Research Article

Recommended cementation for monolithic zirconia crowns

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ABSTRACT

Currently, there is not any best adhesion protocol for zirconia in the field of dentistry, especially in the restorations, where there is a reduced mechanical retention. There is less literature available on which cement is the recommended cement for the cementation of monolithic zirconia crowns. Zirconia-based ceramics show excellent mechanical strength and superior fracture resistance due to an inherent transformation toughening mechanism. Various cement have been used to lute the monolithic zirconia crowns, namely, the zinc phosphate cement, resin cement, glass ionomer cement, and the polycarboxylate cement. Every cement has its own pros and cons. The purpose of this study was to perform a review of the literature about the cementation of monolithic zirconia crowns, evaluating the properties of the luting cement most commonly used. The review was performed through PubMed, and a bibliographic search on the international literature of the past 10 years was made.

KEY WORDS: All ceramic restoration, Dental cement, Luting, Monolithic zirconia, Resin cement

INTRODUCTION

All-ceramic restorations have been widely promoted in the present times for their esthetic outcomes and biocompatibility.[1-3] However, they too had their weaknesses such as the inherent brittleness, low flexural strength, and fracture toughness which limited their extensive use.[2] Zirconia-based ceramics exhibited excellent mechanical strength and superior fracture resistance as a result of an inherent transformation toughening mechanism which led to its better use in the field of dentistry.[3] Translucent veneering porcelains are generally added to the zirconia core materials for better esthetics. However, layered zirconia restorations show great values for failure. However, layered zirconia restorations show great values for failure like fractures originating from the weak points, the veneer or the core/veneer interface which finally resulted in chipping or delamination of the veneer and also cracks extending through the core materials.[4,5] One of the understood reasons for this fracture is the presence of complex intraoral tensile stress distributions in addition to inherent structural flaws of the material.[6]

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Monolithic zirconia is one of the newly developed materials recently. It is basically core zirconia without the veneering porcelain. Computer-aided design (CAD)/computer-aided manufacturing (CAM) technique can be used to develop such crowns. These improve the quality with a high degree of homogeneity and might also decrease the cost. Monolithic zirconia crowns possess sufficient fracture resistance because of their high strength. It is attributed to the phenomenon of stress-induced transformation toughening present in them.[7]

The transformation toughening phenomenon is explained as below. Zirconia is available in three different crystal phases at three different temperatures, namely, monoclinic, tetragonal, and cubic. It is in the monoclinic phase at room temperature which changes into the tetragonal phase at higher temperatures from above 1070°C. At temperatures between 1170°C and 2370°C, zirconia becomes stable in the tetragonal phase. At even higher temperatures above 2370°C, it exists in the cubic phase. On addition of stabilizers such as ceria, magnesia, or yttria, zirconia can maintain the tetragonal phase at room temperature. The transformation of martensitic tetragonal to monoclinic phase may be initiated by stress, like machining, wear, or water which causes a volume expansion by 3–4%. This leads to stoppage of crack

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propagation. Zirconia has a flexural strength ranging between 800 and 1200 MPa and a fracture toughness ranging between 6 and 8 MPa.[8-11]

MATERIALS AND METHODOLOGY

A thorough search was performed through PubMed, a bibliographic search on the international literature. Studies from the past 10 years from January 2017 to January 2007 were searched. The following words were searched: Cementation of dental zirconia, studies in English language, *in vitro* studies, randomized clinical trials, review, meta-analysis, monolithic zirconia, and crack propagation. Following words were excluded: Cementation of endodontic post, descriptive studies, case reports, discussion articles, and opinion letter. Medical subject heading terms used were bonding, luting, zirconia ceramic, zirconium oxide ceramic, bond strength, and surface treatments. Finally, using all this, a review was formulated.

