Zirconium Abutments for Improved Esthetics in Anterior Restorations

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Several esthetically pleasing materials are available for restoring anterior teeth. All-ceramic or metal-free restorations are considered to be high in esthetics. In planning a course of treatment when there are missing teeth, a single-tooth implant is often preferred because it leaves the adjacent teeth intact. In the all-ceramic category, zirconium implant abutments provide a highly desirable option. The zirconium abutment becomes a particularly esthetic choice when there is a gum line location to consider. When a zirconium abutment is used, the problem of matching the shade of adjacent teeth while hiding the dark color of the metal abutment is avoided.

The following case history of an oral surgeon undergoing an anterior restoration also illustrates that, although many patients from different professions might not be as sensitive to the esthetics involved, future patients will have an increasing role in planning and determining the requirements for their restorations. Patients are becoming more educated about the advances in dentistry today and they see esthetic opportunities that never existed to them before.

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CASE HISTORY

In the summer of 2003 the patient suffered a traumatic accident, which resulted in a palatal displacement of tooth #8. He immediately repositioned the tooth in its socket, but there was a slight incisal discrepancy. He sought treatment within 30 minutes of the accident.

Figure 1: View of preparations—#8 is an implant and #9 a preparation for all-ceramic restoration.

Figure 2: Incisal view showing a 4.3-mm wide, 13-mm long tapered implant. Note the position of the laterals; to follow contour is a challenge to match symmetrically.

FINDINGS, DIAGNOSIS, AND INITIAL TREATMENT

Tooth #8 was found to be 1 mm longer than tooth #9, there was slight bleeding at the gingival margin of tooth #8, but all other hard and soft tissues surrounding the area were within normal limits and did not show any signs of trauma.[1] A periapical radiograph revealed a fracture of the apical 3 mm of tooth #8. The tooth was then splinted to the adjacent teeth with orthodontic wire and composite.

The repairs were left in place for one month, during which time the patient did not improve. The tooth showed substantial sensitivity to contact and to temperature. A root canal was then performed, but the tooth continued to show sensitivity to any form of pressure, especially at the apex.

In the fall of 2003, tooth #8 was extracted and extra bone was placed in the socket. A treatment plan wax-up was fabricated in the laboratory, along with a surgical stent and a bullet/cone-shaped flipper. The patient wore the flipper for approximately one year in order to preserve the papillae. During that period, a gingival cleft formed in the palatal tissue. In October 2004, a 4.3-mm wide, 13-mm long tapered implant (Steri-Oss Replace Select, Nobel Biocare; Yorba Linda, CA) was placed.

As the patient is a dental professional, his appearance and dental esthetics are extremely important. Both arches were bleached in order to achieve optimal color. It was decided in April 2005 to use a zirconium abutment. Tooth #9 was prepared for a zirconium restoration. The impressions were taken of the implant and also of the preparation of tooth #9 using a pick-up impression.

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FABRICATION

A tissue cast was fabricated from the final impression. The zirconium abutment was generated by a computer-aided design/computer aided manufacturing (CAD/CAM) process.[2] The combination of zirconium oxide and CAD/CAM gives strength and esthetics. A full treatment plan wax-up was completed in order to check the proper contour and room available, and an index was made of the full wax-up from laboratory putty to assist in fabricating the zirconium abutment and substructure for the restoration.

After removal of the provisional restoration and temporary abutment, the final abutment was secured. Once the fit was assessed radiographically, the abutment screw was torqued to 35Ncm. The screw access holes were obturated with a light-cured temporary restorative material.

