Performance of Metal- and Zirconia-based Crowns with Different Core Designs

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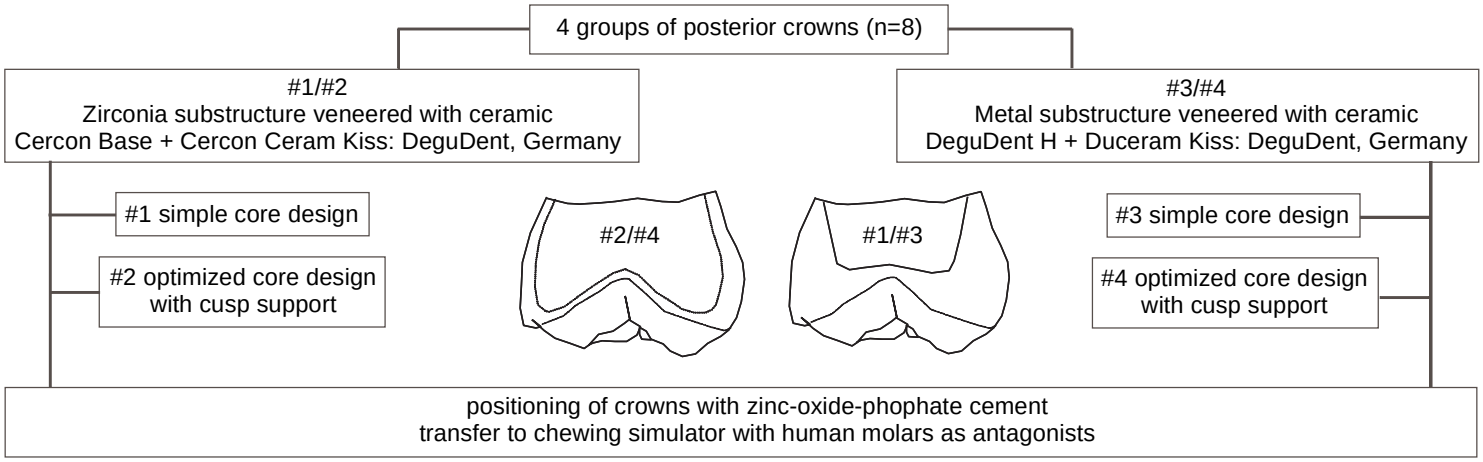
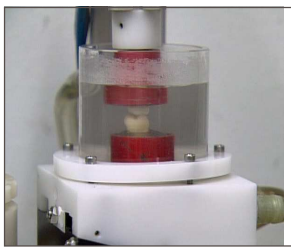
Introduction: All ceramic materials with zirconia substructures offer superior aesthetic solutions for the fabrication of crowns or fixed dental prostheses. Nevertheless one problem with these restorations is the higher number of chippings in contrast to metal ceramic constructions. The aim of this study was to compare the performance of molar crowns made of all ceramic and metal ceramic materials with differently designed substructures. The properties during thermocycling and mechanical loading (TCML) and the fracture force values were examined.

Materials and methods: Extracted human molars (tooth 46) of comparable size were inserted in PMMA resin blocks after covering their roots with a 0.75mm polyether layer. They were prepared with an overall substance removal of 1.5-2mm for posterior crowns resulting in a 1mm deep circular shoulder preparation with rounded inner angles and edges. Four examination groups were classified:





TCML:
3 600 000 mechanical loadings of 50N
18 000 thermal cycles of 5°/55° distilled water (2m in each cycle)

prolonged loading time compared to standard parameters; simulation of 15 years of intraoral service

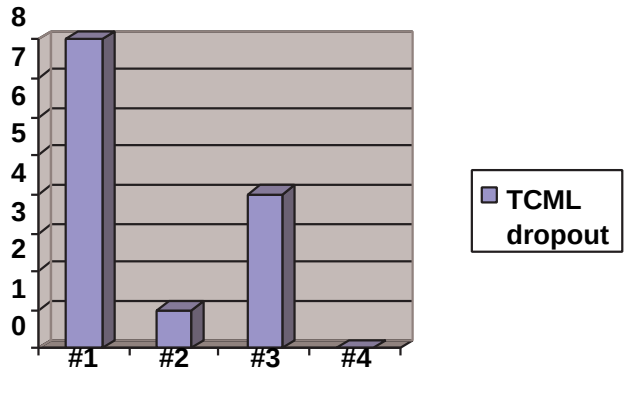
monitoring of the crowns during TCML
report of failures (initial cracks, chipping, fracture)

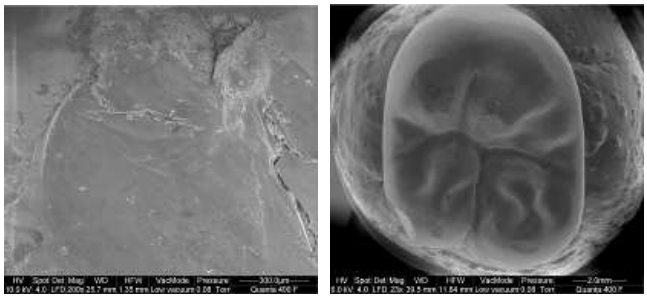
Failed crowns were excluded from further simulation. Failures were optically documented. Intact crowns after TCML were loaded to failure in a testing machine (Zwick, Germany) with a crosshead speed of 1mm/min. Medians and percentiles of the fracture values were calculated. Statistics were done with Mann-Whitney-U- and Kruskal-Wallis-test (p=0.05).

Results: During TCML differing numbers of failures occurred in the individual examination groups. All failures were due to chippings, no substructure fractures happened. Because of high dropout rates in both simple core groups no median/percentiles calculation was done here.
Fracture force values of group #2 and #4 did not show statistically significant differences.

	Group #1	Group #2	Group #3	Group #4
Crown 1	X: 2.600.000	2499	2025	2282
Crown 2	X: 3.600.000	1645	1712	2220
Crown 3	X: 2.600.000	3634	789	1854
Crown 4	X: 3.600.000	862	1774	1423
Crown 5	X: 3.600.000	2540	X: 860.000	1842
Crown 6	X: 3.600.000	1873	X: 1.000.000	3114
Crown 7	X: 3.600.000	1229	X: 3.600.000	2634
Crown 8	X: 2.600.000	X: 3.600.000	X: 3.600.000	2990
Median 25%/75%	Not determined	1873 1437/2520	Not determined	2251 1851/2723

X = Dropout during TCML (with number of loadings at dropout time)
Fracture forces (N) of remaining crowns after TCML





SEM micrographs of chipped crown

Conclusion: An optimized substructure design significantly reduced the number of chippings during long-term TCML for both tested material combinations. More chipping events occured in the all ceramic materials compared to the metal supported constructions. With optimized core design both material combinations showed sufficient fracture force values even after longterm artificial ageing.

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