

# Aesthetic Functional Area Protection Concept for Prevention of Ceramic Chipping with Zirconia Frameworks

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Chipping of the ceramic veneer is reported as a frequent occurrence when using zirconia-based fixed dental prostheses (FDPs). One possible cause of this complication is the inadequate support of the veneering ceramic by the zirconia substructure. In this article, early clinical observations from patients treated with 96 zirconia-based ceramic single- and multiple-unit FDPs on natural teeth and implants are presented. The FDPs were fabricated according to the aesthetic functional area protection concept of framework design for the prevention of ceramic chipping. *Int J Prosthodont* 2014;27:174–176. doi: 10.11607/ijp.3874

The traditional popularity of porcelain-fused-to-metal fixed dental prostheses (FDPs) has been challenged by the advent of all-ceramic systems. This perceptual change in what offers patients and clinicians optimal biocompatibility and aesthetic outcomes results from the introduction of advanced dental technologies and high-strength ceramic materials. Zirconia, a polycrystalline material partly stabilized by yttrium oxide (approximately 3 mol%) and without a glassy matrix, has understandably become a popular option<sup>1</sup> since FDPs with zirconia frameworks exhibit similar technical and biologic outcomes. Moreover, it appears that, despite a reported 13% incidence of chipping of the ceramic veneer,<sup>2</sup> such prostheses exhibit a similar survival rate to metal-ceramic FDPs after a few years of function.<sup>3,4</sup>

Current literature supports the principle that a zirconia substructure should adequately support the veneering ceramic. This preliminary report presents the clinical outcome of 96 zirconia-based ceramic single- and multiple-unit FDPs fabricated according to the aesthetic functional area protection (AFAP) concept for prevention of porcelain chipping.

## Materials and Methods

From January 2011 to June 2012, a convenience selection of 52 consecutively treated patients (32 women and 20 men with an age range of 28 to 55 years and a mean age 45 years) were treated with 96 zirconia-based ceramic FDPs, for a total of 205 units. All patients included in the study did not have any systemic contraindication to dental treatment. The 96 FDPs were divided as follows: 71 FDPs (86 units) were cemented on natural teeth and 25 FDPs (119 units) on implant abutments.

In the natural tooth group, 64 FDPs were single-unit FDPs (38 on anterior teeth, 26 on posterior teeth), while 7 FDPs (22 units) were multiple-unit FDPs (12 on anterior teeth, 10 on posterior teeth). In the implant group, 14 FDPs were single-unit FDPs (3 on anterior abutments, 11 on posterior abutments), while 11 FDPs (105 units) were multiple-unit FDPs (36 on anterior abutments, 69 on posterior abutments).

All FDPs were fabricated by the same dental technician (CB) on a manual copy milling unit (Zirkograph, Zirkonzahn) using presintered Prettau Zirconia (Zirkonzahn). The substructures were designed to fully support the veneering ceramic on the incisal edges of anterior teeth and on the cusps of posterior teeth, a laboratory protocol concept referred to by the authors as aesthetic functional area protection (AFAP). The frameworks were then veneered with a compatible ceramic (Ice Zirkon Keramik, Zirkonzahn) (Figs 1 to 4).

All FDPs were cemented by the same clinician (MB) with transparent cement (Multilink Automix, Ivoclar Vivadent) on natural teeth and with temporary cement

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**Fig 1** Zirconia-based ceramic FDP for an anterior single natural tooth. The substructure was designed to protect the ceramic veneer at the incisal margin.



**Fig 2** The zirconia framework layered with aesthetic ceramic except at the incisal edge, where it is left exposed.



**Fig 3** Zirconia-based ceramic FDP for a posterior single natural tooth. The substructure was designed to support the ceramic veneer at the cusp tips and around the axial surfaces.



**Fig 4** The zirconia framework layered with aesthetic ceramic.

(Temp Bond NE, Kerr Italia) on the implant abutments, following the manufacturers' instructions. All patients underwent regular recall visits at least twice per year. At each recall, the FDPs were inspected for the presence of chipping or framework fracture.

## Results

Ninety-six zirconia-based ceramic FDPs (205 units) were observed in follow-up appointments for at least 12 months and 34 FDPs (101 units) for over 18 months. In this relatively short observation period, only 1 single-unit FDP cemented on an implant abutment (maxillary left lateral incisor) displayed minor chipping after 14 months in function. The problem was satisfactorily solved with polishing of the chipped ceramic area.

## Discussion

When zirconia-based ceramic FDPs are used on natural teeth or implants, it is extremely important to reduce the risk of chipping of the ceramic veneer.

Chipping has been attributed to different causes: coefficient of thermal expansion mismatch with the veneering ceramic, incorrect heating and cooling rates, incorrect surface treatment of the zirconia prior to the application of the ceramic, and inadequate support of the veneering ceramic.<sup>4</sup> The aim of the AFAP concept presented in this paper is to develop a framework design that supports and protects the weaker veneering ceramic while not compromising the aesthetic outcome. A similar concept was proposed for traditional metal-ceramic FDPs by Shoher and Whiteman in 1983.<sup>5</sup> However, unlike metal frameworks, which have to be adequately opacized and, thus, have to be cut back from the surface to apply a sufficiently thick layer of ceramic to provide a natural appearance to the FDP, zirconia's light color allows the technician to bring it to the surface as limited islands of material in specific areas, ie, at the incisal edges of anterior teeth and at the cusp tips of posterior teeth. In these areas, the oblique tensional forces are believed to determine a higher risk of ceramic chipping. The supportive zirconia areas presumably convert the oblique tensional

forces applied on the aesthetic ceramic to compressive forces that are better withstood by the veneering material.

This clinical report, however, presents some limitations: the mixed nature of units sampling (anterior and posterior FDPs, single and multiple units, tooth-supported and implant-supported FDPs); the lack of a control group with FDPs made following more traditional design concepts; the absence of a power evaluation for the number of patients enrolled in the report; the short duration of observation; the lack of information regarding the patient's occlusal behavioral history; and the nature of the antagonist to each FDP.

### Conclusion

Within the limitations of this study, it can be concluded that the preliminary results of 96 single- and multiple-unit FDPs made according to the AFAP concept and cemented on natural teeth and implant abutments suggest a satisfactory outcome regarding the risk of ceramic chipping. Further laboratory and clinical studies should be carried out to evaluate this design under controlled loading conditions and for a longer period of clinical observation. Moreover, all FDPs included in this study were fabricated on a manual copy milling unit. Further studies should be conducted on FDPs made using computer-aided design/computer-assisted manufacturing systems.

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