the resinous cement has been largely studied. Etching with aluminiun oxide particles and the conditioning with fluoride acid has been held as responsible for the micro-mechanical retention, as well as the silanization by chemical bond (KAMADA et al., 1998; BLIXT, 2000).

The resinous cement and most adhesives, having similar radicals, bind chemically and establish a lasting union. However, the low pH of some adhesive systems can interfere in the polymerization or show incompatibility with resinous cements of other brands (SANTOS, 2003).

The interface of union of the tooth-adhesive system depend on the formation of a hybrid layer and represent the point of greater complexity, since many factors are present and can either help or jeopardize the durability of this union, affecting the longivity of the restoration. Among these factors is the type of dentin (sclerotic or not), the dryness of the dentin with ensuing collapse of the collagen fivers, the degree of humidity needed by the adhesive system and the resistance of the union force of the adhesive system to the dentin (DUKE, 2000).

Due to its lower solubility, it was believed that the resinous cement could be used without criteria in order to compensate for the marginal discrepancy of restoration and, thus, allowing the cementation of restoration with poor marginal adaptation. This assertion, however, is regarded with caution since has been described in the literature the low resistance of these cements to weariness (HAYASHI et al., 1998; KRÄMER; FRANKENBERGER, 2000). Some authors have shown that there is increase in the weariness of resinous cement as the extension of the marginal groove increases (GUZMAN et al., 1997).

According to Gemalmaz et al. (2001) the wearing of resinous cement is more pronounced in the ceramic-cement interface due to the high module of elasticity of the ceramic, which instead of absorbing the mastigatory forces, transmits them to the cement, whose module of elasticity is reduced. However, the high level of weariness of the resinous cement may cause the ceramic to lose support in the margins

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of the restoration leading to a microfactrure (HAYASHI et al., 1998; KRÄMER; FRANKENBERGER, 2000). Resinous cements must be used with high contend of inorganic load and that of microparticles as they are the most resistant ones to wearing.

The dual resinous cements, by allowing more time of manipulation and attaining a high degree of conversion in the absence of light have been considered the choice cements in the cementation of ceramic inlays and onlays (BRAGA et al., 2002; CAUGHMAN, 2001; LEE; UM, 2001; McCOMB, 1996).

Chemical polymerization, or self-polimerizable cements, however, have a better degree of conversion of the monomers after the polymerization. This occurs because there is no need of additional light activation, which would need to go through the ceramic before reaching the cement.

In what regards the effectiveness of the cure of the dual resinous cements, the time of light exposition is of top importance to compensate for the attenuation undergone by light; 40 seconds is considered insufficient time (LEE; UM, 2001).

The glass ionomer cement has been considered as a secondary option, despite its excelent properties, such as structural union to the tooth, release of fluoride and thermal expansion coefficient similar to that of the dental structure (NAVARRO; PASCOTTO, 1998). The main disadvantages of glass ionomer cements are its inability to bind to ceramica and the great hygroscopic expansion, which can induce fractures in pure ceramics (SINDEL et al., 1999).

Due to the brittleness of ceramic, the bond to the dental structure by the resinous cement becomes an efficient mechanism in the increase of ceramic resistance against fractures through the transmission of mastigatory forces to the underlying dental tissues, avoiding concentration of forced isolated on the brittle material (MESAROS, 1994).

The clinical success of ceramic restorations relies on many factors, starting from the correct indication and planning of the treatment to the maintenance and follow-up. Carelessness in any of the steps in the manufacture of a ceramic restoration will decrease its longevity. Therefore, the awareness of the properties of the material and the correct utilization and preparation are decisive factors to achieve a satisfactory performance in the proposed treatment.

REFERENCES

1. ANUSAVICE, K. J. Reducing the failure potential of ceramic-

based restorations. *Gen. Dent.*, v. 45, n. 1, p. 30-35, Jan./Feb. 1997.

FREITAS, Anderson Pinheiro de et al. Adhesive luting of ceramic restorations. *Salusvita*, Bauru, v. 24, n. 3, p. 459-468, 2005.

