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Clinical Technique/Case Report

Ultrathin Monolithic Zirconia Veneers: Reality or Future? Report of a Clinical Case and One-year Follow-up

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Clinical Relevance

Translucent zirconia has become esthetic, make it a viable alternative for the manufacturing of ultrathin veneers.

SUMMARY

Yttria-stabilized polycrystalline zirconia ceramics have greatly advanced over the past few years. High-translucent zirconia is a newly introduced ceramic that affords high strength and esthetics and that has significantly increased the clinical indications of monolithic zirconia restorations. Thus, the purpose of this case report was to evaluate the performance of ultrathin monolithic zirconia veneers adhesively luted to enamel surfaces after minimally invasive preparations; in addition, we aimed at presenting a clinical protocol for zirconia surface treatment in order to promote bonding effectiveness to resin cement. This type of restoration presented very acceptable esthetic results and decreased the risk of fracturing the veneer during try-in and clinical use. The results were still satisfactory after one-year follow-up. However, randomized, prospective, controlled clinical trials are required to determine the long-term clinical durability of this treatment.

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DOI: 10.2341/16-350-T

INTRODUCTION

Porcelain veneers comprise a conservative and highly esthetic treatment that also offer high predictability and good clinical performance in the long term.[1] With technological improvement and the evolution of dental restorative materials, it is currently possible to develop/produce ultrathin veneers with thicknesses of 0.1-0.3 mm, adhesively cemented on the tooth surface with minimal or no preparation, to modify color, shape, and/or positioning of the teeth.[2,3]

Several ceramic materials are currently indicated for veneers: lithium disilicate, feldspathic ceramic, feldspathic reinforced with leucite, fluorapatite, and lithium silicate reinforced with zirconia.[4-7] All of these ceramics exhibit high translucency characteristics due to the high content of glassy matrix in their composition, thus providing highly satisfactory esthetics in addition to excellent adhesion to resin cement through the conditioning with hydrofluoric acid (4%-10%) followed by silanization.[5] For these reasons, these ceramics have also been chosen for manufacturing of ultrathin veneers.[8]

On the other hand, high crystalline-content ceramics, such as tetragonal zirconia partially stabilized by yttria (Y-TZP), were originally considered only for the manufacturing of frameworks of crowns and fixed prostheses because of their high fracture resistance and ability to mask the dark substrate.[9] However, in recent years, zirconia ceramics have undergone many changes in microstructure and composition[10] to increase their translucency without significantly losing their fracture resistance,[11] thereby expanding their clinical indication. Thus, translucent zirconia has been considered as an esthetic material, as it offers indications for manufacturing crowns and anterior and posterior monolithic fixed prostheses, including veneers and ultrathin veneers.[12] The main difficulty associated with translucent zirconia involves situations with little mechanical retention of preparation, since polycrystalline zirconia is chemically inert and cannot be etched by hydrofluoric acid (4%-10%), which implies a less effective adhesion when compared to silica-based ceramics (acid-sensitive).[13]

Few clinical studies using monolithic zirconia prostheses have been reported in the literature. Rinke and Fischer[13] evaluated the clinical performance of posterior monolithic crowns and concluded that good esthetic results in the posterior region were achieved, even in cases of minimal occlusal space. In evaluating the wear of the enamel caused by monolithic translucent zirconia crowns in molars during six months of follow-up, Stober and others[14] concluded that the enamel wear of the antagonist tooth was equal to that caused by other ceramics.

