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Comparative adhesive cementation of lithium disilicate and zirconia crowns: two clinical case reports

Badanie porównawcze adhezyjnego cementowania koron z dwukrzemianu litu i cyrkonii: dwa opisy przypadków klinicznych

Malek Abidi[1], Rim Kallala[1], Soumaya Touzi[1], Jilani Saafi[2]

[1] **Department of Dental Anatomy, University of Monastir, Faculty of Dental Medicine, Research Laboratory of Occlusodontics and Ceramic Prostheses LR16ES15, 5000, Monastir, Tunisia**
Head: Professor *Soumaya Touzi*

[2] **Department of Fixed Prosthodontics, University of Monastir, Faculty of Dental Medicine, Research Laboratory of Occlusodontics and Ceramic Prostheses LR16ES15, 5000, Monastir, Tunisia**
Head: Professor *Jilani Saafi*

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Summary

Adhesive bonding is the reference approach for luting all ceramic crowns because it creates micromechanical and chemical interaction between the tooth substrate and the restoration. This interaction increases retention, limits microleakage, improves marginal adaptation and supports aesthetic integration. The bonding strategy depends on the ceramic microstructure. Glass ceramics such as lithium disilicate can be etched with hydrofluoric acid to create surface porosities, followed by silane application to promote chemical coupling with resin cement. Zirconia does not respond to acid etching and requires air particle abrasion combined with a phosphate monomer containing primer and adhesiveresincementaccordingtotheAPCconcept. Two clinical cases of anterior reconstructions treated in the fixed prosthodontics department of the dental clinic of Monastir Tunisia illustrate these protocols. Maxillary anterior teeth restored with a lithium disilicate crown received hydrofluoric acid etching, silanization, and

Streszczenie

Bonding adhezyjny jest referencyjną metodą cementowania koron całoceramicznych, ponieważ tworzy mikromechaniczną i chemiczną interakcję między podłożem zęba a wypełnieniem. Interakcja ta zwiększa retencję, ogranicza mikroprzecieki, poprawia adaptację brzeżną i wspiera integrację estetyczną. Strategia wiązania zależy od mikrostruktury ceramiki. Ceramikę szklaną, taką jak dwukrzemian litu, można wytrawić kwasem fluorowodorowym w celu uzyskania porowatości powierzchni, a następnie nałożyć silan, aby przyspieszyć chemiczne wiązanie z cementem żywicznym. Tlenek cyrkonu nie reaguje na wytrawianie kwasem i wymaga abrazji powietrznej w połączeniu z primerem zawierającym monomer fosforanowy i cementem żywicznym adhezyjnym zgodnie z koncepcją APC.

Dwa przypadki kliniczne rekonstrukcji w odcinku przednim, leczone w oddziale protetyki kliniki stomatologicznej w Monastyrze w Tunezji, ilustrują te protokoły. Przednie zęby szczęki odbudowane koroną z dwukrzemianu litu zostały *adhesive resin cementation. Another anterior tooth restored with a zirconia crown underwent air abrasion, application of an MDP containing primer, and composite resin cementation. Both approaches achieved accurate marginal fit, stable retention and satisfactory aesthetic integration. Material specific adhesion remains decisive for long term clinical performance. Hydrofluoric acid etching with silane ensures durable bonding to lithium disilicate as demonstrated in laboratory and clinical studies that report high bond strength and survival rates. The APC concept improves zirconia bonding through micromechanical retention and chemical interaction between MDP and zirconium oxide. Correct selection and execution of these protocols determine the functional stability and aesthetic durability of anterior ceramic crowns.*

wytrawione kwasem fluorowodorowym, poddane silanizacji i zacementowane żywicą adhezyjną. Inny ząb przedni odbudowany koroną z tlenku cyrkonu poddano abrazji powietrznej, nałożeniu primera zawierającego MDP i zacementowaniu żywicą kompozytową. Obie metody zapewniły dokładne dopasowanie brzeżne, stabilną retencję i satysfakcjonującą integrację estetyczną.

