

Introduction:

The aim of this study was to test whether chipping of ceramic veneering is influenced by the design of a zirconia core. Finite Element Analysis (FEA) data were compared with in-vitro chewing simulation results.

Materials and methods:

Resin molars (Morita, 46, G) were digitalised with μ -CT (SkyScan 1172, Micro Photonics, USA), transformed to CATIA (Dessault Systemes, F) and analysed (Solid187, 0.45mm, ANSYS 12.1 USA). Studies of the in-vitro simulation and FEA analysis were designed accordingly. Human periodontium was simulated with a 1mm thick layer of a polyether material (Impregum, 3M Espe, G). Preparation was a 1mm deep circular shoulder. Load was applied via four point contacts.

Three series of molar copings (n=8) of the yttria-stabilized zirconia (Cercon Base; DeguDent, G) were simulated.

The cores differed in design and thickness:

A: simple core 0.5mm,

B: core with minimal occlusal support (max. 0.8mm) and

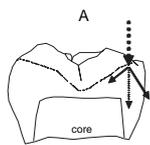
C: core with optimized occlusal support and cusp-design (max. 1.3mm).

The thickness of core plus veneering (Cercon Ceram Kiss) was 2.5 ± 0.1 mm. For FEA verification, one crown was used without core.

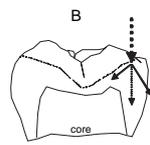
All crowns were cemented (ZnO-Ph-cement Harvard, Hoffman&Richter, G). Identical antagonists were used (CoCr-alloy; Wirobond LFC, Bego, G/ veneered with Duceram Kiss, Degudent, G).

Thermal cycling and mechanical loading (TCML) was performed for aging simulation (1,200,000 mechanical loadings [ML] x 50N sinusoidal loading and 6000 thermal cycles [TC] -2min between 5°C and 55°C). Crown failures were analyzed by means of a SEM.

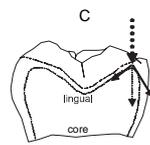
Statistics: One-way ANOVA ($\alpha=0.05$).



simple core 0.5mm



core with minimal occlusal support (max. 0.8mm)



core with optimized occlusal support and cusp-design (max. 1.3mm)

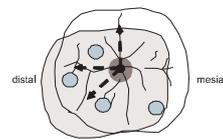
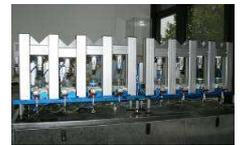


Diagram: contact situation

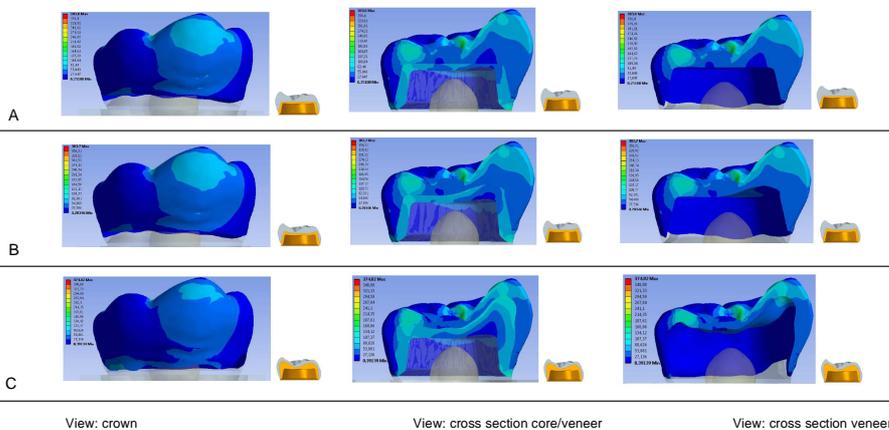


Regensburg chewing simulator

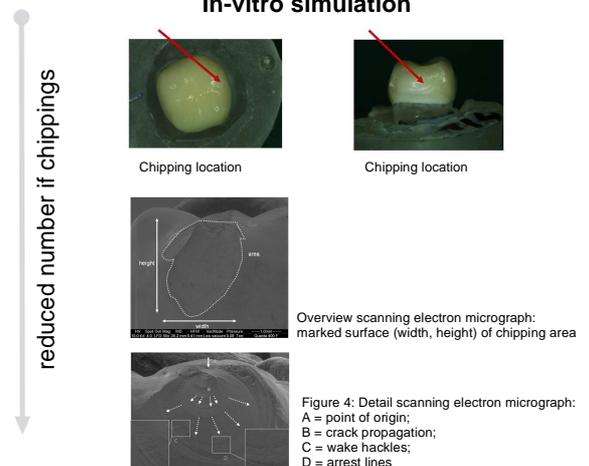
Results:

FEA and in-vitro data confirm that number and size of chippings was dependent on the design of the core. Simple cores showed a survival rate during in-vitro simulation of only 25%, whereas an optimized design increased survival rates up to 75%. Chipping area was reduced from about 8 mm² to 2 mm². FEA figures underline the strong influence of the core design on the force distribution.

FEA



In-vitro simulation



Discussion:

Both, FEA and in-vitro chewing simulation showed that chipping was dependent on the design of the core: the better the support of the veneering ceramic, the lower the chipping rates.