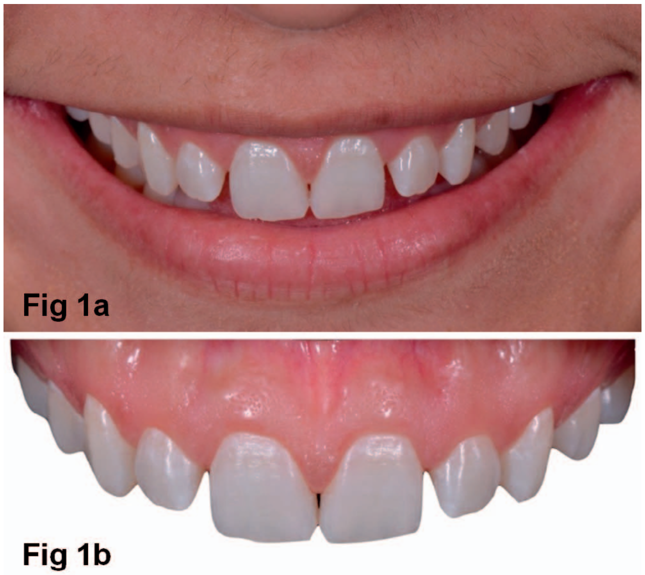
In vitro studies on veneers have reported a higher resistance to fracture of zirconia compared to that associated with lithium disilicate and feldspathic veneers,[16] which can be regarded as a great advantage of this material, as the proof and cementation stages of ultrathin veneers become much less critical compared to those of conventional glass ceramics. However, the same authors[16] also found that there is a possibility of zirconia veneers debonding as a result of less effective adhesion to resin cement.

In order to optimize the adhesion between zirconia and cement, various surface treatments have been proposed: sandblasting with aluminum oxide,[17] tribochemical silica coating followed by silanization,[18] nanostructured alumina coating,[19] resin cement containing 10-methacryloxydecyl dihydrogen phosphate monomer (MDP),[20] universal primers also containing methacrylate monomers,[21] plasma processing, silica infiltration by the sol-gel method,[22] feldspathic glass infiltration,[23] selective infiltration-etching technique,[24] glaze-on technique,[25] and heating of silanes,[26] among others. Therefore, the treatment of zirconia surfaces has been the subject of much scientific research.[17,27-30] Depending on the type of treatment of the zirconia surface, it is possible to significantly improve their adherence to resin cement.[16,17,21,23] However, clinical studies with zirconia veneers and ultrathin zirconia veneers have not yet been published.

Thus, based on the promising results of surface treatments in zirconia and on the esthetic evolution of this material, the aim of this case report was to describe, through a clinical case, the manufacturing of ultrathin veneers using translucent zirconia, as well as to discuss relevant aspects for success in this type of treatment and to report a one-year follow-up of this clinical rehabilitation approach.

CASE REPORT

A female patient, 25 years of age, sought specialized dental care, reporting small, yellowing upper front teeth with diastema as her main complaint. Upon clinical examination, the presence of a disharmonious smile with proclined lateral incisors, unfavorable dental proportions, diastema between lateral incisors and upper central incisors, and inadequate gingival contouring and zenith was observed (Fig-



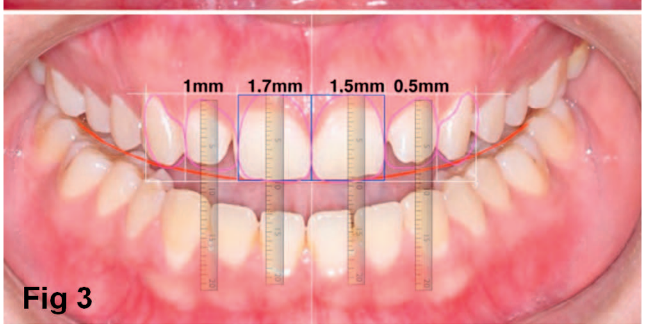


Figure 1. *(a) Initial appearance of patient smile and with (b) unfavorable dental proportions and diastema between lateral incisors and upper central incisors.*

Figure 2. *Intraoral view of teeth in occlusion. Patient with stable occlusion.*

Figure 3. *Digital smile analysis and planning for periodontal surgery before restorative procedures.*

ures 1a,b and 2). The occlusal contacts and the eccentric movements were evaluated by mounting of study models using the facial arch in a semiadjustable articulator. After digitally planning the smile, the need for correcting the contouring and gingival zenith was observed, increasing the incisal edges of the lateral incisors and vertically increasing the central incisors toward the cervical direction, setting a tooth ratio of 80% (the final width to length ratio of the centrals was 9/11.2 mm, approximately 80%). Surgery was then recommended for crown enlargement of teeth 7 through 10 (Figure 3). After 60 days, whitening therapy was initiated with the use of 16% carbamide peroxide (Whiteness Perfect/FGM, Joinville, SC, Brazil) for four weeks.

