

An Introduction to the Implant Crown with an Esthetic Adhesive Margin (ICEAM)

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ABSTRACT

This article describes a novel technique with the addition of a pressed porcelain abutment margin capable of bonding to the porcelain margin of an implant crown restoration. This allows for supragingival margin placement, reduces the potential effect of excess cement-induced peri-implant disease, and provides a controlled environment for the bonding process. Another advantage is the matching esthetics of the crown and supporting abutment, which in the event gingival recession occurs, the restoration appears as a longer tooth without the risk of exposing an underlying abutment margin with different esthetic properties.

CLINICAL SIGNIFICANCE

The transition margin from an implant abutment to a crown is challenging to manage especially esthetically. Placing the abutment margin in a subgingival position helps hide the unesthetic transition, however, this reduces the ability to clean excess cement, increases the risk of peri-implant disease and the inability to control gingival sulcular fluids may affect the cement bond. The implant crown with an esthetic adhesive margin provides for supragingival bonded margins that can aid in complete removal of excess cement at the same time providing an esthetically pleasing result.

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INTRODUCTION

Cement retention as a means of fixing a crown to an implant has become increasingly popular because of multiple factors. These include: esthetics; control of occlusion; less demanding implant placement; cost (component and laboratory); improved passive fit for multiple connected units; and similarity to conventional tooth-supported fixed prosthodontics.¹

Cement-retained restorations, however, are not without their issues. Studies comparing screw-retained implant restorations with cemented implant restorations have reported problems with the cementation process² as well as a measurable difference in health (modified plaque index, bleeding index) with the cement-retained

crowns worsening over time.³ Sinus tracts, inflammation, and continued bone loss have been documented as being related to cement residue remaining in the peri-implant soft tissues.^{4,5} The positive relationship between excess cement and peri-implant disease (peri-mucositis and peri-implantitis) has been documented.⁶ These conditions are classified as inflammatory lesions that may affect the peri-implant tissues, with the potential loss of supporting bone. Although it is possible to treat peri-implant disease, prevention is the goal of supportive therapy. Techniques have been developed^{7–9} to minimize the extrusion of cement into the peri-implant soft tissues, but it is likely that this problem cannot be predictably eliminated.

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One major issue when considering excess cement extrusion into the soft tissues around an implant restoration is crown : abutment margin position. A recent study reported on the influence of margin location and the amount of undetected cement excess after delivery of cement-retained implant restorations. Variation in the position of the crown abutment margin depth was from 1 mm supragingival to 3 mm subgingival. The authors concluded that the amount of residual cement after cleaning increased as the restoration margins were located deeper and more subgingivally.¹⁰ Margin discrepancy is also a known factor when evaluating the clinical quality of a restoration with detection being more difficult when these are subgingival.¹¹ This indicates subgingival cement excess is less likely to be detected as the crown: abutment margin becomes deeper. When coupled with the inability to completely remove cement from the implant abutment surfaces¹² as well as the difficulties in radiographic detection of some commonly used cements,¹³ it becomes apparent that subgingival margins become increasingly problematic. The cementation process is also susceptible to fluid contamination, which becomes increasingly challenging as margins become deeper.

The ability to customize an abutment by raising the margins above the soft tissues has been reported on.¹⁴ A screw-retained custom metal ceramic abutment combined with an adhesively bonded porcelain restoration was used as a permanent solution to an implant inclination issue combined with a short clinical crown. Traditional porcelain stacking methods produced equi-gingival and supragingival margins on an abutment to which a porcelain suprastructure was adhesively bonded—a type III veneer. Although this technique is innovative, it is time consuming and requires the dental laboratory technician be highly skilled.

Abutment materials can be either metal or ceramic in nature. With the appropriate material selection and conditioning it is possible to directly wax, then press, porcelain-ceramic margins to the abutment. Zirconia has been used extensively in dentistry and has gained popularity as an abutment core material because of its

strength, white color, and ability to be milled. However, zirconia presents with limitations because of an inherent opacity, poor translucency and the inability to bond to resin predictably. This is unlike some other ceramic materials that are either susceptible to microabrasion or can be etched resulting in a more predictable bond with resin materials. A method for overcoming the aforementioned limitations of a zirconia is to add a ceramic margin onto the zirconia abutment. This can be achieved using a fluorapatite glass-ceramic ingot that is pressed onto zirconium oxide. This transitional margin material also improves the esthetics of the abutment, yet it is less demanding technically compared with traditional ceramic stacking techniques.

