

Fracture strength of monolithic zirconia crowns with modified vertical preparation: A comparative *in vitro* study

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Aim: The aim of this study was to investigate the influence of different preparation designs (deep chamfer, vertical, and modified vertical with reverse shoulder) on the fracture strength and failure modes of monolithic zirconia crowns. Thirty sound human maxillary first premolar teeth with comparable size were used in this study. The teeth were divided randomly into three groups according to the preparation design (n=10): (1) group A: teeth prepared with a chamfer finish line; (2) group B: teeth prepared with vertical preparation; and (3) group C: teeth prepared with modified vertical preparation, where a reverse shoulder of 1 mm was placed on the buccal surface at the junction of middle and occlusal thirds. All samples were scanned by using an intraoral scanner (CEREC Omnicam, Sirona, Germany), and then the crowns were designed by using Sirona InLab 20.0 software and milled with a 5-axis machine. Each crown was then cemented on its respective tooth with self-adhesive resin cement by using a custom-made cementation device. A single load to failure test was used to assess the fracture load of each crown by using a computerized universal testing machine that automatically recorded the fracture load of each sample in Newton (N). The data were analyzed statistically by using one-way analysis of variance test and Bonferroni test at a level of significance of 0.05.

Results: The results showed that the highest mean of fracture load was recorded by chamfer (2,969.8 N), which followed by modified vertical (2,899.3 N) and the lowest mean of fracture load was recorded by vertical (2,717.9 N). One-way ANOVA test revealed a significant difference among the three groups. Bonferroni test showed a significant difference between chamfer and vertical groups while a nonsignificant difference was revealed between modified vertical with chamfer and vertical groups.

Over the years, the horizontal preparation using the chamfer and shoulder finish lines has been accepted as the gold standard for all-ceramic restoration. However, these types of margins are invasive in terms of sound tooth structure removal that is critical for biological and esthetic concepts. The introduction of high-strength polycrystalline materials allows the use of vertical preparation as a less extensive alternative to the horizontal. The vertical margins can provide the most acute marginal restoration that preserves maximum sound tooth structure. Nevertheless, the type of the restoration margin appears to be the most technically challenging issue as cracks may be induced from the occlusal surface to the thin margin.

In this study, the vertical preparation was modified with a reverse shoulder at the buccal surface of the abutment tooth. This approach has been adopted from a group of Italian clinicians (Tomorrow Tooth Group), who claim that this approach improves the esthetics and biomechanics of zirconia crowns with vertical preparation.

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It is noteworthy that no previous studies are available in the literature concerning the modification of the vertical preparation with a reverse shoulder. However, interestingly, in the present study, the fracture loads obtained with the modified vertical preparation were higher than the vertical group; this could be related to that the reverse shoulder allows more thickness of material on the axial wall, which results in a more favorable stress distribution. Regarding modes of failure, 90% of samples chamfer margins showed a severe fracture of tooth and restoration (catastrophic failure), whereas 60% of samples with vertical and modified vertical showed this mode of failure; this could be attributed to the increased depth of preparation with the horizontal finish line that leads to a decrease in the fracture resistance of the tooth.

Conclusion: Within the limitations of this in vitro study, the mean values of fracture strength of monolithic zirconia crowns of all groups were higher than the maximum biting forces in the premolar region. The modification of the vertical preparation with a reverse shoulder placed at the buccal surface improved the fracture strength up to the point that it was statistically nonsignificant with the chamfer group. However, future studies are still required.

Biography

Marwah Ismael Abdulazeez, M.Sc in Aesthetic and Restorative Dentistry, was born in Iraq, graduated from University of Baghdad/College of dentistry in 2009. He worked as a general dentist at the same University in the Department of Restorative Dentistry since 2012 and finished master program in 2022. Currently he works as Assistant Lecturer at University of Baghdad / College of Dentistry.

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