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Influence of Micromechanical Roughening and Chemical Conditioning on Bond Strength to Zirconia

Ahmed Abdelhafeez Abdelsattar mohamed, Prof. Dr.Ahmed Attia Abo-Elnaga, Dr. Nesma Elgohary

B.D.S. (2013), Faculty of Dentistry, Mansoura University
Professor andChairman Deptof Fixed Prosthodontics, Faculty of Dentistry, Mansoura University
Lecturer of Fixed Prosthodontics, Faculty of Dentistry, Mansoura University

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I. INTRODUCTION

Ceramic materials have rapidly become the material of choice for indirect restorations as they have excellent esthetic and mechanical properties. There are a variety of material types available for use such as feldspathic ceramics, glass ceramics and many types of zirconia. [1]

Zirconia, the strongest of the dental ceramics is widely used as a dental restorative material due to its proven biocompatibility and superior mechanical properties.[2]Increasinglybeing fabricated in monolithic form for a wide range of clinical applications. Y-TZP (yttria-stabilized tetragonal zirconia polycrystal) is the most widely used variant.[3]

The development of computer-aided design or computer-aided manufacturing (CAD/CAM) technology has focused on the precise and consistent manufacturing of high strength and tough zirconia ceramics.[4]With CAD-CAM technology, the design and fabrication process is less time-consuming, less technique sensitive, and does not require multiple steps when compared with the conventional method.[5]

The problem of the clinical use of Y-TZP ceramic is a deficiency in luting with adhesive resin cements. Due to a lack of silicon dioxide and glass phase, ordinary methods of cementation, including ceramic silanization and hydrofluoric acid etching, do not work effectively for zirconia. So that adequate adhesion of the restoration is very important.[6]

To create a strong bond between a resin and ceramic, mechanical and chemical retention are needed. Various surface treatments have been suggested for resin bonding to zirconia including sandblasting, tribochemical silica coating,piranha solution, hydrofluoric acid and laser irradiation.[7]

Sandblasting is important to achieve durable bonding to zirconia through micromechanical interlocking between zirconia and resin cements. Sandblasting with Al2O3 particles is one of the most simple, functional, and widely used procedures. This procedure cleans and roughens the surface to increase the bonding surface area for mechanical interlocking and increase the wettability of the zirconia surface for bonding agents. Airborne-particle abrasion may be performed with different sizes of Al2O3particles.[8 ,9]

The negative influence of sandblasting has also been reported , such as the tetragonal to monoclinic phase (T→M) transformation in surface crystalline structure, as well as the formation of surface flaws and micro cracks which could lead to decrease in the reliability of zirconia framework.[10]However, it was proven that resin cement can flow into microcracks and therefore significantly strengthen the ceramic.[11]

Liu et al ,[12]studied the effects of various chemical surface modifications on adhesion between zirconia and resin adhesives and confirmed that etching of the zirconia using a mixture of HF acid of concentration 48% and HNO3 of concentration 69% with a 1:1 proportion at 100 ◦C for 25 min, leads to an improved dissolution rate of zirconia grains, surface roughness and bonding surface area to cement, with no phase transformation, that improves resin zirconia adhesion.

Another study evaluated the influence of hot acid etching pre-treatment of zirconia crowns and found that it improves zirconia crowns retention with adhesive cements. [13]

In terms of chemical bonding, the application of 10-methacryloyloxydecyl dihydrogen phosphate (MDP)-containing bonding agents can increase bond strength to zirconia because of an interaction between the hydroxyl groups of MDP and the cationic surface of zirconia.[14]

Some studies have evaluated the effect of silica coating on the bond strength of acid-resistant ceramics bonded to resin luting agents [15,16,17]. They found that silica coating "energizes" the substrate surface, which allows the silica to adhere to it. Also, silane improves the bond between the silica adhered to the substrate and the resin matrix. The CoJet System (3M ESPE, Seefeld, Germany) may significantly increase the bond strength for high-alumina and zirconium-oxide ceramics compared to that of airborne-particle abrasion alone in a clinical condition.

The successful cementing of zirconium oxide-based prosthesis is an important factor in its clinical success. They can be cemented using conventional cements. However, adhesive luting of these restorations has been recommended to improve their retention, marginal adaptation and fracture resistance.[18]