The implant crown with an esthetic adhesive margin (ICEAM) is described. It consists of a crown with a porcelain butt margin that is bonded to a custom abutment with a pressed porcelain supragingival margin. In a restoration with harmonious margins the contacting ceramic margins allow for hydrofluoric etching, silane application, and adhesive resin bonding. This type of restoration eliminates some of the disadvantages associated with cement-retained crowns. The ICEAM significantly reduces the amount of excess cement found with traditional subgingival margins, allows for direct verification of seating, and enables access to cleaning the cement margins, which is similarly applicable when using metal or ceramic abutment materials. It can help with retention issues found with crown core materials that are problematic with cement adherence, such as zirconia.

CLINICAL REPORT

A 60-year-old female patient presented with a transverse fracture through the upper right lateral incisor. Clinical and radiographic (Figure 1) assessments indicated the tooth was structurally compromised and the treatment option selected was extraction and immediate implant placement. An atraumatic extraction with immediate implant (Bone level NC, Straumann, Andover, MA, USA) placement was performed by a periodontist. To minimize the effect of

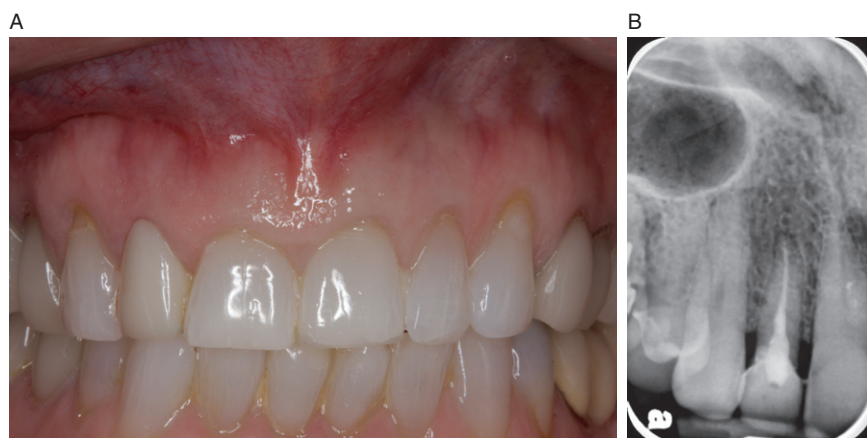


FIGURE 1. A, Initial presentation—maxillary right lateral incisor. B, Initial radiographic appearance, horizontal fracture noted.



FIGURE 2. A, Occlusal view following: immediate implant placement, hard and soft tissue augmentation, and custom healing abutment placement, to support tissues during healing. B, Radiographic appearance of custom healing abutment.

the extraction and implant placement on the soft tissues the implant was placed slightly toward the palatal aspect. A xenograft material (Bio-Oss, Osteohealth, Co., Shirley, NY, USA) was used in the gap between the implant and the bony facial.¹⁵ A soft tissue connective tissue graft using an allograft (AlloDerm, Lifecell Co., Branchburg, NJ, USA) was placed out on facial aspect using an envelope technique.¹⁶ To support the gingival tissues during the healing phase a customized healing abutment was created using a stock temporary abutment (NC temporary abutment, Straumann) modified to the contours of the extraction socket site (Figure 2). Three months after implant placement, the site was deemed ready for restoration. Study casts were obtained along with inter-occlusal records, facebow recordings (Panadent, Colton, CA, USA) and diagnostic waxing of the tooth. The implant location as well as soft tissue contour were recorded by fabricating a custom impression coping. This required duplication of the soft tissue contour subgingival to the

healing abutment. Duplication of the soft tissue was achieved by removing the customized healing abutment from the implant and attaching it to a laboratory analog (Figure 3A) (NC analog, Straumann). An impression of the customized healing abutment/analog complex was made using a fast-setting vinylpolysiloxane (VPS) (Blu-Mousse, Parkell, Edgewood, NY, USA) in a copper matrix (Moyco, Moyco Technologies Inc., Montgomeryville, PA, USA) (Figure 3B). Once set the healing abutment was removed from the analog, leaving the analog firmly fixed in the VPS material, with the soft tissue contour recorded. An open tray impression coping was seated onto the laboratory analog and flowable composite filled the void between it and the VPS imprint made by the customized healing abutment (Figure 4). To assist in placement throughout the impression procedure, the customized impression coping had a buccal location mark placed on it. The custom impression coping was attached to the implant (Figure 5) and a radiograph made to confirm proper