Adhezja specyficzna dla danego materiału pozostaje decydująca dla długoterminowej skuteczności klinicznej. Trawienie kwasem fluorowodorowym z silanem zapewnia trwałe wiązanie z dwukrzemianem litu, co potwierdzają badania laboratoryjne i kliniczne wykazując wysoką wytrzymałość wiązania i wskaźnik przeżywalności. Koncepcja APC poprawia wiązanie tlenku cyrkonu poprzez mikromechaniczną retencję i chemiczną interakcję między MDP a tlenkiem cyrkonu. Prawidłowy dobór i przeprowadzenie tych protokołów decyduje o stabilności funkcjonalnej i trwałości estetycznej koron ceramicznych w odcinku przednim.

Introduction

Ceramic materials play a fundamental role in modern restorative and prosthetic dentistry due to their excellent aesthetic, mechanical and biological properties.[1] Their ability to reproduce the translucency, colour and surface texture of natural teeth makes them the materials of choice for highly aesthetic restorations, particularly in the anterior region. Among contemporary ceramics, lithium disilicate glass-ceramics and zirconia-based ceramics are the most commonly used materials for full-coverage crowns.

To fully exploit the advantages of these ceramics and ensure optimal clinical performance, adhesive cementation has become essential. Bonding is therefore considered the gold standard for the placement of all-ceramic crowns, as it ensures strong micromechanical and chemical adhesion between the restoration and the tooth substrate. This results in improved retention, enhanced marginal adaptation, reduced microleakage and superior aesthetic outcomes.[2]

Nevertheless, bonding protocols are highly material-dependent. Lithium disilicate ceramics are silica-based and can be predictably etched with hydrofluoric acid, followed by silane application to achieve durable adhesion. In contrast, zirconia is a polycrystalline, non-etchable ceramic that lacks a glassy phase, making conventional etching ineffective. Adhesion to zirconia, therefore, relies on alternative strategies, most notably the APC concept (Air-particle abrasion, Primer, and adhesive resin Cementation).[3]

The aim of this article is to compare the adhesive cementation protocols of lithium disilicate and zirconia materials and to illustrate their clinical application through two anterior case reports.

Case presentation

Two clinical cases treated at the fixed prosthodontic department of the dental clinic of Monastir, Tunisia, were selected. Both cases involved anterior teeth requiring full-coverage ceramic crowns with high aesthetic demands.

Fig. 1. Initial situation.

Case 1

A 24-year-old female patient presented to the Department of Fixed Prosthodontics at the Dental Clinic of Monastir for prosthetic restoration of fractured 11 and 12. The teeth were endodontically treated and restored with an unaesthetic resin material (Fig. 1).

Taking into consideration the high aesthetic expectations of the patient, it was decided to perform two all-ceramic lithium disilicate (E-max) crowns on both teeth. After peripheral tooth preparation, the substitution of lost dental tissues was performed with fiber posts and cores (Fig. 2).

Once completed, a full-arch silicone impression was taken, and the shade was selected (Fig. 3). On the day of cementation, rubber dam isolation was performed (Fig. 3).

Fig. 2. Fiber-reinforced post and core restorations.

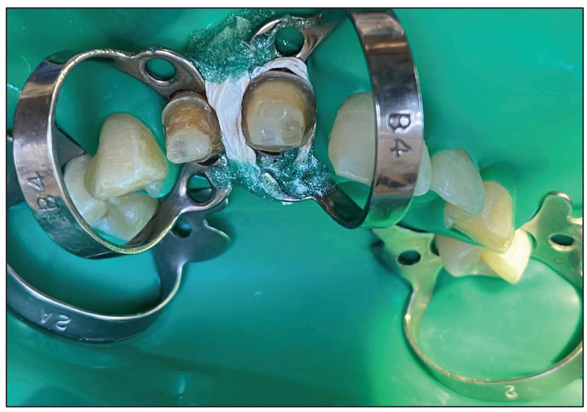

Fig. 3. Rubber dam placement.