The zirconium crowns (Procera) were then tried in. The gingival of the crown on tooth #8 on the implant abutment was tight at the tissue, so it was adjusted with a diamond abrasive. The crowns were then cemented using resin-modified glass ionomer cement; and, after

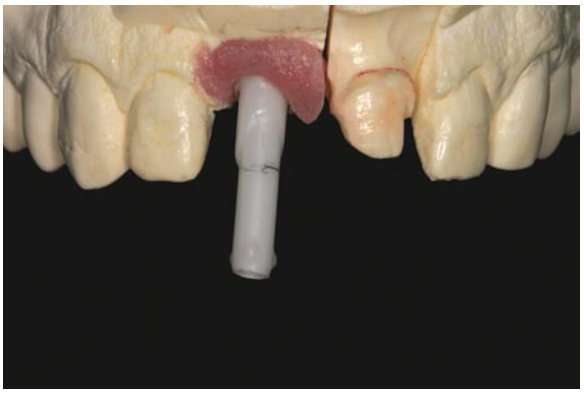

Figure 3: Master model with milled zirconium abutment, still in its machining sleeve.

Figure 4: Zirconia abutment is tried in and prepared for restoration.

Figure 5: Full contour wax-up on master model to check contour and room available for final restoration.

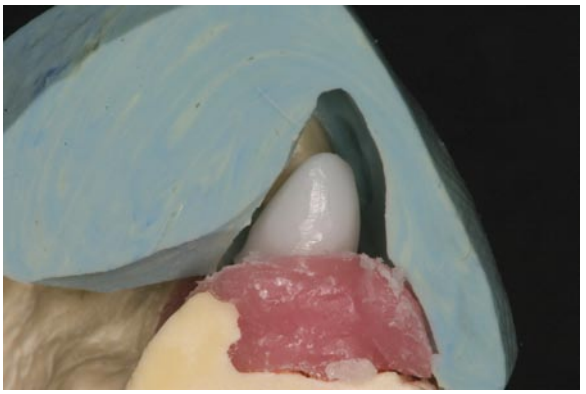

Figure 6: Zirconia copings are checked with putty matrix made from wax-up. The labial separation between the teeth and width of the proposed crowns are assessed.

taking care to see that all of the excess cement was removed, the occlusion was checked to see whether any adjustments were needed.

TREATMENT DESCRIPTION

As seen in Figures 1 and 2, one can design an abutment angle up to a 30° angle, the taper, finish line, height, width and cross sectional form, creating the natural form and emergence profile of the tooth.[3] It is quick and easy to create an abutment using CAD/CAM; or, if one prefers, to do so using a conventional wax-up that is scanned. The abutment can be made in either zirconia or titanium.

As shown in Figure 3, the shape of the abutment comes already complete from the manufacturer, but the technician removes the machining sleeve and does any minor contouring needed. Then, the abutment can be tried and checked in the patient's mouth (Fig 4). A full wax-up (Fig 5) was completed to check the proper contour and room available. The wax-up is a valuable tool to check for room available for the coping and porcelain application. An index fabricated from laboratory putty was made of the full wax-up to aid in the fabrication of the restorations. An abutment and coping can be evaluated with the matrix (Fig 6). The matrix is used to evaluate both the labial separation between the teeth and the width of the proposed crowns.

The key to achieve symmetry of the restorations is the width.

The technician, working with the dentist, completes the shade mapping by doing a detailed multilayered porcelain shade mapping (Fig 7). Not all teeth in a patient's mouth

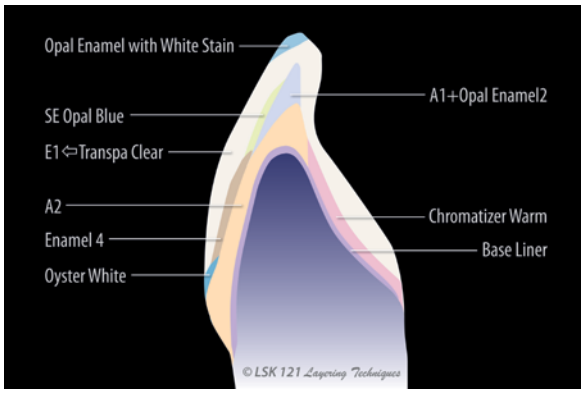

Figure 7: Shade map completed by the technician.

Figure 8: Samples made by the author illustrate the color variation between incisors to canine to premolars and to molars and should be taken into consideration.

