Does Cyclic Loading of Ceramic Components Affect Their Burst Resistance?

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INTRODUCTION:

Decreased grain size and increased purity and density have resulted in dramatic increases in the strength of alumina ceramics used in total hip arthroplasty. This has been demonstrated both by mechanical testing[1] and by a low incidence of failure *in-vivo*[2,3]. The current study investigates the long-term toughness of ceramic components after they have been subjected to the repeated physiological loading.

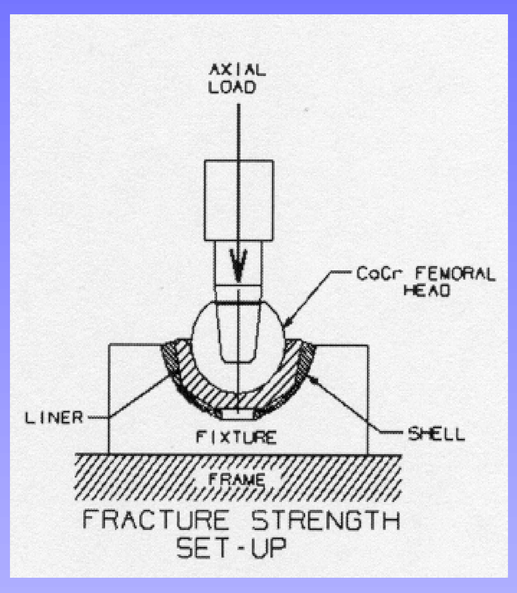
METHODS

Static Test

Twelve ceramic liners (CeramTec,Plochingen, Germany) were assembled into titanium shells (Wright Medical Technology, Arlington, TN). Twelve 28mm ceramic femoral heads were assembled onto spigots representing femoral stem tapers. The assemblies were fixed in the test machine. A compressive force was applied to six of the assemblies until failure of either component occurred. In every case the ceramic head failed first. The debris from each head was removed, and each liner was examined for any evidence of fracture. The head was then replaced with the CoCr head and load application to the liner resumed until failure of the liner occurred.

Fatigue test and subsequent burst

Another six assemblies underwent a cyclic loading regime, with the load varying from 314 lbs to 3147 lbs, for 10 million cycles. Post-fatigue burst testing was performed using the same method as the static burst.



Results

Specimen	Ultimate Peak Force (Std.Dev.),lbs
Static	18,855 (1,858)
Post-fatigue	14,688 (2,443)

DISCUSSION AND CONCLUSION

The mean post-fatigue ultimate peak force to failure of 14,688 lbs represents more than 58 times body weight in a 250’ lb patient. These data demonstrate that ceramic acetabular liners mounted into a titanium shell maintain high ultimate peak force to failure at 10 million cycles.

Figure 1
Lineage™ Acetabular Component with Interchangeable Ceramic, Poly, CoCr Liners
Wright Medical Technology, Inc.
Arlington, TN, USA

REFERENCES

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2. Heros, RJ, Willmann, G.: Ceramics in Total Hip Arthroplasty: History, Mechanical Properties, Clinical Results, and Current Manufacturing State of the Art. Seminars in Arthroplasty, Vol.9, No. 2, 1998, PP 114-122.
3. Murphy SB, Bierbaum BE, Eberle RW. American Experience with Alumina Ceramic-Ceramic Bearings in Total Hip Arthroplasty. In Bioceramics in Joint Arthroplasty. Zippel H and Dietrich M, Editors. Darmstadt Germany. Stenkopff Verlag Publishers. 2003. pp 157-162.