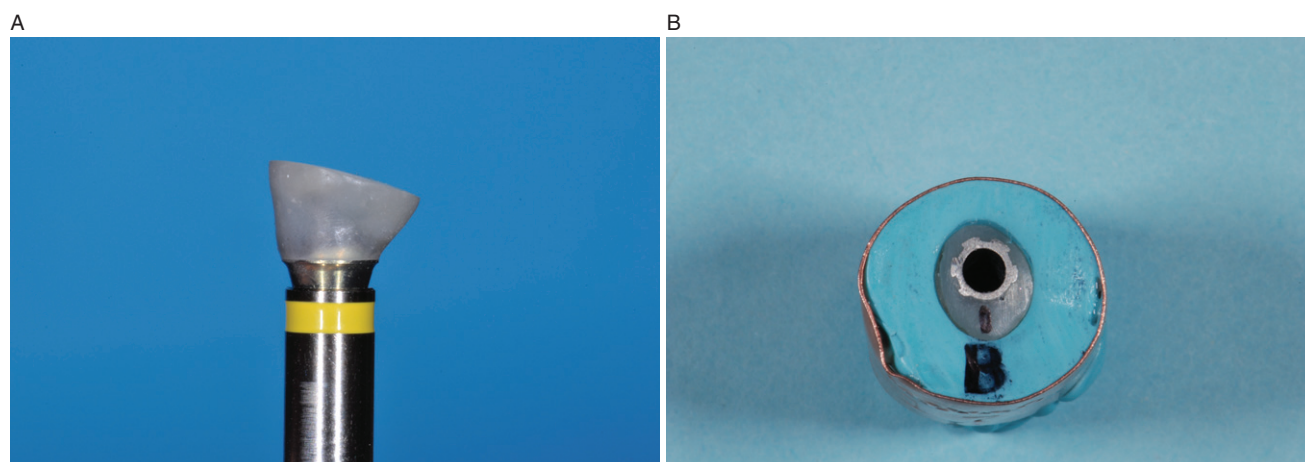


FIGURE 3. A, Copying the healing abutment contours: custom healing abutment removed from the implant, then attached to a laboratory analog. B, Analog and healing abutment seated into the Blu-Mousse. The orientation is noted. Once set the healing abutment is unscrewed, leaving the sort tissue contour recorded in the Blu-Mousse.

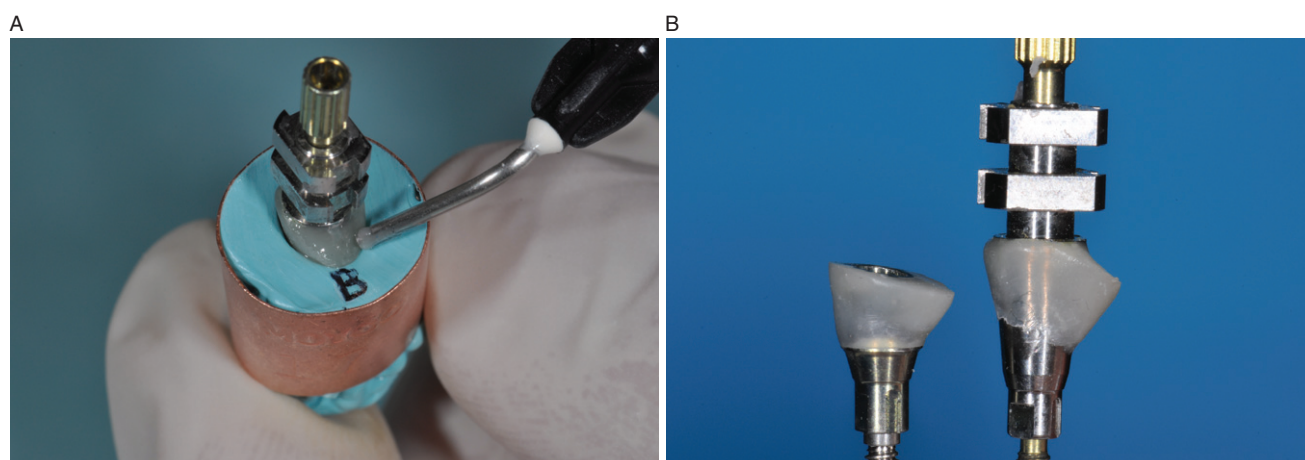


FIGURE 4. A, Fabrication of custom impression coping, the healing abutment is removed and replaced with a standard impression abutment. Flowable composite is added to the impression abutment copying the form of the healing abutment. B, Healing abutment and the custom impression coping compared. Both have the same recording of the soft tissue form around the implant.

seating, an open tray implant level pick up impression was made (Aquasil Ultra: Dentsply, York, PA, USA). In the laboratory an analog (NC, Straumann) was attached to the custom impression coping that had been picked up in the impression. A soft tissue gingival mask (Gingitech, Ivoclar-Vivadent, Amherst, NY, USA) was incorporated and the impression was poured in a type IV stone (Fuji rock, GC, Leuven, Belgium).