Figure 9: Laboratory porcelain sample test for the opal, enamel and transparency. The color is slightly different from the factory-made shade tab, because of variations in laboratory oven temperature.

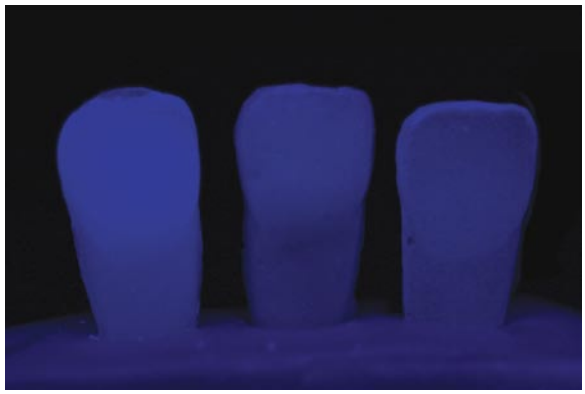

Figure 10: Ultra-violet light sample test checking the fluorescence in the porcelain.

are the same natural color; usually the canines tend to be darker than the others. The incisors are typically the whitest, and the molars tend to be a shade between. The goal is to achieve optimum color matching of the adjacent teeth (Fig 8).

The technician also utilizes porcelain system color-matching tabs. The technician's fabricated samples are shown in Figure 9, the laboratory porcelain sample test for the Opal Blue, Enamel 1, and Transparent Clear (Nobel Biocare) to check the manufacture color wheel and the oven temperature from the laboratory. These samples help the technician in mimicking shadow zones where a restoration will lose both chroma and brilliance. As shown in Figure 10, it is important to have fluorescence in the porcelain, the ultra-violet light shows the degree of fluorescence.

Figure 11 shows that the zirconium is white. The internal colors give the chroma shade so that the restoration matches a patient's natural teeth. Note that the molar distal lingual cusp has no porcelain on it, showing the white zirconium coping understructure. However, while this coping is basically white, a technician can change the foundation (Fig 12) by using base liner. The base liner is used as a wash-bake on the zirconium frame to start the base shade. The first application of porcelain is to get optimal chroma using a dentin shade. Using the dentin and base liner, this will start to make the base chroma shade of the restoration. The incisal third is modified with dentin and Opal Enamel 2 powder mixed at a 1:1 ratio. Then technician applies a white stain at the gingival of the tooth for effect (Fig 13). The first temperature firing is important, firing at 900° C to make sure the porcelain has ma-

Figure 11: The zirconium coping is white; internal colors give the chroma shade and the finished restoration matches natural tooth. The molar distal lingual cusp has no porcelain on it, showing the white zirconium coping.

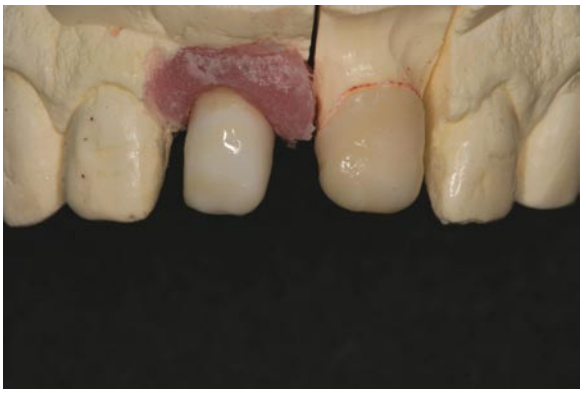

Figure 12: Base liner is a foundation used as a wash-bake on the zirconium frame to change the white color of zirconium coping and start the base shade.

