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ORIGINAL RESEARCH

Comparative study of displacement resistance of four zirconia cements

Estudio comparativo de la resistencia al desplazamiento de cuatro cementos en zirconia

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ABSTRACT

Objective: To compare displacement resistance of four cementing agents. **Material and methods:** An experimental, cross-sectioned prospective research was conducted to assess four cementing agents. Three agents were resinous, self-adhesive, dual polymerization cements containing MDP (10-metacryloxydecyl dihydrogen phosphate), and the remaining was a conventional glass ionomer cement. In the experiment, 40 samples of zirconia partially stabilized with yttrium were prepared. All samples were treated following their specific manufacturer's instructions. Samples were prepared, they were then stored at 100% humidity in a temperature chamber at 37 °C for 24 hours; after this, samples were subjected to shearing detachment mechanical tests at a 1 mm per minute speed in a universal machine for mechanical testing. **Results:** Glass ionomer samples failed before being taken to the universal testing machine. Remaining three cements did not show statistically significant differences. **Conclusions:** Adhesion capacity of glass ionomer to zirconia is nil or extremely low. Likewise, resinous cements containing MDP in their formula, either in their bonding agent or in the cement formulation itself, are presently the best alternative to increase adhesion to a zirconia structure.

RESUMEN

Objetivo: Comparar la resistencia al desplazamiento de cuatro agentes cementantes. **Material y métodos:** Se realizó una investigación prospectiva, transversal y experimental en la que se evaluaron cuatro agentes cementantes, tres de ellos resinosos autoadhesivos de polimerización dual y con contenido de MDP (10-metacriloxidecil dihidrógeno fosfato) y un ionómero de vidrio convencional. Se realizaron 40 muestras de zirconia parcialmente estabilizada con itrio, se dividieron en cuatro grupos, cada uno de ellos fue tratado de acuerdo con las indicaciones del fabricante del cemento a estudiar, se realizaron las muestras, se almacenaron en humedad al 100% en una cámara a una temperatura de 37 °C durante 24 horas para después ser sometidas a pruebas mecánicas de desprendimiento por cizallamiento a una velocidad de 1 mm por minuto en la máquina universal de pruebas mecánicas. **Resultados:** La muestras de ionómero de vidrio fracasaron antes de ser llevadas a la maquina universal, entre los otros tres cementos no existe diferencia estadísticamente significativa. **Conclusiones:** La capacidad de adhesión de ionómero de vidrio a la zirconia es nula o muy baja. Igualmente los cementos resinosos que contengan en su fórmula MDP, ya sea en su agente de acoplamiento o en la fórmula misma de los cementos, son en la actualidad la mejor alternativa para incrementar la adhesión a una superficie de zirconia.

Key words: Cementing agents for zirconia.
Palabras clave: Agentes cementantes para zirconia.

INTRODUCTION

Zirconium oxide partially stabilized with yttrium (Y-TZP) better known as zirconia, has constituted a great success in the field of biomaterial research. Since the decade of the '70s, use of zirconia in dentistry was evidenced through studies proposing its use as a coating for implants.[1] Nevertheless, it was only in the '90s when there were first reports of its use in implants.[2] In 1991, there were reports of zirconia use in orthodontic brackets.[3] Use of zirconia in the field of restorative dentistry began during the middle of this decade when it was used for manufacture of

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intra-root posts and crowns manufactured with CAD/CAM as well as appliances for rehabilitation of dental implants and fixed partial prostheses.[4-6] To the present date, zirconia treatments, due to their high values of fracture resistance, have become ideal candidates to manufacture ceramic prostheses in areas of high mechanical compromise.

