Ceramic CAD-CAM molar crowns luted with **Visalys**® CemCore on **Visalys**® CemCore build-up.

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Fracture force after long-term storage and TCML

Scientific report
Original report shortened/extended in parts

University Hospital Regensburg
Polyclinic for Dental Prosthetics

Prof. Dr. Dipl.-Ing. Martin Rosentritt

Background and aim of the study

Up to now, it was still unclear whether one and the same composite material can serve for luting of crowns and bridges as well as for core build-ups in restorative procedures. Former studies showed significant hygroscopic expansion of luting composites, causing fractures of all ceramic crowns if used as core build-up material.[1] Using only one composite could be beneficial to reduce material stock and complexity, and to guarantee compatibility of the materials.

The aim of this investigation was to test the adhesive resin composite **Visalys**® CemCore Kit for luting procedures and core build-up.

Study design – materials & methods

Therefore, ceramic CAD-CAM crowns were luted with **Visalys**® CemCore on human molars with core build-up of **Visalys**® CemCore. Human teeth were used to evaluate the behavior of molar crowns with core build-up restoration after 90 days storage in water and subsequent thermal cycling and mechanical loading (TCML 4 x 3000 x 5 °C / 55 °C, 2 min each cycle, H^20 dist., 2,400,000 chewing force à 50 N). Subsequent fracture resistance was tested. TCML was used to simulate ten years of oral service.

The roots of freshly extracted human molars were coated with a layer of polyether impression material (1 mm thickness; Impregum, 3M, D) to simulate the resilience of the human periodontium.

The teeth were fixed in PMMA. Preparation and core build-up of the teeth was performed at the Department of Prosthodontics simulating required preparation design (angle: 6°, 3 – 4 mm height, 1 – 2 mm ferrule, enamel margin if possible). All crowns (e.max CAD, > 1.5 mm) were fabricated with CAD / CAM (Cerec Omicam, Cerec MCXL, anatomic crown, polishing) by UKR.

The test group was restored with **Visalys**® CemCore system (**Visalys**® CemCore, **Visalys**® Tooth Primer, **Visalys**® Restorative Primer; Kettenbach, D) as core build-up and luting material for ceramic crowns. Before cementation, the inner sides of all crowns were etched with hydrofluoric acid and bonded according to manufacturers' instructions. All light polymerization was performed with Elipar S10 (3M, D).

During 90 days storage in water and TCML, all crowns were controlled for failures or fractures. If necessary, failed restorations were excluded from further storage and TCML.

Fracture testing: For all crowns, which survived storage and TCML, the fracture force was determined by mechanically loading the crowns to failure in the universal testing machine 1446 (Zwick, Ulm, D). The force was applied on the center of the restorations using a steel ball Ø = 12 mm, crosshead speed = 1 mm / min). A tin foil (1 mm thickness) was inserted between crown and ball. The failure determination was set to a 10 % loss of the maximum loading force or acoustic signal (crack). Mean and standard deviations were calculated. The statistical analysis was performed using one-way Anova (SPSS / PC+ software 25.0, SPSS, USA). The level of significance was set to $\alpha = 0.05$.

[1] Naumann M , Sterzenbach G, Rosentritt M, Beuer F, Frankenberger R. In Vitro Performance of Self-Adhesive Resin Cements for Post-And-Core Build-Ups: Influence of Chewing Simulation or 1-year Storage in 0.5% Chloramine Solution Acta Biomater 2010 Nov;6(11):4389-95.

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Results

After water storage and TCML of teeth restored with **Visalys**® CemCore no debonding or fracture/cracking of the crown was found. Fracture values of the crowns were 1531+/-614 N (min: 795 N, max: 2619 N). Fracture pattern was characterized by a typical fracture of the crown and/or tooth as well as a fracture and debonding of the crown.

Before TCML

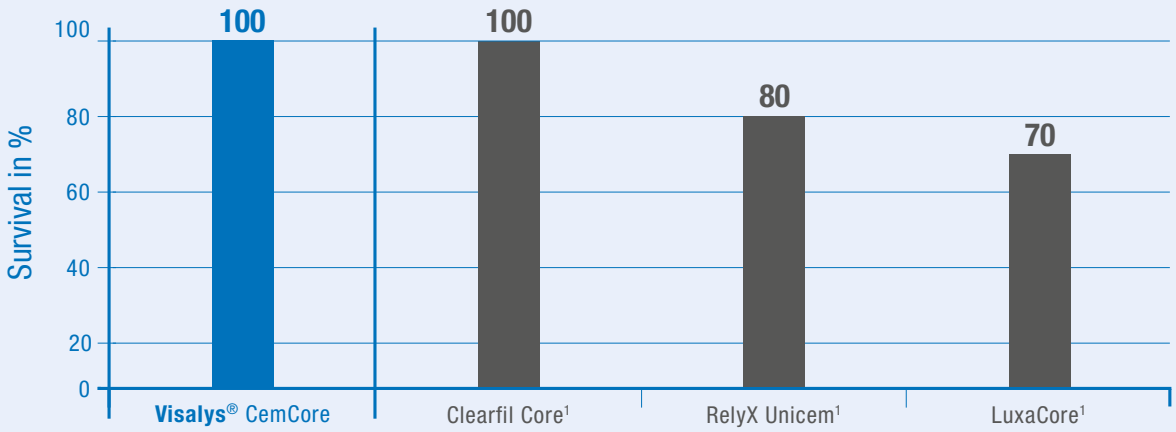
After TCML

After fracture test

Conclusion

No debonding or failure was found for the investigated Visalys® CemCore system during storage and aging. The long-term stress tests (aging and TCML, simulating 10 years of oral service) as one decisive criterion for the clinical assessment were passed by all specimens (8 of 8). Clinical maximum force values (for example for bruxism) are supposed to be between 800 N and 1000 N.[2,3] Resulting fracture forces of the surviving crowns were in a range where a clinical application may not be restricted.

Results: long-term storage and TCML



Visalys® CemCore compared with other products from the study by Naumann et al.
Visalys® CemCore: simulated oral use of 10 years
Clearfil Core, RelyX Unicem, LuxaCore: simulated oral use of 5 years

- **100% survival rate of the teeth treated with Visalys® CemCore after simulated oral service of 10 years**
- No fractures after water storage or thermal cycling and mechanical loading
- Fracture toughness after water storage + TCML: 1531 N (average) ► above critical value for bruxism (ca. approx. 800N-1000 N)
- The simulated oral use for the products Clearfil Core, RelyX Unicem and LuxaCore was even reduced to 5 years. They have been supplemented here for a better classification of the results of Visalys® CemCore.

[2] Varga S, Spalj S, Lapter Varga M, Anic Milosevic S, Mestrovic S, Slaj M. Maximum voluntary molar bite force in subjects with normal occlusion. Eur J Orthod 2011;33(4):427–33.
[3] Koc D, Dogan A, Bek B. Bite Force and Influential Factors on Bite Force Measurements: A Literature Review. Eur J Dent 2010;4(2):223–32.

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