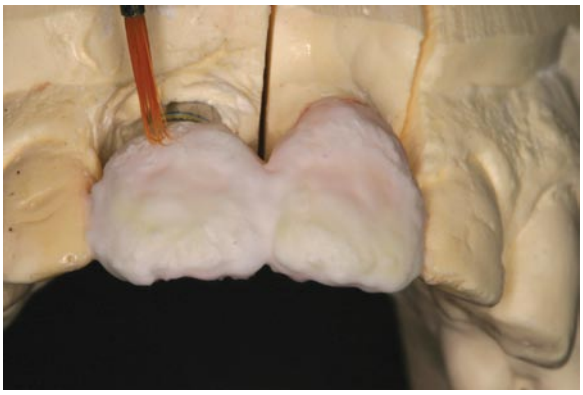

Figure 13: Porcelain powder application and addition of fluorescent transparent white stain internally at gingival, unlike the opaque white stain at the incisal.

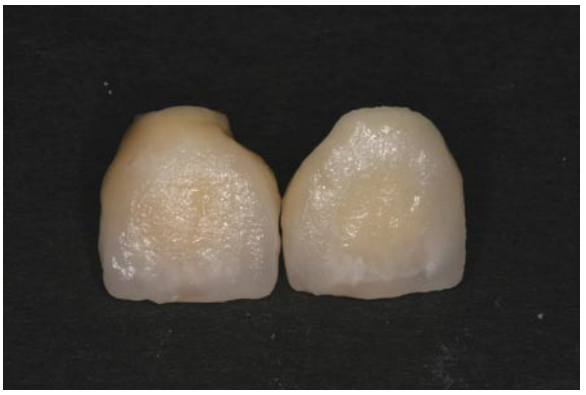

Figure 14: First bake of crowns (will check the proper firing temperature).

tured at the correct temperature to achieve proper colors (Fig 14).

In addition, a thin layer of Transparent Clear powder and Enamel is applied to the restoration. The Transparent Clear is applied in a thin layer between the dentin and the enamel. It brings out true-to-nature depth to the color of the tooth. The porcelain powders are applied to the lingual to mimic color and contour, and the buildup is completed. Thereafter the crowns are fired and checked for proper temperature after coming out of the furnace.

The key to achieve symmetry of the restorations is the width.[4] We can increase and decrease the width using either horizontal or vertical striated lines giving an illusion of blending in with the natural teeth (Fig 15).

The movement of the buccal transition line angles toward the interproximal areas, flattening of the buccal face, or accentuation of the horizontal ridges and lines are some things that will give the illusion of increasing the width.

The movement of the buccal transition line angles toward the center of the tooth, increasing convexity of the buccal face in the mesiodistal direction, rounding the disto-incisal margin starting from the middle third of the tooth, or accentuation of the vertical ridges and lines are some things that will give the illusion of decreasing the width.[5]

To give the illusion of reduced length accentuated breakdown of the three planes of the buccal face in the apico-coronal direction, clear convexity of the cervical third, clear lingualization of the incisal third, or accentuation of the horizontal ridges and lines are done.[4]

To give the illusion of increased length minimal breakdown in the three planes of the buccal face in the apicocoronal direction, reduction

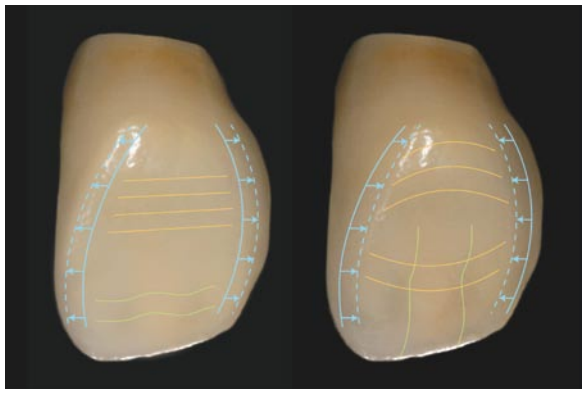

Figure 15: Illusion of increased and decreased width is to achieve symmetry of restorations.

Figure 16: After bisque-bake and final contour, surface texture is checked with articulating paper.

Figure 17: Try in of tooth #8 over a milled zirconium abutment.