The main attribute of Y-TZP (Yttria tetragonal zirconia polycrystalline) was described by Garvie in 1975, when he described the **resistance to transformation** phenomenon, in which, partially stabilized zirconia in tetragonal phase, in the presence of a high stress area such as the extreme of a crack, suffers phase change in that area, passing to crystalizing that area in the monoclinic phase. This change involves an approximately 5% volume increase of the zirconia particle, able to seal the crack. Thus, healing of the area is ultimately achieved arresting crack increase *(Figure 1)*.[7]

Y-TZP is a fracture-resistant material with excellent mechanical properties, it is considered to be biotolerable, and provides flexural strength of more than 900-1200 MPa, these are values two to three times higher than maximum mastication forces (200 to 400 N in anterior teeth and up to 600 N in posterior teeth). This flexural strength is higher than that exhibited by any other previously developed ceramic materials for dental use.[8] It also exhibits a yield strength higher than almost all metallic alloys used in dentistry, its elasticity module (205 GPa) is somewhat lower than that exhibited by stainless steel (210 GPa) and similar to that of titanium alloys (Ti6Al4V);[9] it presents thermal conductivity lower than alumina (zirconium 2.5 W 7 Mk versus alumina 30 W7mk at 37 ºC),[8] therefore, probability of triggering hypersensitivity in the case of sudden thermal changes is decreased.

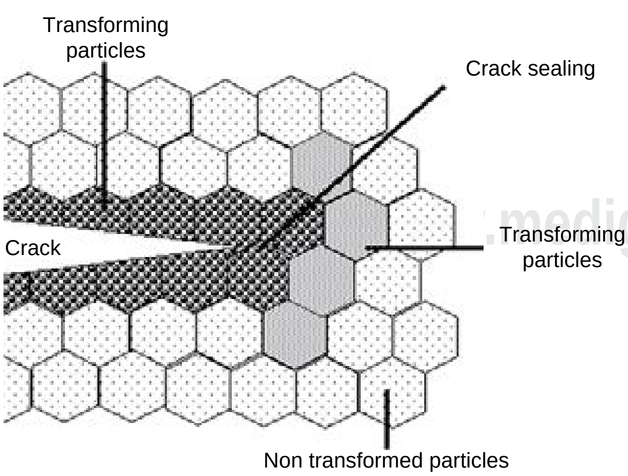

Figure 1. Representation of stress-induced transformation resistance process.

It is a highly biotolerable material[10] with low radioactivity, with radio-opacity similar to that of metals,[11] allowing thus excellent radiographic contrast.

Nevertheless, zirconia is not devoid of problems, among them we can count spontaneous degradation (related to hydro-thermal transformation) and stress derived from manufacturing process.[12] With respect to an ideal cementing agent, even though many research projects have been conducted, to this date, there are no strong results to help us determine which cementing system can be more suitable or more effective, therefore, protocols with resinous cements as well as glass ionomer protocols are recommended.[13,14]

Zirconium is an acid-resistant ceramic material, differing from vitreous porcelains, it does not react to acid etching, moreover, it is quite unstable when subjected to thermal and mechanical changes.[15] Traditional protocols of acid etching with hydrofluoric acid and silanization used to adhere other ceramic structures to dental structure are not applicable to zirconia, since there is absence of vitreous matrix and its nature is relatively inert; this renders it a low reactivity surface.[16,17] Development of selective acid etching methods, sanding or infiltration have been attempted in order to prime zirconium surfaces to chemically or micromechanically adhere to dental structure with the use of resinous cements, targeting improvement of their mechanical properties without generating stress on the structure which might cause fractures and thus lead to failure.[14,18] Nevertheless, to the present date, there are no studies to support effectiveness and durability of new protocols proposed for roughness generation (sanding, three-fold mechanical/chemical treatment, porcelain pearls, plasma spray) and thus chemically activate the zirconia surface (silanization, acrylization, silicon tetrachloride vaporization, MPD silanes and cements).[19]

Presently the most widely used technique to cement zirconia restorations would be use of sanding with aluminum oxide micro-spheres (50-110µ, 2 to 3 pressure bars, 3 to 4 cm distance) along with cementing agents which contain phosphate monomers (MDP)[8,19] are perhaps the technique more frequently used to cement zirconia restorations. It has been shown that cements containing monomer 10 metacryloxydecyl dihydrogen phosphate (MDP) exhibit particular affinity to metallic oxides such a zirconium dioxide, alumina and metal. MDP is a relatively hydrophobic monomer, due to its 10 carbons chain; it contains a hydrophil phosphate terminal which chemically adheres to zirconium oxide, and a polymerizable methacrylate terminal which adheres to resin.[20]

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