2. AUDENINO, G. et al. In vitro evaluation of fit of adhesively luted ceramic inlays. *Int. J. Prosthodont.*, v. 12, n. 4, p. 342-347, July/Aug. 1999.
3. AWLIYA, W. et al. Shear bond strength of a resin cement to densely sintered high-purity alumina with various surface conditions. *Acta. Odont. Scand.*, v. 56, n. 1, p. 9-13, Feb. 1998.
4. BANKS, R. G. Conservative posterior ceramic restorations: a literature review. *J. Prosth. Dent.*, v. 63, n. 6, p. 619-626, June 1990.
5. BLATZ, M. B.; DENT, M. Long-term clinical success of all-ceramic posterior restorations. *Quintessence Int.*, v. 33, n. 6, p. 415-426, June 2002.
6. BLIXT, M. et al. Bonding to densely sintered alumina surfaces: effect of sandblasting and silica coating on shear bond strength of luting cements. *Int. J. Prosthodont.*, v. 13, n. 3, p. 221-226, May/June 2000.
7. BRAGA, R. B.; CESAR, P. F., GONZAGA, C. C. Mechanical properties of resin cements with different activation modes. *J. Oral Rehab.*, v. 29, n. 3, p. 257- 262, Mar. 2002.
8. BROWN, D. The status of indirect restorative dental materials. *Dent. Mat.*, v. 25, n. 1, p. 23-34, Jan./Feb. 1998.
9. CAUGHMAN, W. F.; CHAN, D. C. N.; RUEGGEBERG, F. A. Curing potential of dual-polymerizable resin cements in simulated clinical situations. *J. Prosth. Dent.*, v. 85, n. 5, p. 480-484, May 2001.
10. DELLA BONA, A.; ANUSAVICE, K. J.; HOOD, J. A. A. Effect of ceramic surface treatment on tensile bond strength to a resin cement. *Int. J. Prosthodont.*, v. 15, n. 3, p. 248-253, May/June 2002.
11. DÉRAND, P.; DÉRAND, T. Bond strength of luting cements to zirconium oxide ceramics. *Int. J. Prosthodont.*, v. 13, n. 2, p. 131-135, Mar./Apr. 2000.
12. DIETSCHI, D. et al. In vitro resistance to fracture of porcelain inlays bonded to tooth. *Quintessence Int.*, v. 21, n. 10, p. 823-831, 1990.
13. DIETSCHI, D.; MAEDER, M.; HOLZ, J. In vitro evaluation of marginal fit and morphology of fired ceramic inlays. *Quintessence Int.*, v. 23, n. 4, p. 271-278, Apr. 1992.
14. DIETSCHI, D.; SPREAFICO, R. *Restaurações adesivas:* conceitos atuais para o tratamento estético de dentes posteriores. São Paulo: Quintessence, 1997. 215 p.

15. DONOVAN, T. E.; CHEE, W. W. L. Conservative indirect restorations for posterior teeth cast versus bonded ceramic. *Dent. Clin. N. Amer.*, v. 37, n. 3, p. 433-443, July 1993.
16. DUKE, E. S.; PLATT, J. A.; RHODES, B. Investigation of adhesive system used with direct and indirect applications. *Comp. Continuing Educ. Dent.*, v. 21, n. 12, p. 1.043-1.053, Dec. 2000.
17. GARBER, D. A.; GOLDSTEIN, R. E. Preparo do dente. In: ______. Inlays *e* onlays *de porcelana e resina composta.* São Paulo: Quintessence, 1996. Cap. 4, p. 38-55.
18. GEMALMAZ, D.; ÖZCAN, M.; ALKUMRU, H. N. A clinical evaluation of ceramic inlays bonded with different luting agents. *J. Adhes. Dent.*, v. 3, n. 3, p. 273-283, Fall 2001.
19. GROTEN, M.; PRÖBSTER, L. The influence of different cementation procedures on the fracture resistance of feldspathic ceramic crowns. *Int. J. Prosthodont.*, v. 10, n. 2, p. 169-177, Mar./Apr. 1997.
20. GUZMAN, A. F.; MOORE, B. K; ANDRES, C. J. Wear resistance of four luting agents as a function of marginal gap distance, cement type, and restorative material. *Int. J. Prosthodont.*, v. 15, n. 1, p. 415-25, Sept./Oct. 1997.
21. HAYASHI, M. et al. 6-year Clinical Evaluation of Fired Ceramic Inlays. *Oper. Dent.*, v. 23, n. 6, p. 318-331, Nov./Dec. 1998.
22. HULS, A. All ceramic restorations with the In-Ceram System: 6 years of clinical experience. *Manual VITA*, Gottingen, Feb. 1995.
23. JENSEN, M. E. et al. Posterior etched-porcelain restorations: an *in vitro* study. *Comp. Continuing Educ. Dent.*, v. 8, n. 8, p. 615-622, Sept. 1987.
24. KAMADA, K.; YOSHIDA, K.; ATSUTA, M. Effect of ceramic surface treatments on the bond of four resin luting agents to a ceramic material. *J. Prosth. Dent.*, v. 79, n. 5, p. 508-513, May 1998.
25. KERN, M.; THOMPSON, V. P. Bonding to glass infiltrated alumina ceramic: Adhesive methods and their durability. *J. Prosth. Dent.*, v. 73, n. 3, p. 240-249, Mar. 1995.
26. KRÄMER, N. et al. IPS Empress inlays and onlays after four years – a clinical study. *J. Dent.*, v. 27, n. 5, p. 325-331, July 1999.
27. KRÄMER, N; FRANKENBERGER, F. Leucite-Reinforced glass ceramic inlays after six years: wear of luting composites. *Oper. Dent.*, v. 25, n. 6, p. 446-472, Nov./Dec. 2000.
28. LEE, I. B.; UM, C. M. Thermal analysis on the cure speed of

FREITAS, Anderson Pinheiro de et al. Adhesive luting of ceramic restorations. *Salusvita*, Bauru, v. 24, n. 3, p. 459-468, 2005.