

## ADHESIVE CEMENTATION PROTOCOL OF ZIRCONIA RESTORATIONS

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**Abstract:** Reliable cementation of fixed prosthetic restorations represents one of the most sensitive and crucial tasks during the prosthetic dental treatment with desirable long term clinical success. Because of its particular structure, zirconia restorations require a special conditioning before cementation in order to achieve a strong bond to dental structure. The lack of information about adhesive cementation technique of zirconia based ceramics could lead to undesired failure. Our aim is to acquaint practitioners with particular structure of zirconium oxide and microscopic interaction with resin cement in adhesive cementation.

We have studied the indication for use of eight out of the most used Zirconia brands in Romania. The results show that every manufacturer indicates to sandblast the inner surface of zirconia copings prior to adhesive cementation. The cementation itself could be done in two ways: usage of phosphate-monomer based luting agent or silicatisation of the zirconia surface followed by a regular adhesive cementation.

**Key words:** zirconia, adhesive cementation, MDP monomer, silicatisation.

### INTRODUCTION

Continuous evolution of dental materials has determined the development of some new manufacturing and cementing techniques for indirect restorations. The popularity of all-ceramic restorations has increased in the last few years because of their superior esthetic appearance and metal-free structure. Due to the relatively recent entry of zirconia and alumina based ceramics in Romanian dental practice, there is a lack of information about adhesive cementation technique respectively, about the special preparation of zirconia and alumina surface in order to use adhesive cement.

Achieving the bond between any resin cement and a ceramic material requires surface conditioning. For regular glass-ceramic restoration is recommended 4-5 % Hydrofluoric acid etching and the

usage of a silane coupling agent in order to obtain a chemical network between silica from the ceramic surface and resin matrix. The lack of vitreous phase (below 1%) of densely sintered alumina and yttria-tetragonal zirconia polycrystal (Y-TZP) ceramics makes them resistant to acid etching. As a consequence, alternative conditioning methods have been proposed: sandblasting and use of a MDP (10-methacryloyloxydecyl dihydrogen-phosphate) primer/cement or silica coating of zirconia surface and use of regular adhesive cement.

The purpose of our study is to identify what surface conditioning recommends each manufacturer of the most used zirconia brands in Romania.

## METHOD

In Romanian dental laboratories are currently used few of the many available brands of zirconia such as: ZirCAD (Ivoclar Vivadent), Cercon®Zirconia (Dentsply), Zirox (Wieland), Procera Crown Zirconia (Nobel Biocare), Ceramill (Amann Girrbach), Lava (3M Espe), inCoris (Sirona) and inVizion (Vita). The manufacture process of restorations is either CAD/CAM or manual milling of pre-sintered zirconia blocks followed by final sintering. We have studied the indications provided by each manufacturer regarding to preparation of the inner surface of zirconia restorations for the adhesive cementation. In same time we have inquired ten dental technicians, as follows: Bucharest (4), Constanța (1), Iasi

(2), Timisoara (2), Cluj (1) who are frequently using these brands of ZrO<sub>2</sub> in order to find out how they are conditioning the zirconia copings.

## RESULTS

All eight manufacturers (Table 1) indicate the sandblasting of the inner surface of zirconia restoration with Al<sub>2</sub>O<sub>3</sub> particles, 50-110 μm sizes, at different pressures (1-2,8 bar). Furthermore, they indicate the usage of a primer or adhesive cement with MPD monomer. The only exception is 3M Espe which provides one product for silicatisation, Rocatec®Plus, silica-coated Al<sub>2</sub>O<sub>3</sub> 110 μm particles, in order to improve the bonding between a non-MDP resin cement like Relyx ARC® and zirconia surface.

Zirconia	Sand blasting	Pressure	Silicatisation	Silanisation	Adhesive Cement self/adhesive
<b>IPS ZirCAD</b> Ivoclar	Al <sub>2</sub> O <sub>3</sub>	1 bar	NO	Monobond Plus®Ivoclar	Variolink® II Ivoclar Multilink®Ivoclar SpeedCEM®Ivoclar
<b>Cercon</b> Dentsply	50μm Al <sub>2</sub> O <sub>3</sub>	2-3 bar	NO	Prime&Bond NT® Dentslay	Calibra Esthetic Resin Cement®Dentsplay
<b>Zirox</b> Wieland	Al <sub>2</sub> O <sub>3</sub>	1 bar	NO	ED Primer A, B®Kuraray	RelyX Unicem®3M Espe Panavia®F2.0 Kuraray
<b>Procera Zirconia</b> Nobel Biocare	max. 100 μm Al <sub>2</sub> O <sub>3</sub>	2,5 bar	NO	Alloy Primer® Kuraray	Panavia® 21TC Kuraray RelyX Unicem®3M Espe
<b>Ceramil</b> Amann Girrbach	110 μm Al <sub>2</sub> O <sub>3</sub>	1 bar	NO	Monobond Plus ®Ivoclar	Multilink®Ivoclar
<b>Lava</b> 3M Espe	Al <sub>2</sub> O <sub>3</sub> +Si O <sub>2</sub>	≥2,8 bar	YES	Espe Sil®3M Espe	RelyX™ ARC®3M Espe*
			NO	NO	RelyX Unicem®3M Espe
<b>inCoris</b> Sirona	50μm Al <sub>2</sub> O <sub>3</sub>	≤2,5 bar	NO	NO	Panavia®F2.0 Kuraray Panavia® 21TC Kuraray
<b>inVizion</b> Vita	max. 50μm Al <sub>2</sub> O <sub>3</sub>	2,5 bar	NO	NO	Panavia®F2.0 Kuraray Panavia® 21TC Kuraray

