Fracture Strength of Zirconia-Ceramic, Laser-Sintered and Cast Alloy Molar Crowns

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Introduction:

New technologies like computer designed laser-sintering of alloy crowns or computer manufacturing of all-ceramic zirconia restorations were introduced supplementing or competing with conventional cast processes. This in-vitro study compared the fracture resistance of all-ceramic veneered cast alloy, laser-sintered alloy and computer manufactured (CAM) all-ceramic zirconia molar crowns with conventional cementation and adhesive bonding.

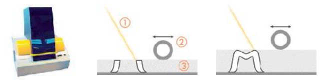
Materials and methods:

48 human molars were inserted in a PMMA resin representing a posterior oral situation. The roots of the teeth were covered with an about 1mm thick layer of polyether to simulate the periodontium. Human antagonists were used and antagonist/tooth relation was adjusted in the dental articulator (Girrbach, G). Eight crowns of each series were made and fixed with an adhesive bonding system (Syntac classic/Variolink2; Ivoclar-Vivadent, FL) or conventional cementation (Zinc-phosphate, Harvard, G). Alloy crowns were tribochemically treated (Rocatec, 3M-Espe, G), zirconia crowns were sandblasted. The crowns were made of the materials:

A.) high gold-alloy (Biopontstar, Bego cast technique; control)
B) high gold-alloy (Biopontstar, Bego computer designed laser-sintering technique) and
C) Zirconia all-ceramic (Cercon/CeramS, DeguDent, computer manufactured)

Alloy crowns were veneered with Vita Omega 900 (Vita Zahnfabrik, G).

Cercon/Cercon Ceram S (DeguDent, G).



Laser-sintering procedure (Bego, G).

48 molar crowns

alloy cast technique | alloy laser-sintering | all-ceramic CAM

adhesive bonding 3x8 crowns | conventional cementation 3x8 crowns

thermal cycling and mechanical loading (6000 thermal cycles/1.2x10^6 mastication cycles)

TCML: masticator

UTM testing device

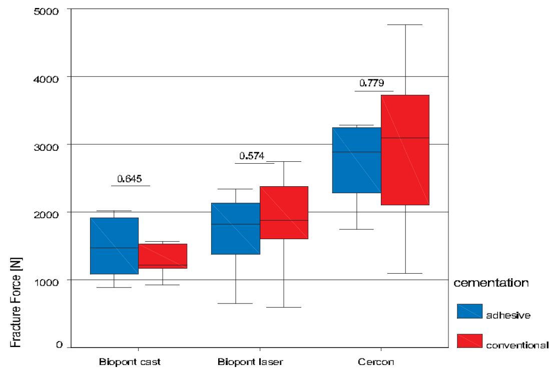
fracture test

Testing design includes: simulation of periodontium, tooth bonding to dentine or enamel, human antagonist, Youngs-modulus of tooth tissue

After thermal cycling and mechanical loading (TCML; 1.2x10^6 mastication cycles [50N]) and 6000 thermal cycles [5°C/55°C] fracture strengths (UTM 1446; Zwick; v=1mm/min) of 8 crowns of each series were determined. Failure detection was set to 10% of the maximum force.

Statistical analysis was performed with the Mann-Whitney U-test (p=0.05).

Results:



Fracture of the veneering (ex.: zirconia)

Fracture of the veneering (ex.: laser-sintered)

All crowns showed fracture of the veneering, no copings failed.

	Adhesive		Conventional		
	laser	zirconia		laser	zirconia
cast	0.574		cast	0.083	
cast		0.400	cast		0.012*
laser		0.210	laser		0.161

Statistical analysis: Mann Whitney-U test (P=0.05)
*: indicates significant differences

Fracture Force N	Biopontstar cast		Biopontstar laser-sintering		Cercon CAM	
Cementation :	Variolink	Harvard	Variolink	Harvard	Variolink	Harvard
Median	1471	1221	1823	1875	2886	3097
25 % percentile	1141	1183	1410	1654	2288	2287
75 % percentile	1872	1515	2050	2199	3246	3622

Conclusion:

Zirconia restorations showed highest fracture resistance. The sintered alloy crowns provided a higher fracture force than the cast alloy. The type of cementation had no significant influence on the fracture results. CAM zirconia and CAD laser-sintering –independent on the type of cementation- showed a fracture resistance after artificial aging, which is expected to withstand the loading in posterior areas.

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