

A CLINICAL CASE SERIES IN ORAL REHABILITATION

PureForm™ Ceramic Restorative System: Overview and Clinical Evaluations

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Introduction

The exponential growth of oral implantology in recent years has been coupled with increasing patient demands for natural-looking esthetics. While implant-supported, porcelain-fused-to-metal (PFM) crowns have been used to successfully restore missing teeth, the metal framework beneath the thin porcelain veneer could make the prosthesis appear dull next to the adjacent natural dentition. Porcelain degradation from toothbrushing over time could further darken the prosthesis,¹ and the supporting abutment could create a metallic smile line that worsened with subsequent oxidation and gingival recession.²⁻³

New ceramic restorative systems that replace the traditional metal framework of PFM restorations with an opaque ceramic base have significantly improved esthetics. This paper presents an overview of a new ceramic restorative system designed for esthetic implant-supported restorations, and reports on its clinical use to restore tooth form, function and esthetics in partially edentulous patients.

Overview

Description

The PureForm Ceramic Restorative System (Centerpulse Dental Inc., Carlsbad, CA) consists of six ceramic copings that are shaped like prepared natural teeth [Fig. 1]. Little or no additional coping modifications are generally required. When some preparation is necessary,

the ceramic material (70% alumina, 30% zirconia) can be modified without the chipping, cracking and difficulty associated with all-alumina and all-zirconia components. Porcelain is applied directly to the ceramic coping without preliminary waxing or casting, and the finished prosthesis cements onto a screw-retained, titanium core abutment that provides a precision-machined interface with the implant.

Fig. 1. PureForm ceramic copings are shaped like six prepared natural teeth: premolar, canine, small incisor (straight and angled 17°) and large incisor (straight and angled 17°).



In addition to the restorative components, the system includes a surgical try-in pin to help guide implant placement, and color-coded core abutment analogs for laboratory use.

Strength Analysis

Fatigue and 17° compression tests were conducted on MTS Equipment to assess the mechanical strength of six PureForm ceramic copings restored under “worst case” clinical conditions. Each coping was prepared to the lowest allowable wall thickness (0.5 mm) with a diamond grinding wheel, and no irrigation was used during preparations to allow the strength of the coping to be evaluated under conditions of excessive heat generation. Either AllCeram® (Ducera Dental GmbH & Co, Rosbach, Germany) or

Table 1. Results of Fatigue Tests at 22.2 to 244.7 N (5 to 55 lbs) of Load⁴

Sample	Cycles	Failure Mode	Comments
1	5 Million	No Failure	No chips, cracks or debonding
2	5 Million	No Failure	No chips, cracks or debonding
3	5 Million	No Failure	No chips, cracks or debonding
4*	1,845,800	Abutment Screw Bent	No chips, cracks or debonding
5	5 Million	No Failure	No chips, cracks or debonding
6	5 Million	No Failure	No chips, cracks or debonding
7	5 Million	No Failure	No chips, cracks or debonding
8	5 Million	No Failure	No chips, cracks or debonding
9	5 Million	No Failure	Incisal edge chip due to poor contour
10	5 Million	No Failure	No chips, cracks or debonding
11	5 Million	No Failure	No chips, cracks or debonding

*Loaded to 22.2 - 289.1 N (5 - 65 lbs)

Vitadur Alpha® (Vident, Brea, CA) porcelain was applied directly to the coping to form the crown.

Fatigue and 17° compression test results are presented in Tables 1 and 2. In both cases, overall crown strength ranged from 46% (compression) to 70% (fatigue) higher than the minimum strength requirements for each test. During fatigue testing, one sample (No. 4) was tested at a higher rate of 22.2 - 289.1 N (5 - 65 lbs) to deliberately determine the failure mode, which occurred when the abutment screw fractured at 1,845,800 cycles [Table 1]. All of the remaining test samples withstood 5 million cycles without failure. Each test sample was carefully examined under microscopic magnification. Only one sample (No. 9) exhibited signs of porcelain chipping due to a poor contour that delivered the entire test load to a single point on the incisal edge of the crown. All samples were checked for cement bonding and no signs of loosening between the crown and titanium core abutment were

Table 2. Results of 17° Compression Tests⁴

Sample	Coping Design	Mode of Failure	Failure Load
1	Small Incisor	Porcelain Fractured	614.9 N (168 lbs)
2	Small Incisor	Porcelain & Coping Fractured	512.4 N (140 lbs)
3	Small Incisor	Porcelain Fractured	629.6 N (172 lbs)
4	Large Incisor	Porcelain & Coping Fractured	673.5 N (184 lbs)
5	Large Incisor	Porcelain & Coping Fractured	724.7 N (198 lbs)
6	17° Large Incisor	Porcelain Fractured	611.3 N (167 lbs)
Mean			611.3 N (167 lbs)

observed. Fatigue testing did not determine the actual fatigue endurance limit of the restored test samples, which only experienced failure of the core retaining screw in one sample that was subjected to loads that exceeded the test parameters [Table 1: Sample 4].