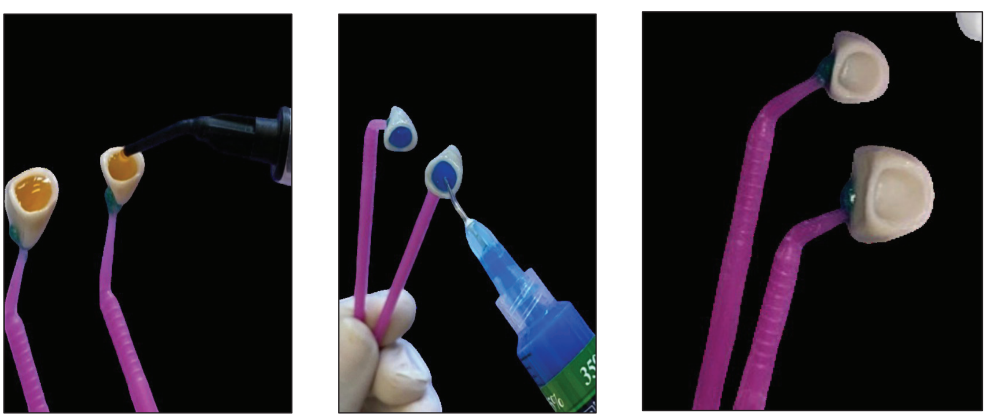

Fig. 4. a – etching with hydrofluoric acid, b – application of orthophosphoric acid, c – after silane application.

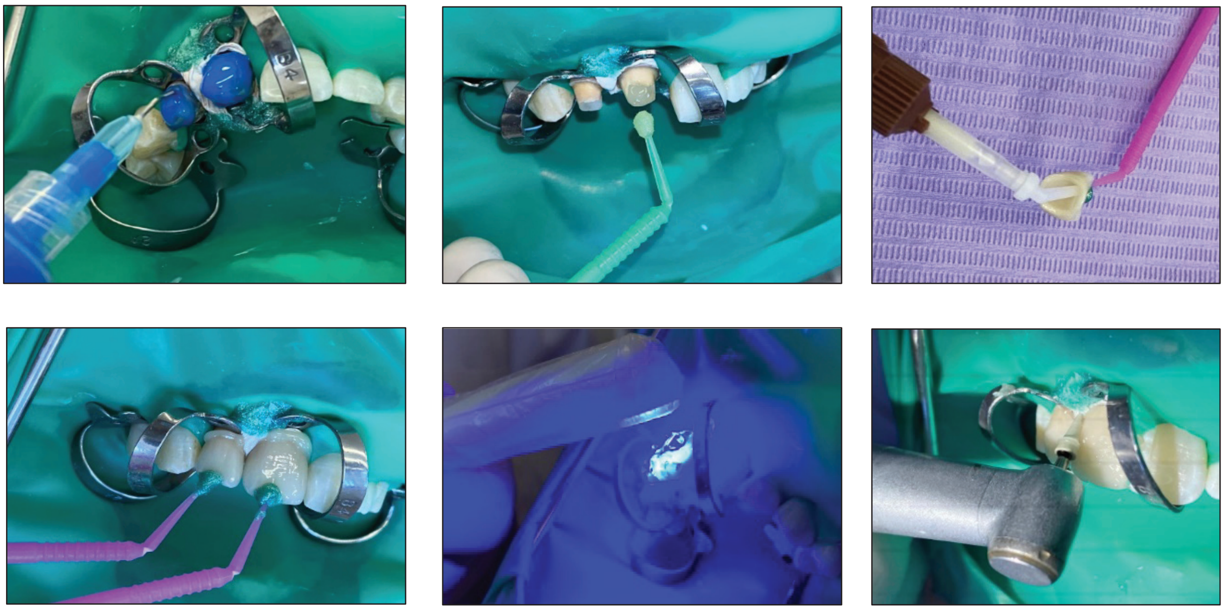

Fig. 5. a – orthophosphoric acid application, b – bond application, c – application of resin cement, d – insertion, e – polymerization, f – excess cement removal.

Fig. 6. Final result.

The internal surface of the lithium disilicate crowns was etched with 4% hydrofluoric acid for 20 seconds (Fig. 4 a) then thoroughly rinsed and dried. Orthophosphoric acid was subsequently applied (Fig. 4 b), followed by rinsing and drying. A silane coupling agent was then applied to promote chemical bonding between the ceramic surface and the resin cement (Fig. 4 c).