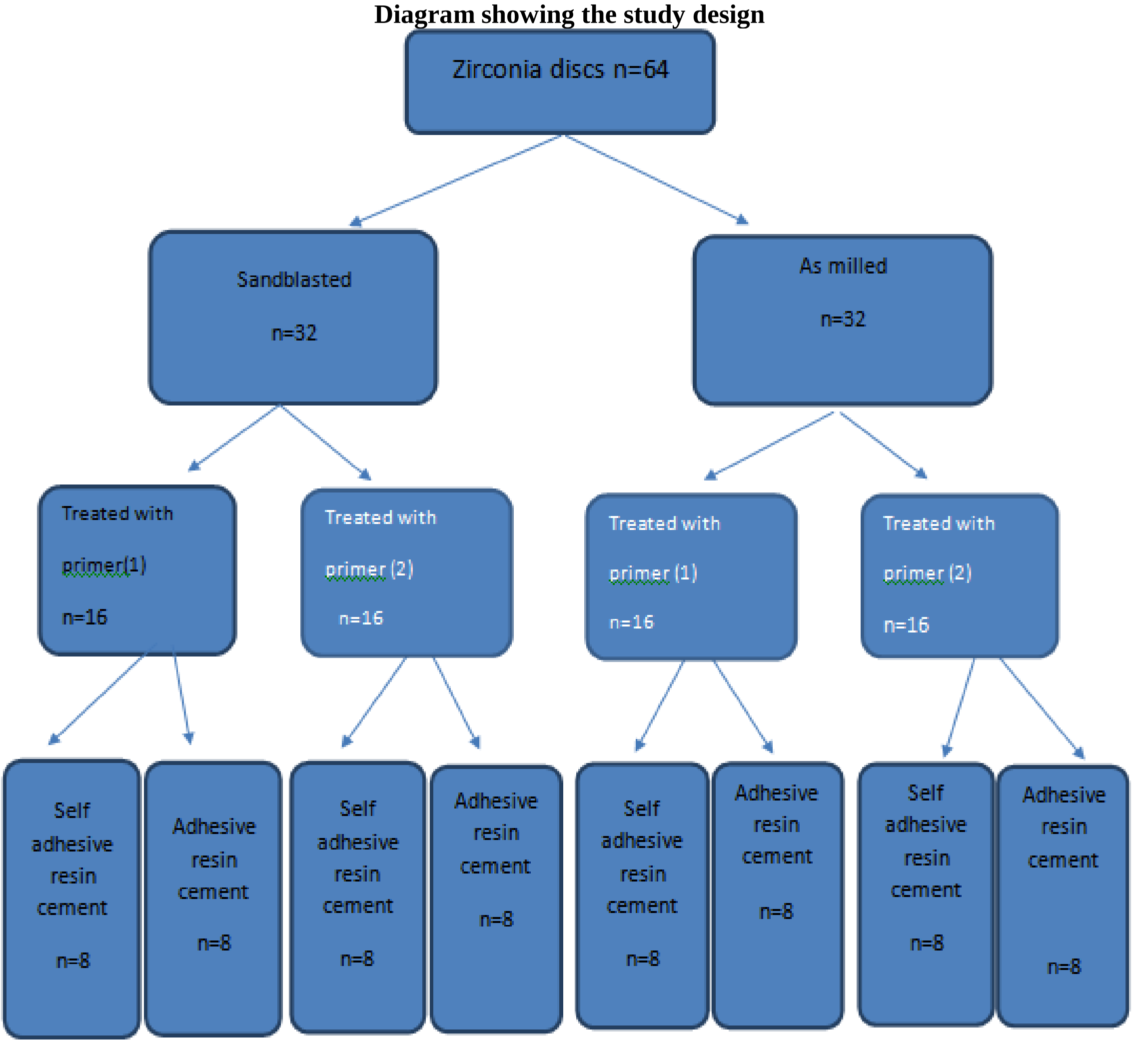
Resin-based cements are generally used for esthetic restorations (ceramic or resin based) and have become popular because they have addressed the disadvantages of solubility and lack of adhesion noted in previousmaterials.[19]MDP-based and self-adhesive resin cements are recommended for zirconia-based restorations. 10-MDP improves surface wettability and forms cross-linkages with methacrylate groups of the resin cement, as well as siloxane bonds, with the hydroxyl groups of the ceramic surface.[20, 21]

II. AIM OF THE STUDY

This in vitro study will evaluate:

The influence of zirconia primers as a chemical surface conditioning with and without micromechanical surface treatment on bond strength of resin cements to zirconia.

Diagram showing the study design



III. METHODS:

A total of 64 zirconia discs will be laboratory fabricated with 8 mm diameter and 3 mm thickness. Discs will be divided into2 main groups**:**

Group 1 : Discs as milled (n=32)

Group 2 : Discs will be air abraded with AL_2O_3(n=32)

Each main group will be subdivided into 2 subgroups (n=16) according to type of primer to be used:

primer 1 (n=16)

primer 2 (n=16)

Each subgroup will be divided into 2 division (n=8) according to type of luting cement will be used for bonding.

Division 1 (n=8) adhesive resin cement

Division 2 (n=8) self-adhesive resin cement

One hour after cementation, bonded specimens will be stored in water bath at 37℃ for 3 months followed by thermal cycling for 3000 thermal cycles. A universal testing machine will be used for recording bond strength of each bonded specimen. Data will be collected and tabulated for statistical analysis.

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