Contact damage of new chairside CAD/CAM materials for full posterior crowns

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#1422

1 Objectives

New CAD/CAM materials, consisting of ceramics and polymer, are available for chairside fixed-dental prosthodontics (FDPs). Due to their polymer component, they are less brittle compared to pure glass ceramics, so they might be promising for patients with higher masticatory forces.[1-2] Previous studies analyzed contact damage of glass ceramics.[3] Thus, it was the aim of this in vitro study, to investigate damage of polymer based CAD/CAM posterior crowns and compare the results with establishes lithium disilicate ceramics.

2 Materials & Methods

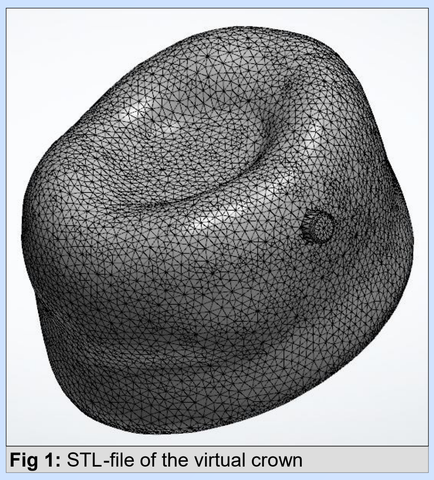

Fig 1: STL-file of the virtual crown

For manufacturing of standardized test specimens, one STL dataset of a posterior crown (Fig 1) and another of the corresponding die were constructed. After milling, ninety-six CAD/CAM-fabricated crowns were luted with their recommended materials on identical prepared human dies (Tab 1). In a mouth-motion simulator (prematec F1000, WL-tec) (1 million cycles, 50-500 N, 2 Hz, 37 °C) contact damage was simulated. A dye penetration test (basic fuchsin) was performed to detect fatigue damage. Finally, all specimens were sliced in equidistant discs of 1 mm (Buhler) and inspected by a digital microscope (Zeiss). Data was subjected to Tukey-test.

Code	Milling Block (Manufacturer)	Luting material (Manufacturer)
LU	Lava Ultimate CAD/CAM Restorative (3M ESPE)	Scotchbond Universal + RelyX Ultimate (3M ESPE) (LC and CC)
EX	IPS e.max CAD (Ivoclar Vivadent)	Multilink Automix (CC) and Varilolink Esthetic (Ivoclar Vivadent) (LC)
BC	Brilliant Crios(Coltene)	One Coat7 Universal (+One Coat 7 Activator, only for CC) + DuoCem (Coltene) (LC and CC)
VE	Vita Enamic (Vita Zahnfabrik)	ED Primer II + Panavia 2.0 (Kuraray) (CC) and Vita A.R.T. Bond + Vita DuoCement (Vita Zahnfabrik) (LC)
CS	Cerasmart (GC)	G-Premio Bond (+ G-Premio Bond DCA , onlx for CC))+ GC G-Cem LinkForce (GC) (LC and CC)
EB	Universal Adhesive	Dual-curing composite

Tab 1: Milling blocks and luting materials (16x6 specimens) (LC=light-curing, CC=chemical curing

3 Results

All specimens showed contact damage in the occlusal contact area (OCA) (Fig 2). EX exhibited the significant highest fatigue damage compared to all other groups ($p < .05$). The same applies for VE, which also showed a significant difference to all other groups ($p < .05$) (Tab 2 and Fig 3). Where as the CAD/CAM composites showed the significant lowest fatigue damage with an occlusal area without microcracking between 76.1-84.1% (mean) ($p < .05$).

Specimens	Mean (SD)	Median
LU	76.1 (9.6)	77.4
EX	28.4 (5.5)	27.3
BC	80.15 (7.2)	80.8
VE	56.4 (8.4)	56.1
CS	84.1 (9.2)	87.9
EM	73.9 (6.7)	74.4

Tab 2: Area without microcracking [%]