DISCUSSION

Monolithic zirconia crowns are gaining a lot of popularity in the field of restorative dentistry. While there are a variety of dental cement presently available in the market including zinc phosphate cement (ZPC), polycarboxylate cement (PC), glass inomer cement (GIC), and resin cement, for luting of crowns, there are no well-established guidelines for the selection of cement for the monolithic zirconia restorations.[12]

Dental cement provide stability and retention to the restorations in the complex oral environment. Retention mechanisms may be further divided into chemical, mechanical, and micromechanical elements. In general, 2 or 3 mechanisms work together in combination, depending on the nature of the cement and material.[13] Following are various kinds of cement used:

ZPC

It has been initially counted as one of the most useful cement for luting of crowns in spite of its various drawbacks such as lack of adhesion, solubility, and low hardness properties. Even now this cement is used for some all-ceramic systems, but its long-term effect is not yet established. Although CAD/CAM has greatly improved the final marginal accuracy of crowns, there is the presence of large internal gaps which may require thicker cement layers for the abutments.[14,15]

PC

Polycarboxylate was the first cement discovered to exhibit adhesive properties to the tooth. However, it has low compressive strength and tensile strength. It may also undergo significant plastic deformation under functional force after set.[11]

GIC

This cement is widely used for luting of prosthetic crowns. It has several clinical advantages, including physicochemical bonding to tooth structures, low coefficients of thermal expansion, and long-term release of fluoride. However, it has low mechanical strength. This compromises its use in the high strength region prosthesis. Hence, GIC would not be a preferred cement for ceramic restorations which require support from the cement.

Resin Cement

Resin cement are composed of bisphenol-A-glycidyl methacrylate and other methacrylates. It has properties such as high bonding strength, high compressive strength, and low solubility. It is widely used as the choice of cement for ceramic restorations due to the disadvantages of other cement such as lack of solubility, support, and adhesion. It plays a significant role in the final clinical success of the treatment.[16-19]

From a study of Luthy *et al.*,[20] it was contemplated that bond strength of glass-ionomer cement and conventional Bis-GMA-based composites was much lower, especially after aging by thermocycling. The combination of sandblasting and phosphate monomer 10 methacryloyloxydecyl dihydrogen phosphate (MDP) used for the cementation of crown is the best for resin cement according to few recent studies.[21] MDP monomer can make a chemical bond with metal oxides, such as zirconium oxide.[20,22] The mean bond strength using macroshear test was higher in MDP-based cement after physiochemical conditioning.

They are also known as self-adhesive cement.

Several authors have studied different cement and their role in adhesion. Various cement can be used for different materials. Proos *et al.*[23] worked on the influence of adhesive resin and ZPC on in-ceram coping and gold coping, and their results suggested that the type of dental cement has a minor effect on the resultant stress distribution. Kamposiora *et al.*[24] studied the stress level and distribution of the cement layer with four types of cement and found that zinc phosphate cement shows a greater stress value than other cement materials. According to a study by Abdelaziz *et al.*,[25] cement substrate bonding quality is not affected by the size of sandblasting particles. Resin cement bond better to different coping substrates. Self-adhesive resin cement is the best choice to bond zirconia-based substrates.

A study by Nakamura *et al.*[26] on the effect of cement on fracture resistance of monolithic zirconia crowns exhibited that crowns with a minimum thickness of 0.5 mm may have a good resistance against fracture in spite of any cement used.

May *et al.*,[27] who studied the influence of the cement thickness and bonding condition on the feldspathic porcelain crown, found that the well-fitted, bonded feldspathic crown can withstand a greater load than the non-bonded crown, but the bonding effect disappears under a large cement layer.

Not only the properties of cement but also the surface of zirconia play an important role in adhesion. The primary prerequisite for an effective adhesion of polymeric compounds is to have a clean surface free of contaminants which can be gained by surface conditioning. This can be achieved by various methods such as grinding zirconia specimen with silicon carbide paper, use of various solvents, use of abrasives such as aluminum oxide (Al2O3) and silica, air abrasion, cleaning agents, or primers.

Although a lot of articles have been compared and analyzed in this review, more research needs to be done. There is not a perfect cement for any material. All the cement have some advantages and disadvantages. Depending on the material of the crown and various other factors, one should choose the cement which best suites that particular case.

CONCLUSION

Basing on this literature review, we derive the following conclusions:

Sandblasting with Al2O3 is the best surface treatment for improving adhesion between resin cement and zirconia. Although some studies have indicated sandblasting with Al2O3 as potentially damaging for mechanical properties of the material, it is the best surface treatment for improving adhesion between resin cement and zirconia. Silanization and acid etching are not effective on zirconia because it is inert and without glassy matrix on which those substances act. Resin cement with MDP monomer is the recommended cement for monolithic zirconia crowns.

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