A wax up sleeve (Straumann) was modified and fixed to the implant analog and waxed to contour. Then a putty matrix (Sil-Tech, Ivoclar-Vivadent) was made from the

diagnostic waxing (Figure 6A). The matrix provided a cutback guide for the abutment framework dimensions needed to support the proposed restoration. The wax pattern incorporating the wax up sleeve was scanned (Etkon, Straumann) and a computer aided design/ computer aided manufacturing (CAD/CAM) abutment designed and then fabricated in zirconia (Straumann) (Figure 6B). The margins of the zirconia abutment followed the contour of the silicone gingival margin but were placed 1.5 mm subgingival to allow for the proposed pressed margin to have a minimum height of 2 mm. This would allow the pressed porcelain



FIGURE 5. Custom impression coping placed into the implant site. Checked for orientation, before making an open tray impression.

abutment margin to begin at 1.5 mm below the gingival margin and end 0.5 mm supragingivally. The contours of the proposed ceramic abutment margins were waxed directly to the zirconia abutment and corresponded to the soft tissues that were modeled on the healed soft tissue site (Figure 7).

The waxed zirconia abutment was attached to a sprue and invested in porcelain pressing investment (Microstar HS Investment, Microstar Dental, Lawrenceville, GA, USA). The appropriate shade of ingot was selected (IPS e.max Zir-Press, Ivoclar) and the pressing was made following the manufacturer's recommendations in the pressing furnace (Ivopress 5000, Ivoclar-Vivadent). The zirconia abutment

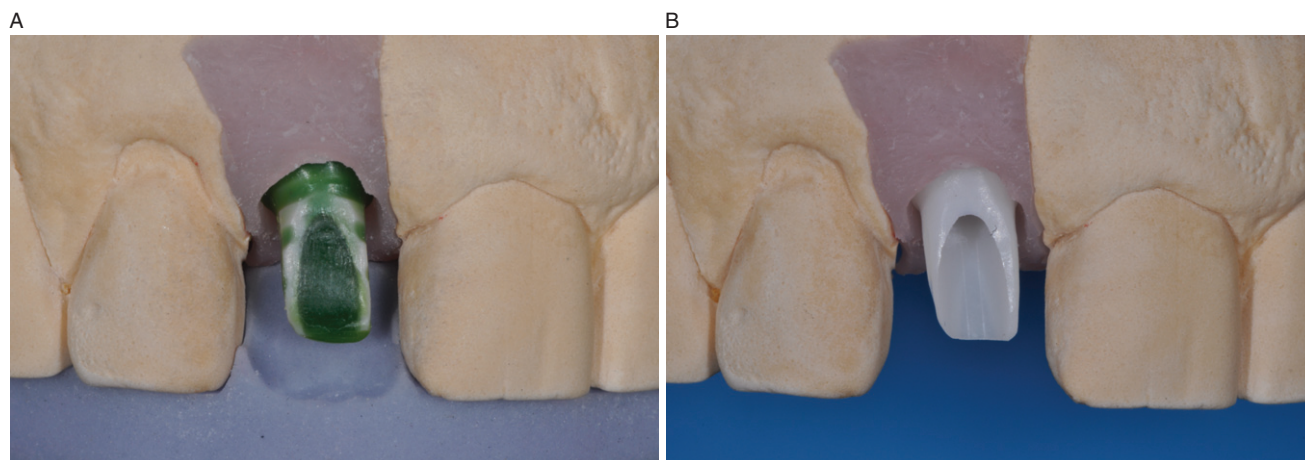


FIGURE 6. A, For the CAD/CAM process a scan replica is initially made: wax up sleeve, cut to size, and waxed to dimensions according to putty matrix of the original diagnostic waxing. B, CAD/CAM zirconia abutment once fabricated is placed into the original soft tissue cast.

