Introduction and Objectives

The purpose of this in-vitro study was to evaluate the fracture resistance of adhesively luted or conventionally cemented monolithic posterior single crowns made from zirconia (ZI), lithium disilicate (LS2) or feldspar ceramic (FC). The null hypothesis was two-fold: (1) various types of full-contour all-ceramic posterior single crowns would give an acceptable load bearing capability to withstand mean masticatory forces and (2) full-contour zirconia crowns allow for reduction of occlusal layer thickness and enable for reduction of dental hard tissue loss during abutment preparation.

Material and Methods

A total of 53 all-ceramic single crowns were fabricated. All crowns were fabricated in anatomic design and with equal standardized external geometry. They were fabricated from ZI (Cercon® ht, DeguDent GmbH, Hanau, Germany) (n=21), LS2 (emaxCAD, Ivoclar Vivadent GmbH, Ellwangen, Germany) (n=21) or FC (TriLuxe, VITA Zahnfabrik GmbH, Bad Säckingen, Germany) (n=11). The minimum occlusal layer thickness of the crowns was adjusted according to the manufacturer specifications (ZI: 0.4mm, LS2: 1.6mm, FC: 1.6mm). All crowns were luted adhesively or cemented conventionally on resilient mounted metal tooth analogs (CoCr alloy). Physiological lateral mobility of the metal abutment tooth analog was simulated with a 0.3mm rubber shell, interposed between abutment socket and an aluminium base plate. ZI and LS2 crowns each were luted adhesively (AD) or cemented conventionally (CE) with glass-ionomer cement (Ketac Ceram Aplicap, 3M ESPE, Neuss, Germany). Feldspar ceramic crowns were luted adhesively (Panavia F 2.0, Kuraray Europe, Hattersheim, Germany). All specimens underwent axial loading until fracture. The spherical stainless steel piston had a diameter of 4mm and was positioned to the central socket with contact to three cusps. Fracture loads were recorded and analysed using non-parametric statistical tests (i.e., Mann-Whitney-U and Kruskal-Wallis). An additional crown of each material group was embedded in clear acrylic (Ivoclar ProBase Cold, Ivoclar Vivadent, Ellwangen, Germany). The resulting plastic blocks were trimmed and sectioned axially at the presumed thinnest occlusal region by an electrical diamond saw (Struers Secotom, Struers GmbH, Willich, Germany) to measure the thickness of the ceramic material.

Results

ZI-crowns showed the highest values for fracture load independently from the mode of fixation. Compared to the other groups with crowns made from LS2 or FC the difference was statistically significant. FC crowns revealed the lowest fracture loads (1344N±162N), which differed in a statistically significant way from all other tested groups. Adhesive fixation lead to a significantly higher load bearing capacity compared to all other groups (AD: 5620N±239N; CE: 4339N±288N), but not in the LS2-groups (AD: 2703N±109N; CE: 2712N±125N). The majority of the conventionally cemented zirconia and lithium disilicate crowns showed a total fracture of the crown. The adhesively luted zirconia and lithium disilicate crowns all showed only the fracture of one cusp. The feldspar ceramic crowns exhibited both fracture types. The ZI-crown showed with 0.4mm only a quarter of the LS2- and FC-values (1.6mm).

Conclusions

All tested types of single crown restorations showed fracture loads above normally occurring masticatory forces but it should be considered that the chosen test set-up represents a very favorable loading situation and not a worst case scenario. Crowns in the ZI-groups possessed the highest fracture resistance, which could support less invasive preparation protocols.

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