These test results demonstrate that, when the PureForm ceramic coping is properly prepared and the applied porcelain has the coefficient of thermal expansion range comparable to those tested (i.e. range = 6.9 to 8.1 x 10⁻⁶), the porcelain crown will withstand the occlusal loads expected within the anterior and premolar regions.

Clinical Technique

For optimum orientation of the prosthesis, the implant should be indexed toward the buccal at the time of surgical placement. This is achieved by rotating the implant in the receptor site until the fixture mount's flat side (Tapered Screw-Vent or Screw-Vent implants) or edge of two flat sides (Splines implants) is buccally oriented [Fig. 2].

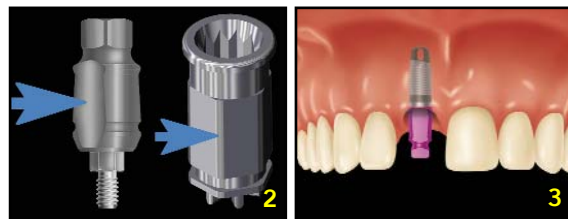


Fig. 2. When seating the implant, rotate the fixture mount until its flat side (Tapered Screw-Vent or Screw-Vent System, left) or edge of two flat sides (Splines System, right) is oriented toward the buccal.

Fig. 3. Attach an implant-level impression post and make a transfer impression.

After osseointegration and second-stage soft tissue healing have been achieved, the healing collar or provisional prosthesis is removed from the implant and a fixture-level impression post is attached. In the Tapered Screw-Vent System, the fixture mount can be used as the impression post [Fig. 3]. Standard impressions with medium-density and low-density material are made. After removing the impression, the impression post is unthreaded from the implant, attached to an implant analog, and reinserted into the impression. The healing collar or provisional restoration is replaced and the patient is



Fig. 4. Pour the working cast in dental stone.



Fig. 5. Attach the titanium core abutment to the implant analog in the working cast.



Fig. 6. Seat the ceramic coping on the abutment to determine if any modifications are needed.



Fig. 7. Modify the ceramic coping with rotating disks under copious irrigation.



Fig. 8. Apply porcelain directly to the prepared ceramic coping instead of a metal framework.



Fig. 9. Verify the form, contours and esthetics of the finished crown on the working cast.

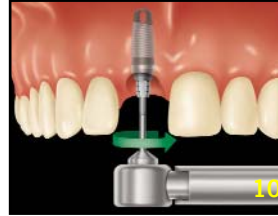


Fig. 10. Attach the sterilized core abutment to the implant with 30 Ncm of torque.



Fig. 11. Occlude the opening with cotton to facilitate future access, if need.

dismissed until the definitive prosthesis delivery appointment. If a soft tissue replica is desired, the impression material around the impression post and implant analog assembly is lubricated with a separating medium, and a soft tissue replica material is injected around the interface margin of the assembled transfer components. Undercuts are created in the soft tissue material with a sharp instrument to facilitate mechanical retention in the working cast. The impression is boxed, poured in dental stone, and a working cast with a soft tissue replica is separated after setting [Fig. 4]. The working cast is mounted with the opposing arch cast using an interocclusal record.

The impression post is unthreaded from the implant analog embedded in the working cast, the selected core abutment (or color-coded analog) is seated on the implant analog with the flat side oriented toward the buccal surface, and its retention screw is tightened to 30 Ncm to secure it in place [Fig. 5].