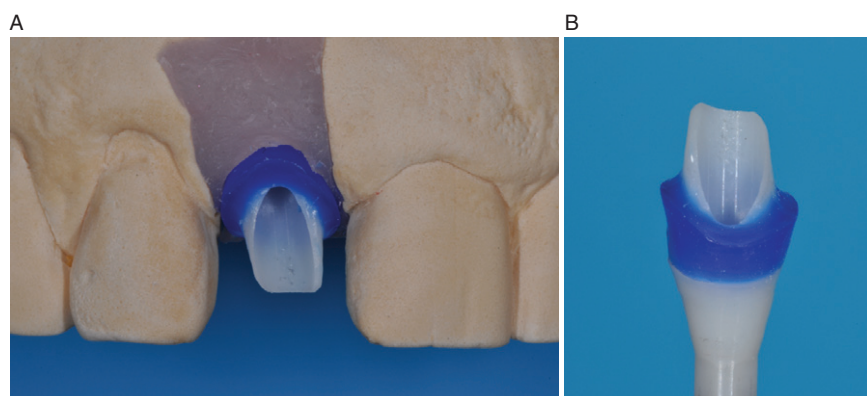


FIGURE 7. A, Zirconia abutment with wax added to customize and produce a supragingival margin. B, The CAD/CAM zirconia abutment modified with wax.

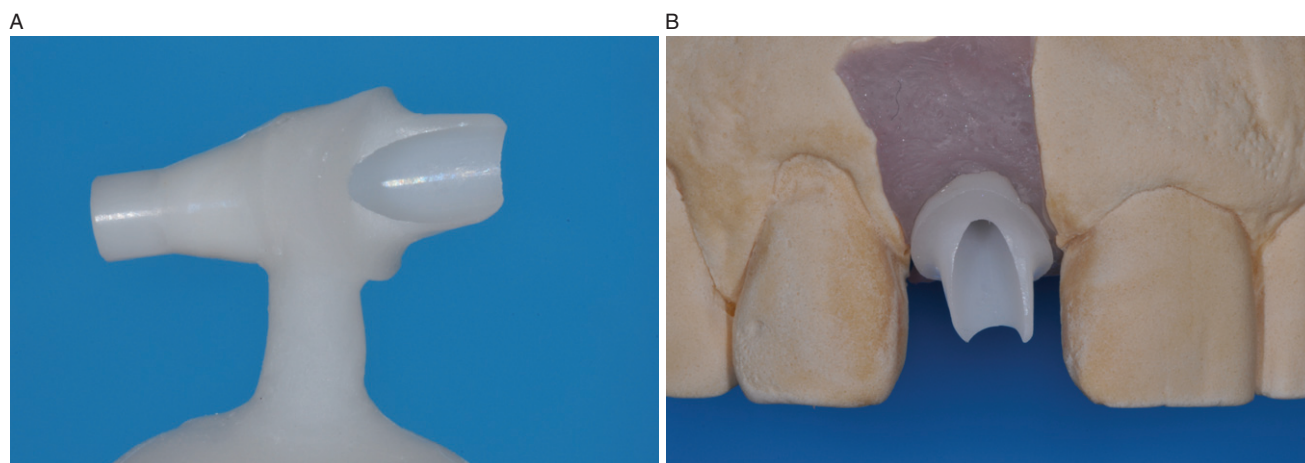


FIGURE 8. A, Pressing supragingival margin with IPS e.max Zirpress ceramic. The ceramic sprue is still attached. B, Zirconia abutment customized with supragingival pressed porcelain margin.

(Figure 8) with pressed ceramic margin was recovered using airborne particle abrasion with the engaging surfaces of the implant abutment protected with a layer of wax. The abutment was used to fabricate a ceramic crown (IPS e.max, Ivoclar-Vivadent) of the desired color, by fabricating a wax coping crown according to the dimensions dictated by the initial diagnostic waxing, then investing (Microstar HS Investment) and fabricating by the pressing technique described earlier. The porcelain of the crown and zirconia abutment with the pressed porcelain margin were customized with stains and glazed.