In the next session, an impression was made with vinyl polysiloxane/silicone (Express XT [commercially available in the United States as Express VPS], 3M ESPE, St Paul, MN, USA) to prepare stone models, a diagnostic wax-up, and mock-up (Systemp/Ivoclar Vivadent, Schaan, Liechtenstein) of teeth 6 to 11, according to the digital smile design (Figure 4a-c). In this stage, the occlusal contacts and the eccentric movements were evaluated again, clinically in the patient's mouth, with the assistance of articulating metallic film (Arti-fol [12 μm], Bausch, Germany). There was no need for any mock-up adjustment. Next, minimally invasive preparations were performed in teeth 6 through 11. A medium-grit diamond bur with rounded edge was used on the buccal surface of the teeth to remove a uniform thickness of 0.3 mm. Approximately 0.6 mm of the buccal surface of teeth 7 and 10 was removed because they were slightly proclined.

In order to guide all steps of tooth preparation, an index was made with a condensation silicone (Zetaplus/Zhermack, São Paulo, Brazil) (Figure 5a,b). All angles were rounded, and the cervical finish line in tilted chamfer was continuous, defined, and clear. The preparations were finished and polished with fine diamond burs, followed by multilaminated burs (Komet, Lemgo, Germany) and an Arkansas polisher (Komet) with the aid of a multiplier contra-angle (Sirona, Bensheim, Germany). In the same session, an impression of the prepared veneers was taken with addition silicone (Express XT [commercially available in the United States as Express VPS], 3M ESPE) and sent to a dental technician to manufacture the restorations in a prosthetic laboratory. Because the preparations were minimally invasive, there was no need to manufacture temporary veneers (Figure 6).

The stone models were scanned and the ultrathin veneers were fabricated with monolithic translucent zirconia (Prettau Anterior, Zirkonzahn, Gais, Switzerland) (Figure 7a,b) and milled in a Zirkonzahn CAD/CAM system. The veneers were characterized in the following way: before sintering, polishing with rubber tips followed by staining, and after sintering, new polishing and glaze. No veneering ceramics were applied.

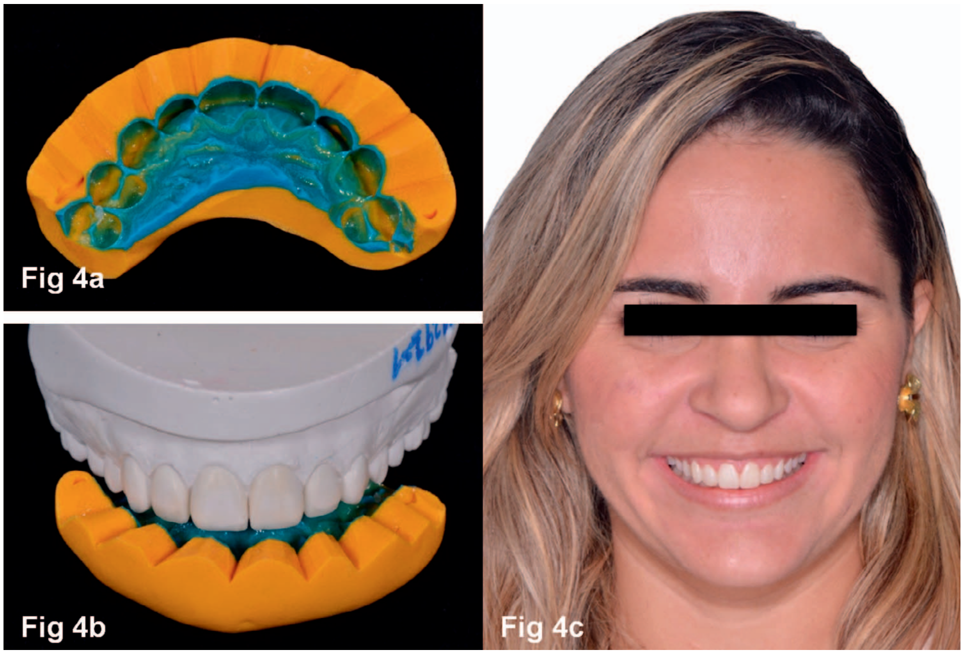


Figure 4. *(a) Silicone index for mock-up, (b) wax model, and (c) aspect of the patient after mock-up.*