Table 1 Manufacturer's indications for adhesive cementation

\*non MDP Adhesive Cement

The technicians have unanimously answered that they send the zirconia restorations to dental practices without any special conditioning, neither sandblasting, nor silicatisation.

**DISSCUTIONS**

Reliable cementation of fixed prosthetic restorations represents one of the most sensitive and crucial tasks in the course of prosthetic dental treatment for long term clinical success. Any error during the cementation process could affect esthetic result or, even more, the lastingness of restoration. The bonding between a tooth and a restoration is supposed to provide better retention, marginal adaptation, higher fracture resistance of restorations and, moreover, the inhibition of secondary caries.

The zirconia based ceramic is a glass-free (vitreous phase below 1%) polycrystalline microstructure, with high fracture strength and fracture toughness but in the same time an acid-resistant or non-etchable material. This fact determines poor adhesion for resin

cements. For this reason, there have been some efforts of manufacturers and researchers to modify the surface properties of zirconia by using various methods. The most used two are:

1. The first method recommends a ceramic primer or resin cement, which contains a bio-functional monomer, 10-methacryloyloxydecyl dihydrogen-phosphate (MDP). This monomer has the same basic chemical structure as any primer or bonding M-R-X, where M represents a methacryl group and its role is to copolymerize with resin matrix, R is a different length hydrocarbon chain with spacer function and X is an acidic phosphate group and has the property to combine directly with metal oxides as  $ZrO_2$ ,  $Al_2O_3$ , etc. (fig.1). In the same time it provides the highest bond strength to dentin among the functional monomers from adhesive systems.

The cementation protocol on natural teeth supposes dentin conditioning, zirconia surface conditioning with a special MDP primer and MDP or non-MDP composite cement (fig.2).

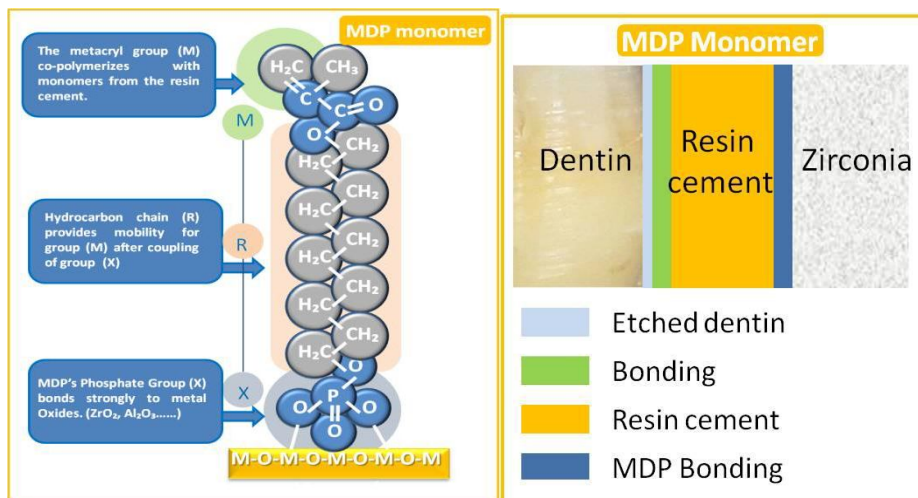


Fig. 1 MDP monomer – chemical structure

Fig.2 Successive layers between dentin and zirconia surface in MDP cementation

In vitro studies indicated that the presence of MDP monomer in both ceramic primer and resin cement provides higher bond strength than the usage of only one of them, MDP primer or MDP resin cement.

2. The second method called “silicatisation” is usually applied in dental laboratories and is an airborne particle

abrasion using 50-110  $\mu\text{m}$   $\text{Al}_2\text{O}_3$  coated with silica (fig.3). Due to the very high speed of these particles, about 1000km/h, these are embedded on the ceramic surface with the result of a chemically silica-modified surface. Furthermore this surface is acting as a usual glass ceramic surface, and resin cement bonds to it via silane coupling agent (fig.4).

