

Strength of a Zirconia Matrix Ceramic Coated with a Macroporous Ceramic Layer: The Application of the Ball-on-Three-Balls Test

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Currently, there is a trend toward designing monoblock acetabular cups for hip arthroplasty containing macroporous part with interconnected macropores for direct anchorage to the bone and the bone ingrowth. For the all-ceramic acetabular cups, the design comprises a thin-walled dense ceramic liner with a convex backside covered with a macroporous coating. The macroporous coating strongly influences the mechanical properties of the ceramic liner. Therefore, it is of great importance to investigate the influence of the coating and to determine the mechanical properties of the monoblock ceramic. The standard testing methods have restrictions, which make them unsuitable to test ceramics covered with macroporous coating. Recently, the ball-on-three-ball test was introduced as a simple method for measuring the strength of brittle ceramics, where deviations from the requested geometry are tolerable. The aim of this work was to extend the applicability of the ball-on-three-balls test for measuring the strength of bilayer ceramics, with one of the layers comprising a high porosity. An analytical approach was used to assess the mechanical strength and to investigate the influence of the porous coating on the overall fracture behaviour of the samples. A Weibull distribution was used to describe the reliability of the results, and fractographic analysis and fracture mechanics were used to explain the deviations of the strength. The study showed that the ball-on-three-balls test can be extended to measure the bending strength of a dense ceramic covered with a macroporous coating.

Keywords: zirconia matrix ceramic, macroporous layer, bending strength, ball-on-three-balls test