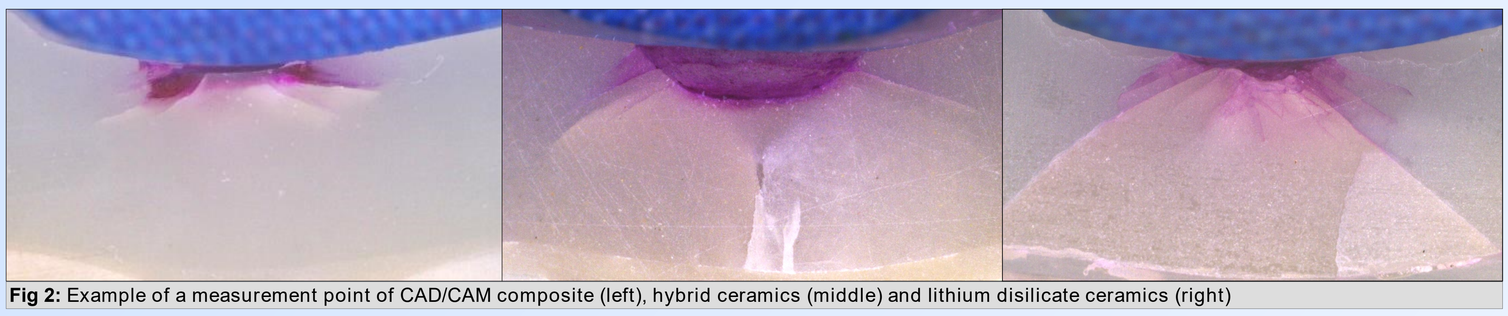

Fig 2: Example of a measurement point of CAD/CAM composite (left), hybrid ceramics (middle) and lithium disilicate ceramics (right)

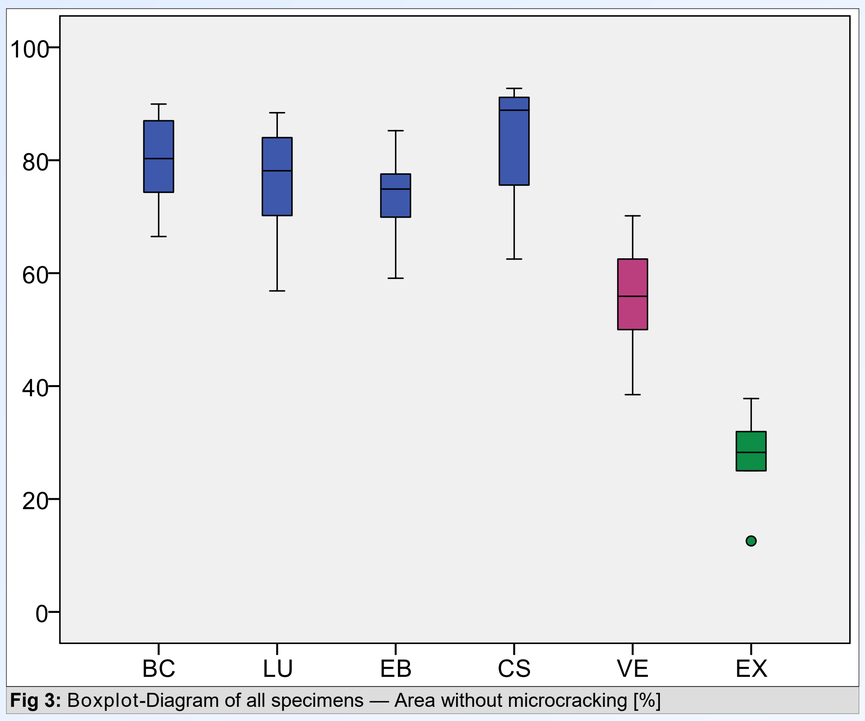

Fig 3: Boxplot-Diagram of all specimens — Area without microcracking [%]

4 Discussion & Conclusion

Overall the results CAD/CAM composites showed the greatest area without damage. On the contrary, glass ceramics showed the significant highest damage compared to the polymer based groups, which is in good accordance to the literature.[4] Ceramics compensate higher stress through transferring energy in outer areas, where as stress distribution in polymer materials is mainly located under the OCA.[5] Finite element methods calculated a stress concentration at the cementation interface and the OCA for lithium disilicate ceramics. For CAD/CAM composites only a stress concentration under the OCA was described.[6] Within the limitations of this in vitro study, CAD/CAM composites demonstrate a potential for patients with higher masticatory forces (e.g. bruxism) regarding fatigue damage.

5 References

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