To determine if any modifications are necessary, the selected ceramic coping is placed on the core abutment with its flat surface oriented toward the buccal [Fig. 6]. If modifications are desired, the coping is attached to a holder and reduced to the correct dimensions with conventional porcelain finishing burs in preparation for porcelain application [Fig. 7]. Care is taken not to

overheat the ceramic coping during modifications. The surface of the coping is sandblasted with 120 μm particles of aluminum oxide at 35-38 PSI, then cleaned with distilled water in an ultrasonic



Fig. 12. Cement the definitive crown onto the core abutment.

cleaning unit. A porcelain with a coefficient of thermal expansion that ranges from 6.9 to 8.1 is recommended for the restoration. When preparations are completed, porcelain is applied directly to the ceramic coping [Fig. 8] according to the manufacturer's guidelines for application of color modifiers, ceramic build-up and firing temperatures. The definitive porcelain crown is completed using conventional laboratory techniques [Fig. 9].

At the prosthesis delivery appointment, the healing collar is removed from the implant and the titanium core abutment is seated under 30 Ncm of applied torque [Fig. 10]. The opening in the top of the core abutment is occluded with a cotton pellet to prevent the ingress of crown cement [Fig. 11]. The finished tooth prosthesis is cemented onto the titanium core component to complete the case [Fig. 12].

CLINICAL CASE REPORTS

Case 1: Missing First Bicuspid

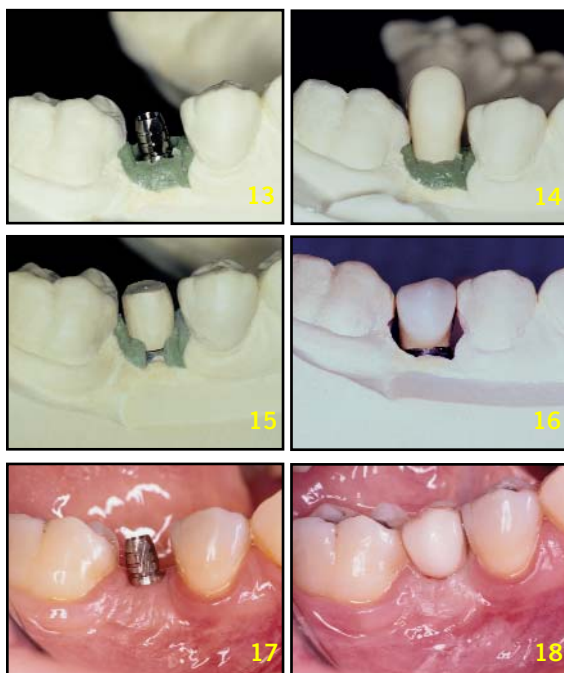


Fig. 13: Flat side of the core abutment is oriented buccally.
Fig. 14: Plastic try-in tooth confirms excellent positioning.
Fig. 15: Ceramic coping is prepared for porcelain application.
Fig. 16: The finished abutment is ready for delivery.
Fig. 17: The core abutment is delivered and occluded.
Fig. 18: Cemented crown provides an esthetic restoration.

A 48-year-old female with a missing mandibular left first bicuspid was treated with a Tapered Screw-Vent implant. After fabrication of a working cast containing replicas of the implant and the peri-implant soft tissue, a core abutment with a 1.5 mm-high cuff height was seated on the implant analog in the working cast with 30 Ncm of torque [Fig. 13]. The premolar ceramic coping was reduced and contoured with high-speed diamond wheels and external irrigation, then grit-blasted and cleaned in an autoclave [Figs. 14-15]. Porcelain was then applied to the coping to form the crown [Fig. 16]. At the delivery appointment, the sterilized core abutment was seated with its flat side oriented buccally and tightened to 30 Ncm of torque [Fig. 17]. Full seating was confirmed radiographically. The screw access hole in the top of the core abutment was occluded, and the sterilized crown was cemented onto it with composite material [Fig. 18].

Case 2: Periodontally Hopeless Cuspid

A 39-year-old female had severe root resorption of a maxillary right cuspid. The tooth was extracted and an MTX™ microtextured Tapered Screw-Vent implant was placed. After osseointegration and stage-2 soft tissue healing, a working cast was fabricated. The core abutment [Fig. 19] and ceramic coping [Fig. 20] were attached, and modifications were made to the coping without chipping or cracking [Fig. 21]. Porcelain was applied to the fully prepared coping to complete the crown [Fig. 22]. At the delivery appointment [Figs. 23-24], tooth form, function and natural-looking esthetics were successfully achieved.