The tooth surfaces were conditioned according to an adhesive protocol (Fig. 5 a, b), and the crown was luted using a resin cement (Fig. 5 c, d). Excess cement was carefully removed, and polymerization was completed according to the manufacturer's instructions (Fig. 5 e, f).

Once cemented, static and dynamic occlusion was checked. The patient was satisfied with the final outcome (Fig. 6).

Case 2

A 42-year-old patient presented to the Department of Fixed Prosthodontics at the Dental Clinic of Monastir for the restoration of tooth 21, which was severely damaged and endodontically treated (Fig. 7). Considering the shade of the adjacent teeth, the treatment choice was oriented toward a 3D zirconia crown.

On the day of cementation, rubber dam isolation was performed. The procedure started with the treatment of the intaglio surface: the crown was air-abraded with aluminum oxide, and since the prosthesis had been tried in the oral cavity, it was subsequently cleaned with a zirconia cleaner (Fig. 8 a). A zirconia primer was then applied (Fig. 8 b).

For the tooth surface, etching with orthophosphoric acid was carried out, followed by the application of the adhesive system (Fig. 9 a). Finally, the resin cement was injected (Fig. 9 b), the crown was seated intraorally (Fig. 9 c), and light polymerization was performed (Fig. 9 d).

The final aesthetic and functional outcome is shown in Figure 10.

Fig. 7. Initial situation.

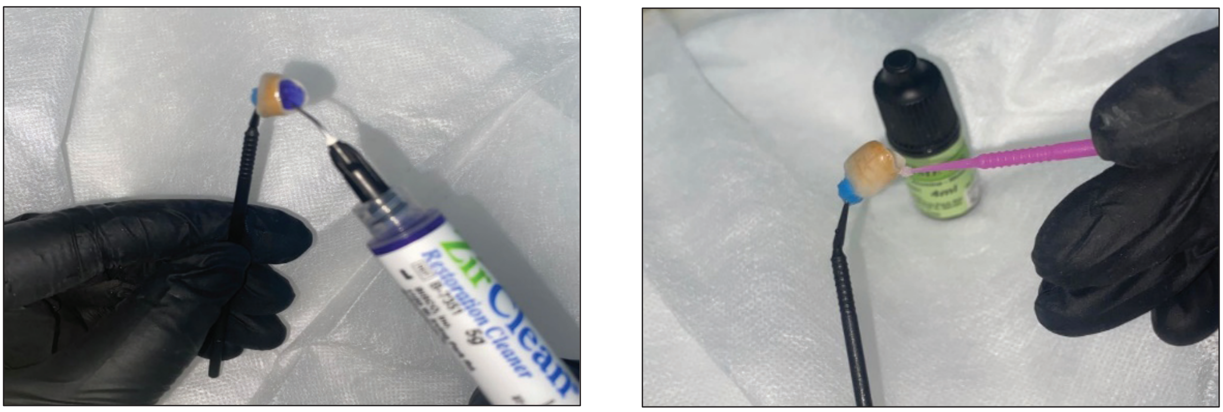

Fig. 8. a – cleaning the internal surface with a zirconia cleaner, b – application of zirconia primer.

Fig. 9. a – application of the adhesive system, b – injection of resin cement, c – insertion, d – light polymerization.

Fig. 10. final result.

Discussion

Matching maxillary central incisors remains one of the most demanding aesthetic challenges in fixed prosthodontics.[4] In the present clinical cases, aesthetic integration was satisfactory for both materials, with harmonious colour matching, stable marginal adaptation and healthy surrounding periodontal tissues at follow-up. No debonding, marginal discoloration, or postoperative sensitivity was observed, confirming the clinical effectiveness of the material-specific bonding protocols applied.

