Alternative framework designs for zirconia-ceramic crowns

LILIANA POROJAN¹, SORIN POROJAN², CRISTINA SAVENCU¹
¹Department of Prostheses Technology, ²Department of Oral Rehabilitation, Specialization Dental Technology, School of Dentistry “V. Babeș” University of Medicine and Pharmacy 9 Revolutiei 1989 Blv., 300041 Timișoara ROMANIA
lilianasandu@gmail.com

Abstract: The strength of an all-ceramic restoration depends not only on the fracture resistance of the material, but also on a suitable preparation design with adequate material thickness. The objective of this study was to provide alternative framework designs of molar zirconia-ceramic crowns. A plaster die was replicated from a plastic maxillary right first molar prepared for all ceramic crowns. Three different framework designs were found to be possible to create using the soft of the CAD/CAM system. Framework design modifications have been suggested by the soft, in order to improve strength by providing support to veneering porcelain and also to improve aesthetics without compromising strength. Different framework designs for zirconia-ceramic crowns can be chosen in order to provide adequate support for the veneering material.

Key-Words: zirconia-ceramic crown, molar, CAD/CAM, framework design, support.

1 Introduction
Advances in CAD/CAM technology have enabled the dental applications of zirconia ceramics, which become increasingly popular because of the excellent esthetics of anterior and posterior teeth. Regarding the preparation guidelines and design parameters there are no defined limits. A minimum thickness of 0.4 mm, respective 0.5 mm is recommended for Y-TZP ceramic crown frameworks in the anterior or posterior region. In principle, tooth preparation for zirconia-ceramic crown restorations with conventional Y-TZP frameworks requires a shoulder finish line with rounded internal angles. However, a light chamfer can also be prepared. This would allow less reduction for tooth preparation and help to preserve the tooth structure without damaging the remaining pulp in vital teeth, which is preferable in terms of the minimal intervention concept [1]. The slight chamfer, pronounced deep chamfer, and beveled shoulder preparations did not differ significantly with regard to breaking load. This could be attributed to the adequate strength attained with preparation designs that require minimal removal of sound tooth structure, such as slight chamfer preparation. In light of this result, consideration should be given to these designs from a prophylactic point of view with emphasis on conserving tooth structure and preventing preparation trauma [2].

Recently, yttria-stabilized tetragonal zirconia polycrystals (Y-TZP) have been introduced to the dental professionals. These materials have to be fabricated in CAD/CAM (Computer-Aided Design/Computer-Aided Manufacturing) procedures. The partially stabilized zirconia shows high fracture strength and structural reliability when fabricated into prostheses framework. However, due to their low translucency of the light, all zirconia frameworks have to be veneered with glass-ceramics or porcelain for esthetic reasons. These veneering materials have to directly face with chewing force and moisture, resulting in cracks or chipping [3].

The strength of an all-ceramic restoration depends not only on the fracture resistance of the material, but also on a suitable preparation design with adequate material thickness. The assumption that increased material thickness automatically produces greater strength was disproved by different studies [2]. Nowadays, frameworks for all-ceramic crown design by CAD/CAM have been based upon empirical machine guidelines rather than clinical scientific data. Most of all CAD/CAM systems, the frameworks of the crowns are design to arbitrary thicknesses of 0.4 to 0.6 mm [4]. This is leading to non-uniform thicknesses of veneering porcelains. Like porcelain fused to metal restorations, zirconia frameworks should be designed to provide the
appropriate veneering porcelain thickness and support to minimize internal stress, reduce mechanical failures, and optimize esthetics of the veneering porcelains[5].

2 Purpose
The objective of this study was to provide alternative framework designs of molar zirconia-ceramic crowns.

3 Materials and Method
A plaster die was replicated from a plastic maxillary right first molar prepared for all ceramic crowns. A chamfer finishing line and an occlusal convergence angle of 6° were chosen for the preparation. The master die was scanned using the Cercon Eye scanner (Degudent, Hanau, Germany). Scanned data were computed (Fig. 1) and then designed for all-ceramic crown framework using the Cercon Art 3.2 software (Degudent, Hanau, Germany).

Three different framework designs were found to be possible to create using the soft of the system. First, a uniform thickness of 0.5 mm was chosen for the framework (Fig. 2). Second, a cutback design was prepared as same as for metal-ceramic crowns in order to obtain uniform, adequate thickness and support for the veneering ceramics (Fig. 3). Third, a reduction of the framework was made only in the vestibular area, in order to achieve esthetics (Fig. 4).
3 Results and Discussions
Framework design modifications have been suggested by the soft, in order to improve strength by providing support to veneering porcelain and also to improve esthetics without compromising strength (Fig. 5).

One of the reasons for porcelain fracture is improper framework design. The improper framework design causes the improper support for the porcelain veneer layer and also the nonappropriate thickness of the veneering layer. The modification of the framework design by creating an appropriate support and allowing the proper veneering thickness has been proved to reduce the porcelain chipping rates. Different framework designs have influence on the failure load and failure characteristics of all ceramic zirconia crowns [6].

The individual design of a crown will, of course, influence the stability and the longevity of the final dental restoration. Especially an anatomically reduced crown framework possesses--in comparison to a simple coping design--several advantages [7]. Anatomic core design modification significantly increased the reliability and resulted in reduced chip size of either veneering techniques [8]. Anatomically guided zirconia frames resisted significantly higher loads than flat and PFM-like frame designs [9]. A cusp supporting framework design can significantly decrease the maximum tensile stresses in the veneering material of single crowns [10].

4 Conclusion
Within the limitations of the present study because of the multitude of parameters involved in the design, the following conclusions can be drawn:
1. Different framework designs for zirconia-ceramic crowns can be chosen in order to provide adequate support for the veneering material.
2. The cutback design allows the control of the veneering material thickness in order to ensure proper aesthetics, without compromising strength.

5 Acknowledgements
This work was supported by UEFISCDI, project number PN-II-RU-TE-2014-4-0476.

References:


