

SCIENTIFIC REPORT

Grandio blocs – Flexural strength and surface hardness

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For the CAD/CAM production of workpieces for indirect restorations, the proven feldspar and zirconium dioxide ceramics are established on the market. Ceramic-based hybrid materials have been an alternative for some years now and offer many advantages. They have excellent strengths that can compete with those of ceramics.^[1] At the same time they show tooth-like properties such as the modulus of elasticity or the thermal conductivity, which has a beneficial effect on the luting of the workpieces.^[2] A study was carried out at the University of Valencia which compares seven selected hybrid materials. The flexural strength as well as the Weibull modulus were determined, the latter describes the homogeneity of the materials. Furthermore the surface hardness of all materials was measured. The results are presented in this Scientific Report.^[3]

Study design

The following ceramic-based hybrid materials have been evaluated in the study: Artesano (Yamahachi Dental), Brilliant Crios (Coltène), Cerasmart (GC), Grandio blocs (VOCO GmbH), Lava Ultimate (3M ESPE), Shofu Block HC (Shofu) and VITA ENAMIC (VITA). The 3-Point flexural strength was determined according to ISO 4049. For this purpose, rod-shaped test specimens (14 mm x 2 mm x 2 mm) were produced from the respective blocks and loaded at a speed of 0.5 mm/min until breakage with a universal measuring device. The results were evaluated with a two-parameter Weibull distribution function. The Vickers hardness was carried out with a weight of 1 kg at 15 s setting time on 2 mm thick specimens (VH1).

Results

The following chart 1 summarises the measured values of the study, which are presented in table 1.

Table 1: 3-Point flexural strength, Weibull modulus and position parameters of the Weibull distribution (characteristic force T) as well as surface hardness (Vickers)

| Product | Manufacturer | 3-Point flexural strength | Weibull modulus | Characteristic force T, where 63.2 % of the samples fail | Vickers hardness |
|-----------------|------------------|---------------------------|-----------------|--|------------------|
| | | [MPa] | | [MPa] | |
| Grandio blocs | VOCO GmbH | 221.08 | 12.55 | 230.27 | 121.8 |
| Brilliant Crios | Coltène | 197.14 | 9.67 | 207.45 | 65.85 |
| Cerasmart | GC | 189.69 | 7.59 | 202.05 | 63.86 |
| Artesano | Yamahachi Dental | 174.26 | 5.91 | 187.96 | 69.04 |
| Lava Ultimate | 3M ESPE | 167.93 | 8.64 | 177.63 | 95.15 |
| Shofu Block HC | Shofu | 149.12 | 10.76 | 156.28 | 69.42 |
| VITA ENAMIC | VITA | 143.42 | 8.44 | 151.96 | 213.8 |

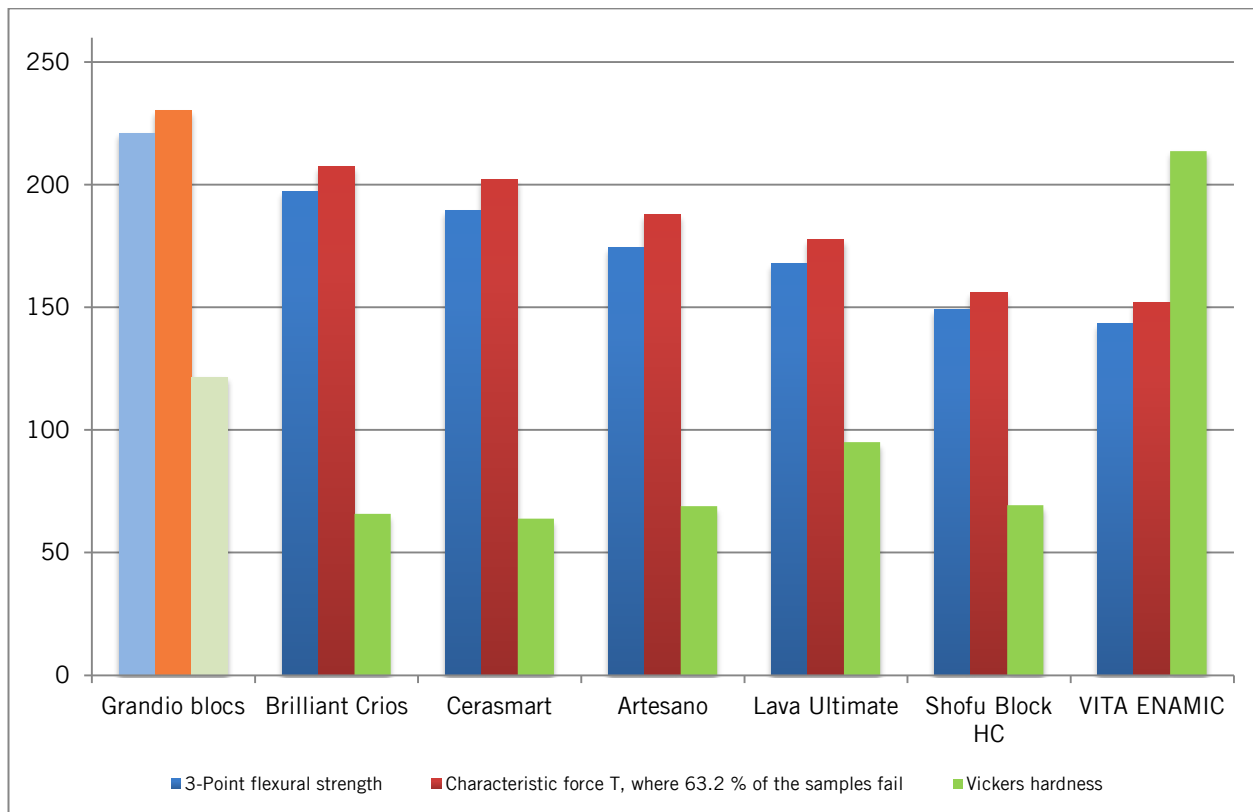


Figure 1: Graphic presentation of the 3-point flexural strength, the characteristic force T, where 63.2 % of the samples fail and the Vickers hardness

Figure 1 clearly shows that with 221 MPa Grandio blocs has the highest value regarding the flexural strength of the here tested hybrid materials. Thus the VOCO blocks have a higher flexural strength of about 11 % than Brilliant Crios (197 MPa) and 65 % than VITA Enamic blocks, which have the lowest flexural strength with 143 MPa.

The Weibull modulus of the materials rank from 5.9 to 12.5. The higher the modulus, the more homogeneous the material. Which results in a lower dispersion of forces that leads to failure. Modern ceramics reach a Weibull modulus between 10 and 20.^[4] From the Weibull distribution, the characteristic force T can then be determined at which 63.2 % of all samples fail.^[4] Here too, Grandio blocs shine with the highest strength value of 230 MPa.

The highest Vickers hardness was measured at 214 HV1 with the VITA Enamic blocks, which is about 43 % higher than of the second-placed Grandio blocs. However, the high surface hardness of VITA Enamic correlate with the lowest flexural strength (143 MPa) of all here tested materials. This characteristic can be explained by the fundamentally different structure of the material. VITA Enamic is a porous, sponge-like ceramic that is filled with resin by infiltration. On the contrary, all other ceramic-based blocks are manufactured by enriching a resin matrix with ceramic particles to achieve the required strength of a filling material. The results of this study show that the surface of the blocks are indeed easier to damage, but possible defects spread considerably slower than with the VITA Enamic hybrid ceramic.

Conclusion: In this independent study, it is shown *in-vitro* that Grandio blocs is one of the most stable ceramic-based hybrid materials. Grandio blocs shows the highest values in flexural strength as well as the best homogeneity. The value of the surface hardness is only exceeded by the VITA Enamic block.

[1] Rosentritt M, Preis V, Behr M, Hahnel S, *J. Dent.* (2017) 65: 70.

[2] Strasser T, Preis V, Behr M, Rosentritt M, *Clin Oral Invest* (2018) 22: 2787.

[3] Astudillo Rubio D, Delgado Gaete A, Pascual Moscardo A, *Poster: ConsEuro Berlin 2019*.

[4] Brevier, Technical ceramik, 4th edition 2003, Association of the Ceramic Industrye.