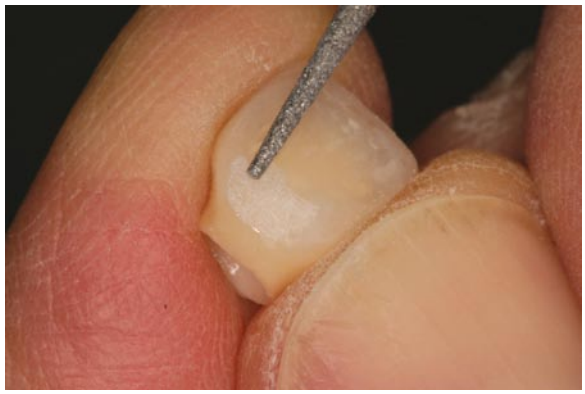

Figure 18: Crown was tight at gingival, adjustment made using a diamond, being careful not to lose texture.

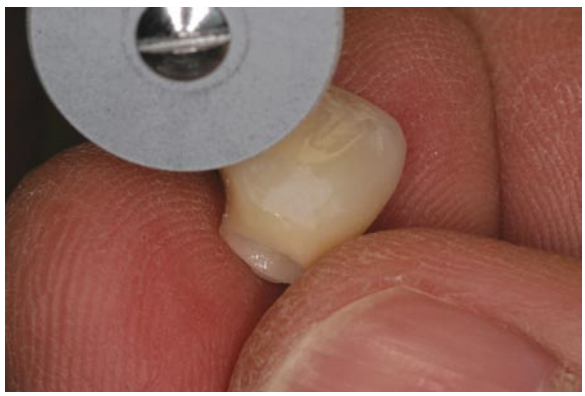

Figure 19: Rubber wheel gingival area to a medium polish.

Figure 20: Hand polished to a high shine to match same amount of shine of crown.

Figure 21: Try in of tooth #9.

Figure 22: Right lateral view checking the line angles.

Figure 23: Postoperative view: Immediate shot of the two zirconium crowns; #8 is a zirconium crown over a milled zirconium implant abutment.

and/or elimination of convexity of the cervical third, with mesial and distal transition line angle extended up to the cervical area, or accentuation of the vertical ridges and lines are worked upon.

Even though the color of a crown coming out of the furnace can match the adjacent teeth perfectly, changing its surface texture will affect how it blends into the surrounding dentition. Surface texture can affect many factors, including brightness, color saturation, and luster (Fig 16). A technician can apply multiple porcelain buildup layers and demonstrate technical ability in this regard, but the quality of the surface texture of the result demonstrates how ultimately skillful they must be.

The zirconium crowns were tried in (Fig 17). The gingival of the crown #8 on the implant abutment was tight at the tissue, so it was adjusted (Fig 18) with a diamond abrasive. You do not have to reglaze, but can hand polish. After the adjustment with the diamond, a rubber wheel is used (Fig 19) so the area has nice texture and not too rough. Then hand polished to a high shine (Fig 20) and the crown is ready to try in (Fig 21) again.

The final restorations were checked showing the line angles, and emergence profile matching other teeth in the mouth and the implant with crown (Fig 22). The immediate view of the zirconia crowns has an emergence profile matching the crown color matching of adjacent teeth inward and outward the same angulation and shade matching was an esthetic match (Fig 23).

OBSERVATIONS AND CONCLUSIONS

Zirconium can be a very useful choice in spite of the higher degree of care required in working with it. Clearly, it possesses a higher flexural strength, approximately 1,200 MPa.4 It eliminates the need for metal, and it gives excellent color

matching.[4] When combined with internal staining, it allows the technician to have full control over the chroma, hue, and color value of a tooth; and its ability to allow light to pass through it creates a superior appearance of depth and life in the tooth. But because its opacity is high, the dentist and the technician must be extremely meticulous. Also, when there is a lack of room, there may be difficulty in achieving color value and the proper degree of translucency. In providing a good support framework, it generally requires as much room as possible.

Today we expect all patients to be well educated in dental advancements, and, working as a team, the dentist, the dental technician and the patient can achieve the highest levels of function and esthetics.

Acknowledgement

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