After dry testing to check the marginal fit, the resin cement shade was selected using try-in pastes (Variolink Veneer Try-In, Ivoclar Vivadent, Schaan, Liechtenstein). It was possible to observe that the color was significantly affected by the shade of the try-in paste (Figure 8). Next, the veneers were washed, thoroughly dried, and the intaglio surfaces of the zirconia veneers and the tooth surfaces were treated as described below.

Prophylaxis was performed on the tooth surfaces with pumice and water, and then the surfaces were washed and thoroughly dried. These surfaces were then etched with 35% phosphoric acid (Ultra-Etch/Ultradent) for 20 seconds, rinsed in running water, thoroughly dried, and treated with an adhesive system (Excite F/Ivoclar Vivadent). The intaglio surfaces of the veneers were abraded with particles of aluminum oxide coated with silica (CoJet, 3M ESPE) for 20 seconds (2.8 bar, 10-mm standoff distance) and dried. Silane was then applied (Monobond Plus/Ivoclar Vivadent) and left to dry for two minutes before the application of an adhesive system (Excite F/Ivoclar Vivadent) without curing.

Light-cure resin cement Variolink Veneer of "0" medium value (Ivoclar Vivadent) was inserted into the ceramic veneers, which were placed on their respective abutments. The excess resin cement was removed with a brush and floss, followed by light-curing for 40 seconds on each veneer surface (Radii Cal, SDI Limited, Victoria, Australia; 1000 mW/cm^2). The Radii light intensity was confirmed by a radiometer (Kondortech-Kondentech, São Paulo, Brazil). Next, glycerin gel (Liquid strip, Ivoclar Vivadent) was applied to the cervical and incisal regions of veneers and another curing cycle was performed on each face (Figure 9a-d). After curing, additional excess cement was removed with a No. 12 scalpel blade. The clinical appearance of the veneers after luting and one-year follow-up can be seen in Figures 10a,b and 11a,b, respectively. There was no need for any occlusal adjustment in the ultrathin zirconia veneers. Moreover, no protective splint was needed since the patient had no clinical signs or symptoms of bruxism.

DISCUSSION

In the present clinical study, ultrathin veneers of monolithic cubic ultratranslucent zirconia were manufactured (Prettau Anterior, Zirkonzahn). This type of zirconia has recently been developed to provide adequate esthetic and mechanical properties for all-ceramic restorations for both anterior and posterior teeth.[31]

Several types of zirconia have been most often used in clinical dentistry, including traditional tetragonal (opaque) zirconia, with a strength range from 900 to 1200 MPa; high-translucent zirconia (900 to 1200 MPa), and cubic ultratranslucent zirconia (500 to 800 MPa).[31] This last generation of zirconia has excellent optical features compared to the other two types of zirconia described previously, and therefore we chose it for this clinical case.

Figure 5. *Index positioned on the teeth before preparations: (a) buccal and (b) incisal views.*
Figure 6. *Clinical aspect after final preparation of the anterior teeth.*

In order to achieve adequate translucency, the microstructure of zirconia was modified. It is known that zirconia can exist in three crystallographic forms depending on the temperature at ambient pressure: monoclinic, tetragonal, and cubic phases.[32] In conventional zirconia, 0.5%-1.0% of its weight is alumina and 3%-6% is yttrium oxide. On the other hand, translucent zirconia has 0.11% to 0.26% alumina[33] and a yttria concentration close to 12%.[34]

Alumina acts as a light-scattering center in zirconia as a result of its different refractive index, reducing the translucency of zirconia.[33] Further-