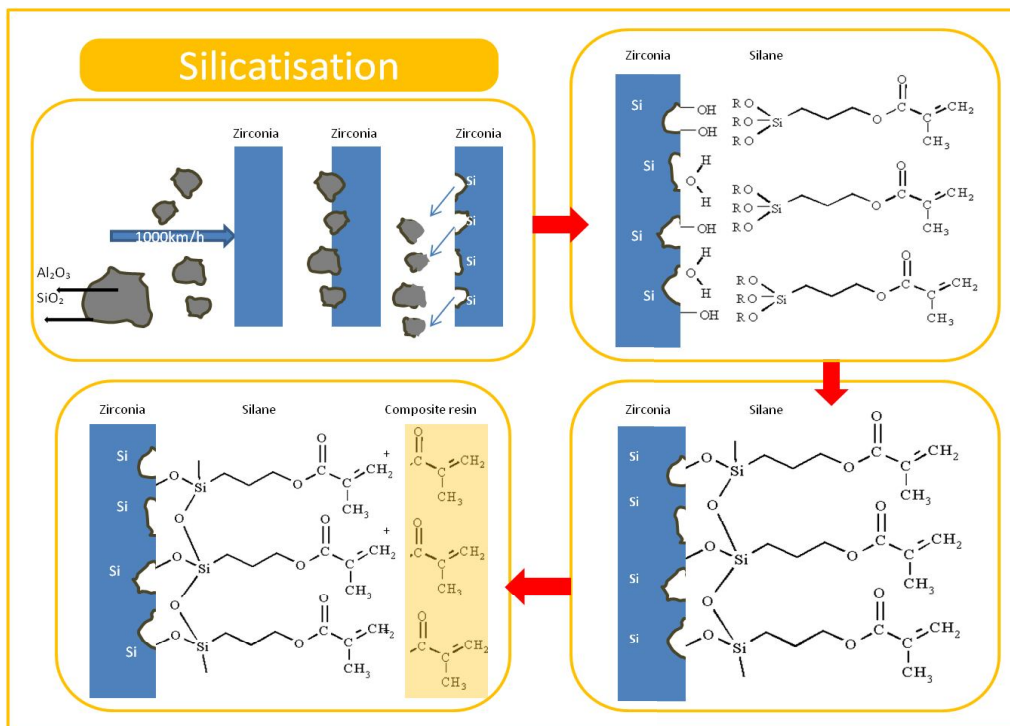


Fig. 3 Silicatisation process

Because the bond of resin cement to glass ceramic is already studied and seems to be possible, some researchers are trying to develop new technologies for etching zirconia surface such as: hot etching, selective infiltration-etching or microwave thermal etching, but these are still experimental methods and further clinical studies are necessary to investigate the bond strength achieved in this way. From the same perspective, other authors propose so-called “Internal coating

technique”, silica based ceramic layer fused to zirconia surfaces which can be conditioned as a glass ceramic surface.

Based on the both theories, some researchers adhere to the idea that a combination between MDP monomer and a silane-coupling agent on silica-coated zirconia restoration could be a promising method for improving bond strength of resin cements. It seems that the hydrophilic silane coupling agent can play a double role: to form a stabile network

between Si particles from glass ceramic surface and resin matrix and the second one, due to its wettability it could promote the adherence of hydrophobic resin matrix

on hydrophilic surface such silica, glass, glass-ceramic, or even adequate pretreated Zirconia surfaced.

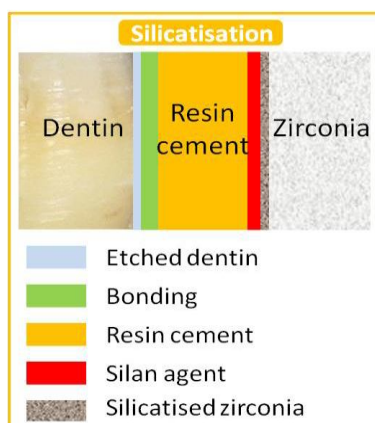


Fig. 4 Successive layers between dentin and zirconia surface in silicatisation/silanisation cementation

## CONCLUSIONS

Adhesive cements have different composition and lack of knowledge concerning the properties of these materials and their interaction with zirconia/alumina may compromise long-term outcome. After a fairly extensive literature review and research appears that there is not a unique specific surface treatment protocol recommended to optimize zirconia bonding. Different

studies have different results about the best way to achieve a strong bond to this dental material and only our own knowledge and practical experience can lead us to the proper alternative of adhesive protocol.

Consequently, the dentists must consult the manufacturers' recommendation on how to optimally treat the internal surface of zirconia and what resin cements are compatible with the specific brand they use.

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