The choice between lithium disilicate and monolithic zirconia should be guided primarily by the aesthetic complexity of the adjacent natural tooth. Optical parameters such as opacity, translucency, circumferential or layered translucency patterns, incisal halos, mamelons, and internal characterizations play a decisive role in material selection.[5] In our cases, material-related differences were mainly related to optical behaviour and bonding requirements.[4]

Lithium disilicate demonstrated superior aesthetic outcomes, particularly in the anterior region, due to its high translucency and excellent light transmission. These properties allowed a more faithful reproduction of the optical characteristics of adjacent natural teeth, including translucency gradients and incisal effects.[5] Despite its lower flexural strength compared with zirconia, lithium disilicate provided adequate mechanical performance for single-unit anterior restorations.[6,7]

Monolithic zirconia exhibited excellent mechanical stability and resistance, ensuring reliable retention and functional performance in both cases. However, its translucency remained inferior to that of lithium disilicate, even with high-translucency zirconia formulations. For this reason, zirconia remains more suitable for posterior crowns, multi-unit restorations, or patients presenting parafunctional habits.[6,8]

Bonding protocols represent a critical determinant of clinical success and are strictly material-dependent. In the lithium disilicate case, a standardized protocol based on hydrofluoric acid etching followed by silane application ensured stable retention and satisfactory marginal integrity.[5] Bonding relies on micromechanical retention combined with durable chemical adhesion through silica-based coupling.[2] Scientific evidence supports the use of approximately 4-5% hydrofluoric acid for 20 seconds, with no clinically significant benefit associated with longer etching times.[9] After hydrofluoric acid etching, insoluble silica-fluoride salts may remain on the ceramic surface. These residues may interfere with resin bonding and reduce bond strength.[10] Several cleaning methods have been proposed to eliminate these deposits, including phosphoric acid application, ultrasonic cleaning in alcohol or distilled water and the use of specific cleaning agents.[11,12]

The application of an additional adhesive layer after silanization remains controversial. Current evidence indicates that this step does not improve bond strength to etched and silanized glass ceramics and may even reduce adhesion by interfering with the silane-mediated chemical coupling.[13]

Zirconia bonding presents specific challenges due to its polycrystalline, non-etchable structure and high susceptibility to contamination during clinical try-in. Saliva contamination significantly reduces bond strength. Among available cleaning methods, air-particle abrasion remains the most effective approach to restoring bonding potential.[14] When mechanical cleaning is not feasible, zirconia-specific cleaning agents represent a reliable alternative.[15]

In the zirconia case, adhesion was achieved using the APC concept, which includes air-particle abrasion, application of a phosphate-monomer–containing primer, and adhesive resin cementation. This strategy has proven effective for achieving durable bonding to zirconia surfaces.[3] The effectiveness of this approach is largely attributed to the chemical interaction between 10-methacryloyloxydecyl dihydrogen phosphate and zirconium oxide. The phosphate group forms stable covalent bonds with zirconia oxide, while the methacrylate group copolymerizes with the resin cement, creating a cohesive and hydrolytically stable adhesive interface.[16-18]

An additional clinical advantage of zirconia lies in its versatility. Depending on preparation geometry and clinical conditions, zirconia restorations may be retained either by conventional cementation or by adhesive bonding.[19] Conventional cementation is sufficient for full-coverage crowns with adequate mechanical retention, whereas adhesive bonding becomes mandatory in minimally invasive restorations or in cases with compromised retention.[6]

The decision between bonding and cementation, as well as the choice of ceramic material, must be based on a comprehensive evaluation of aesthetic demands, preparation design, occlusal loading, and long-term functional requirements.

Conclusion

The choice between lithium disilicate and zirconia restorations must always be guided by both the clinical situation and the material-specific bonding requirements.[1] Lithium disilicate benefits from hydrofluoric acid etching and silane application, which create strong micromechanical retention and durable chemical adhesion.[5] Zirconia, in contrast, is a non-etchable polycrystalline ceramic that requires the APC protocol– air-particle abrasion, an MDP-containing primer, and adhesive resin cement– to ensure stable bonding.[3]

Both case reports presented in this study highlight the fact that successful adhesive cementation depends not only on selecting the appropriate ceramic material but also on strictly following evidence-based protocols. Understanding the fundamental differences in composition, surface reactivity, and adhesion behaviour is essential for achieving predictable long-term outcomes.

Ultimately, proper bonding enhances marginal integrity, mechanical performance, and aesthetic stability, contributing to the long-term success of indirect restorations.[20]

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Adres autorów: Department of Dental Anatomy, University of Monastir, Faculty of Dental Medicine, Research Laboratory of Occlusodontics and Ceramic Prostheses LR16ES15, 5000, Monastir, Tunisia