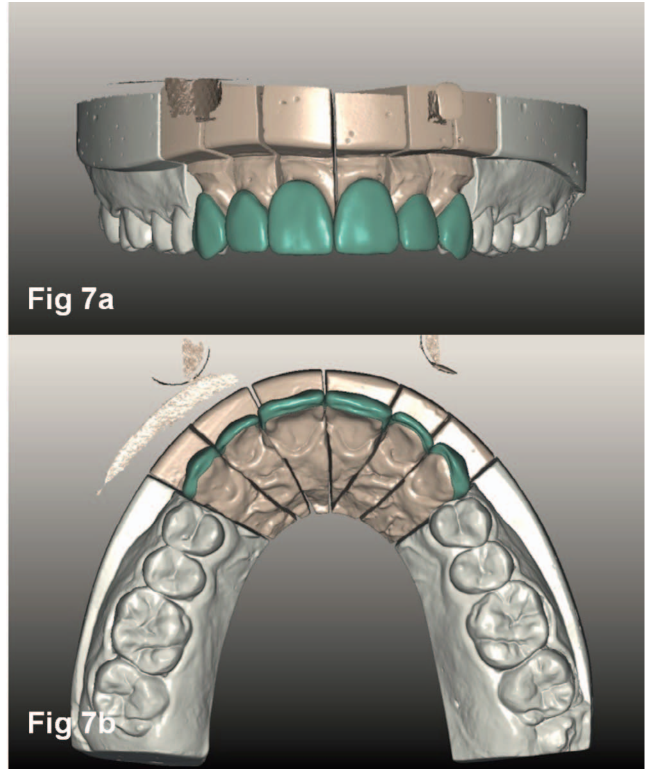


Figure 7. *Three-dimensional images of the veneers from 13 to 23 on the scanned model of the prepared teeth: (a) buccal and (b) incisal views.*
Figure 8. *Resin cement color test of ceramic veneers with try-in pastes (Variolink Veneer, Ivoclar Vivadent) of medium value 0 (left) and low value −3 (right). The cement of medium value 0 was selected.*

more, the amount of zirconia in the tetragonal phase was reduced and a larger amount of cubic zirconia was incorporated, thus enabling a more uniform transmission of light through zirconia.[9] Factors such as porosity[35] and grain size[36] also affect the translucency of zirconia. It was evident that zirconia is less translucent than glass ceramics, and the translucency decreased more slowly with material thickness.[37]