The patient approved the esthetic appearance of the restoration, then, confirmation of complete seating of the abutment and the crown was done with a radiograph prior to cementation. Both the zirconia abutment and IPS e.max crown were returned to the laboratory for conditioning prior to final seat. The fitting surfaces of the abutment's porcelain margin and the internal of the ceramic crown were prepared for adhesive bonding by etching with hydrofluoric acid (IPS Ceramic Etching Gel, Ivoclar-Vivadent) for 20 seconds (Figure 9), then rinsed for 20 seconds. Further cleaning with 35% phosphoric acid (Ultra-Etch, Ultradent Products Inc., South Jordan, UT, USA) for 30 seconds and a 20-second rinse followed. Finally, cleaning was completed by separate immersion of the crown and abutment in distilled water in an ultra-sonic bath for 5

minutes. The bonding surfaces were silanated (Silane, Ultradent Products Inc.) following thorough oil-free air drying and dried at 100°C for 5 minutes in the oven, according to an established protocol for bonding porcelain to porcelain restorations.¹⁴

The zirconia abutment was seated (Figure 10) and the screw was tightened to the appropriate torque (35 Ncm). A small pellet of sterilized polytetrafluoroethylene tape (Oatey Co., Cleveland, OH, USA) was placed into the screw access channel over the screw head,¹⁷ and the previously etched and silanated supragingival porcelain surfaces were then coated with adhesive resin (Prime and Bond, Dentsply) followed by the application of resin luting agent (Ultra-Bond Plus, DenMat, Santa Maria, CA, USA). The IPS e.max crown was seated (Figure 11) and held in place for light polymerization. The final ICEAM was cleaned of excess resin, occlusion evaluated, adjusted, and the crown polished with porcelain polishing points (Dialite, Brasseler USA, Savannah, GA, USA) (Figure 12).

DISCUSSION

Immediate implant placement following atraumatic extraction is considered an acceptable treatment option for the hopeless tooth. Maintaining the soft tissue form after extraction of the tooth remains a challenge because



FIGURE 9. Hydrofluoric conditioning of ceramic bondable surfaces. Both the margins of the abutment and crown as well as the intaglio of the crown are susceptible to this process.



FIGURE 10. Zirconia abutment with custom-pressed ceramic margin being seated.



FIGURE 11. Seating of the IPS e.max crown on the modified zirconia abutment. Note that the margin of the abutment is supragingival.



FIGURE 12. The final implant crown with an esthetic adhesive margin restoration 1 week after cementation.

of alveolar housing resorption. One means of accomplishing this is to provide tissue augmentation at the time of implant placement surgery. The implant soft tissue emergence profile can also be established early during the implant healing if an appropriately formed healing abutment is fabricated. This can be copied once osseointegration is confirmed by customizing an impression coping as described in this article.

When considering the restorative phase of the treatment, the abutment/crown margin of an implant restoration presents a contentious challenge. By placing this margin subgingival, the transition from the abutment (usually a metal or zirconia substrate) to

the crown is hidden, but this exacerbates the issue of excess cement extrusion. This can negatively impact the health and integrity of the implant supporting tissues. Alternatively, if the junction is supragingival the cement issue is negated, but the margin transition becomes visible. One method of overcoming these problems is to use materials for the abutment margin and crown margin that are compatible esthetically, and capable of uniting by adhesive bonding. This allows for the margin junction to be placed supragingival. The customization of the abutment and crown components has been previously described,¹⁴ however, the materials and techniques used were that of traditional porcelain stacking followed by sintering the porcelain. This is a

very technique sensitive procedure, as the materials shrink markedly, requiring multiple porcelain application and sintering cycles.

With the introduction of pressed ceramic systems comes the ability to wax directly to the implant abutment, invest, and then process in porcelain, with minimal dimensional change. The technique is less demanding on the skills of the technician as multiple applications are not required, it can also be more economical as more than one unit can be invested and pressed at the same time. This form of customization with the pressed ceramic systems available today allows for processing directly onto either metal or zirconia substructures. Pressed ceramics also allow the ceramist to be more innovative with other types of implant restoration designs.¹⁸ The pressed ceramic can also be readily etched with hydrofluoric acid so the two margin surfaces can be bonded together. This gives an esthetic and almost seamless transition from implant abutment to cemented coronal restoration, much like that seen with traditional porcelain veneers bonded onto teeth. Moisture control is an important factor in achieving predictable adhesive bonding. The use of supragingival margins facilitates the ability to control moisture when compared with subgingival margins where sulcular fluid may negatively affect the bonding process.

ICEAM abutments, because of their supragingival design, can also aid in the clinical evaluation of complete seating of the restorations.

CONCLUSION

The ICEAM is a restoration that has several advantages, which include: control of cement lute site that has the potential to reduce cement induced peri-implant disease; easier cleanup; and the ability to improve adhesion of zirconia abutments. It is an esthetic restoration that can be economically made and is applicable to both metal and ceramic abutment materials capable of being used with pressable ceramic systems. It is considerably less demanding on the laboratory technician compared with other means of creation of a porcelain margin on an abutment.

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