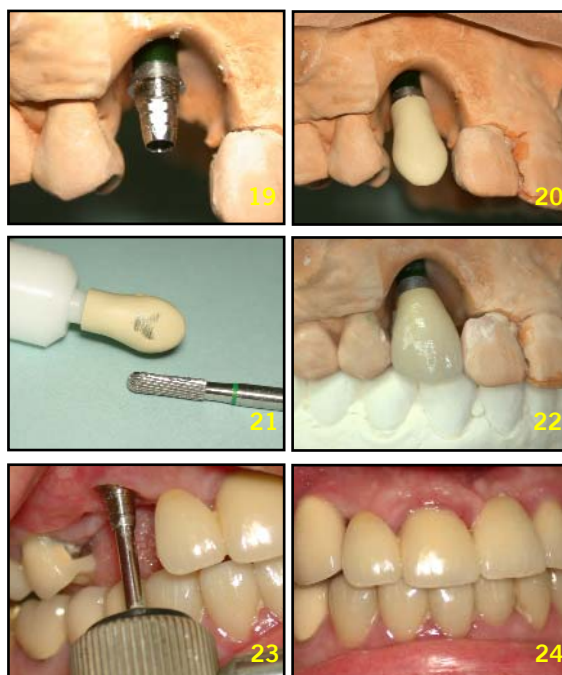


Fig. 19: The core abutment is oriented buccally.
Fig. 20: Coping modifications are determined on the cast.
Fig. 21: No chipping or cracking occurs during preparations.
Fig. 22: Porcelain is applied to complete the crown.
Fig. 23: The core abutment fully seats with 30 Ncm of torque.
Fig. 24: Natural-looking esthetics are achieved after cementing the porcelain crown.

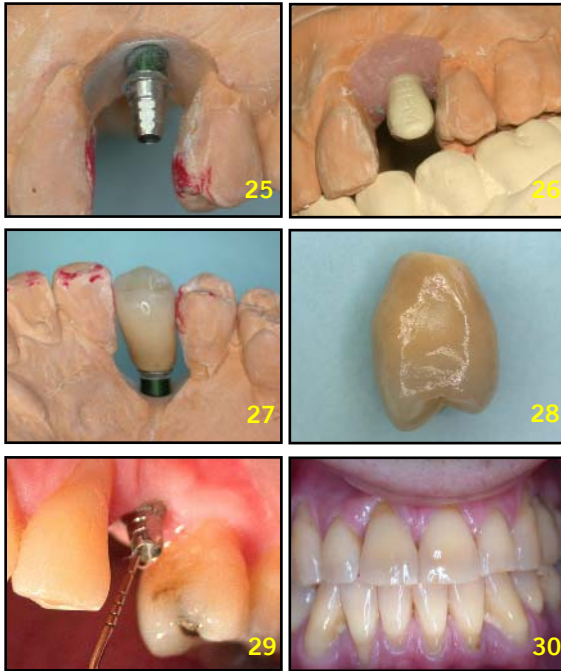


Fig. 25: The flat side of the core abutment is placed buccally.
Fig. 26: Plastic try-in coping shows a good emergence profile.
Fig. 27: Removal of soft tissue replica shows excellent contours.
Fig. 28: Porcelain crown is ready for delivery.
Fig. 29: The core abutment is delivered and occluded.
Fig. 30: The porcelain crown is cemented onto the abutment.

Case 3: Missing First Bicuspid

A 52-year-old male presented with a missing maxillary left first bicuspid. The patient chose to have an implant-supported, single tooth restoration rather than a fixed or removable partial denture. A Tapered Screw-Vent implant was placed and a working cast was fabricated from a stage-1 impression. At the stage-2 uncovering, a provisional prosthesis was delivered and allowed to function for three weeks until the soft tissues were fully mature. A second working cast was fabricated and the core abutment [Fig. 25] and plastic try-in coping [Fig. 26] were attached to verify the soft tissue emergence profile. After minimum preparations, porcelain was applied to the ceramic coping [Figs. 27-28]. At the delivery appointment, the sterilized core abutment was seated with 30 Ncm of torque, and the screw access hole was occluded with a cotton pellet to facilitate future retrievability [Fig. 29]. The porcelain crown was cemented to the core abutment and final adjustments were made.

Discussion

The use of ceramic crowns restorations in anterior partially edentulous cases is rapidly becoming a preferred restorative option due to patient demands for improved esthetics. In the present cases, the PureForm Ceramic Restorative System was simple to use and achieved excellent clinical results. Strength testing under “worst case” clinical conditions demonstrates that the system is able to maintain its strength and integrity far beyond the normal limits of clinical functioning. The core abutment successfully withstood attachment and removal with the appropriate tools without any evidence of distortion or damage.

References

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