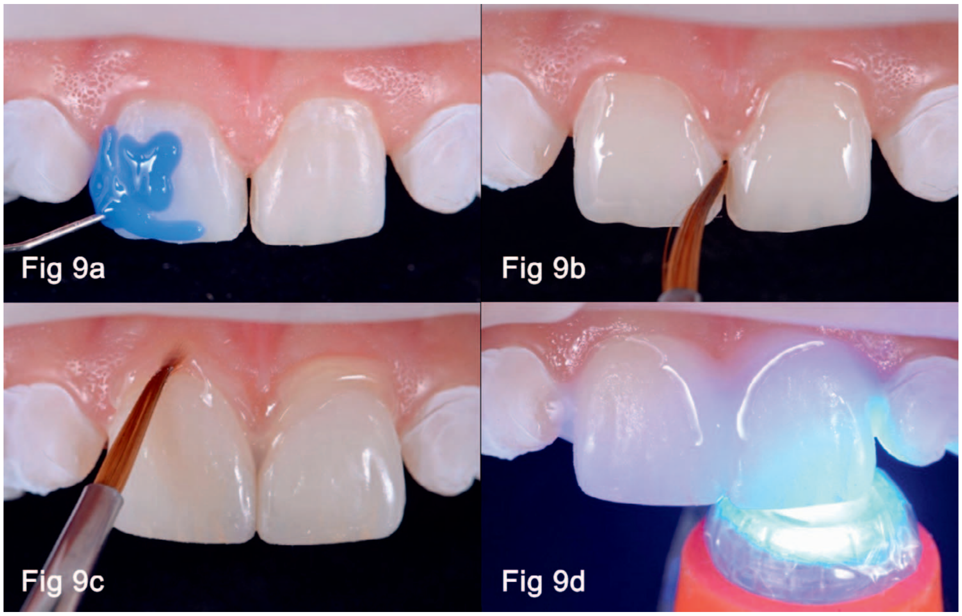


Figure 9. *Teeth surface treatment—(a) Etching with 35% phosphoric acid/15 seconds; (b) Application of the adhesive on the the tooth surface; (c) Removal of excess cement with a thin brush and dental floss; (d) Cement photopolymerization with glycerine gel application on the adhesive interface.*

However, high translucency can be observed for thinner translucent zirconia, specifically that which measures about 0.3 mm.[38] This was confirmed by the pleasant appearance achieved in this clinical case, in which 0.3 mm translucent zirconia veneers were used.

Few studies on zirconia veneers have been reported,[15,39] and none of them have used translucent zirconia. Alghazzawi and others[38] evaluated the influence of cement color on the final color of ceramic veneers and observed that conventional zirconia was

Figure 10. *(a) Final intraoral view in occlusion; (b) Close-up view of the central incisor characterization.*
Figure 11. *Final (a) smile and (b) facial aspect after one-year follow-up.*

neither influenced by the color of the resin cement nor by the color of the substrate, even at a minimum thickness. Currently, it is possible to manufacture veneers/ultrathin veneers made entirely from translucent zirconia.[40] According to our observations, and contrary to what was found for conventional zirconia, there was an influence of cement shade on the final color of the veneers during the selection of cement with the try-in test pastes.

With regard to the mechanical properties of translucent zirconia, the zirconia used in this clinical case exhibits a flexural strength of 670 MPa, according to the manufacturer's data sheet. This high-strength ultratranslucent zirconia offers great advantages over feldspathic ceramics or lithium disilicate ultrathin veneers, considering that these restorations are difficult to manipulate before cementation as a result of their brittleness, which may lead to fracture during the try-in stage.

Unarguably, the greatest difficulty in performing a treatment with zirconia veneers lies in its low adherence to resin cement, compared to that of the ceramics that can be conditioned by hydrofluoric acid (4%-10%) followed by silanization.[12] The loss of retention (debonding) of zirconia restorations has been reported in clinical studies.[41] For this reason, many surface treatments have been proposed to modify the surface of zirconia and to optimize adhesion to resin cements.[16,17,21,23,26,42] Among these treatments, silica coating has presented some of the best bonding results.

The tribochemical silica coating process (Cojet and Rocatec, 3M ESPE) consists of air-abrasion of the zirconia surface with alumina particles coated by silica, which promotes adhesion between the 3-methacryloxypropyltrimethoxysilane silane coupling agent and the silica adhered on the zirconia surface because of the impact.[16] The silicatization associated with a 10-MDP primer seems to be the most common form of surface treatment through which to provide long-lasting bonding to zirconia.[17,26] The phosphate ester groups in this silane bond directly to the surface oxides of zirconia, and the methacrylate group makes covalent bonds with the resin matrix of the cement.[43] Therefore, in the present clinical case, the monolithic zirconia veneers were air-abraded with 30 μm of alumina coated by silica (Rocatec Soft, 3M ESPE), followed by 10-MDP silane agent. We know that the one-year follow-up does not offer enough time with which to validate this type of treatment, but up until the writing of this article, none of the veneers had debonded. However, further *in vitro* and long-term clinical trials should be conducted to predict the clinical performance of high-translucent monolithic zirconia veneers.

CONCLUSIONS

Based on the clinical case presented herein and scientific evidence, we can conclude that the use of translucent zirconia ultrathin veneers provides satisfactory esthetics; however, further longitudinal studies are necessary to confirm this type of treatment.

Acknowledgement

The authors are grateful to Vagner Laboratory (São Paulo, Brazil) for manufacturing the monolithic zirconia ultrathin veneers.

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of the Federal University of Rio Grande do Norte, Brazil.

Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

(Accepted 17 April 2017)

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