Alumina Ceramic–Ceramic Bearings in THA: The New Gold Standard

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Debris-associated osteolysis is the most common cause for revision total hip arthroplasty (THA) when polyethylene is used. Cross-linked polyethylenes show some promise but raise more questions. New polyethylenes are supported only by laboratory studies and have no clinical data to support their use. Studies have shown that cross-linked polyethylenes are stiffer and weaker than conventional polyethylene, and wear debris particles generated usually are <1 µm (0.1-0.5 µm), the most biologically active particle size.[1] Retrievals show that metal femoral heads are typically scratched. Laboratory studies of wear with cross-linked polyethylene against a roughened surface show dramatic increases in wear.[2]

By contrast, the use of alumina ceramic–ceramic bearings is supported by laboratory and clinical data. In vitro wear studies[3] and retrieval studies have consistently shown alumina–alumina bearings have the lowest wear rate of any available bearing. Retrievals have shown that alumina–alumina bearings have 4000 times less linear wear than conventional polyethylene.[4] There are no retrieval data of current cross-linked polyethylene bearings that show such dramatically reduced wear. Further, retrievals of alumina bearings show their resistance to scratching from third body particles.[5] Scratch resistance is not a feature of cobalt–chromium (CoCr) on cross-linked or conventional polyethylene bearings.

Improvements in density and grain size have increased the strength of the bearings to the point where load to fracture now exceeds 17,000 lbs. This means that liner chipping or wear generally is seen only in cases of recurrent subluxation or dislocation—situations that would require revision in any case.

Current designs of alumina–alumina bearings have been used in Europe for >14 years and in the United States for >5 years. The US patients have been carefully studied as part of Food and Drug Administration investigational device evaluations. The modern versions of alumina–alumina THA feature titanium shells with an internal 18° taper. Some of these acetabular components are designed to accept polyethylene, CoCr, and alumina bearings interchangeably (Figure 1).

Figure 1: Alumina–alumina THA can feature titanium shells that accept polyethylene, CoCr, or alumina bearings interchangeably (Lineage acetabular component; Wright Medical Technology Inc, Arlington, Tenn).

One US clinical study included 1196 THAs performed between April 1997 and March 2002 (Transcend and Lineage acetabular components; Wright Medical Technology, Arlington, Tenn). Of these, 405 hips were followed for a minimum of 24 months (mean: 30.5 months, range: 24-56 months). Average patient age was 53 years. Results showed no postoperative bearing fractures and no osteolysis thus far. Reoperations included 1 (0.25%) for deep infection, recurrent dislocation in 3 (0.75%), failure of osseointegration of 1 femoral and 1 acetabular component, malinsertion of 1 acetabular liner, loosening of a cemented femoral component without lysis, and wear in 1 case due to repeated subluxation.

These results show that alumina-alumina bearings are reliable at 2-5 years in a young patient group. The data exceed any reports of cross-linked polyethylene in terms of number of patients and length of follow-up. The low incidence of infection is statistically significantly lower than that reported by the Swedish Hip Registry. This may be related to the fact that bacteria typically adhere more strongly to polyethylene than to alumina,[6] suggesting that both early and late infection rates may be lower for alumina than polyethylene THA (Figure 2).

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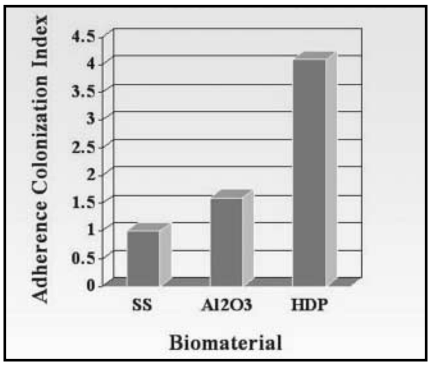

Figure 2: Polyethylene and infection: bacterial adhesion. Bacteria colonize various biomaterials differently. The strain of *Staphylococcus epidermidis* studied adhered 2.5 times more strongly to high density polyethylene than alumina (adapted from Oga M et al[6]).

In summary, polyethylene wear debris-associated osteolysis is the most significant problem following THA. Alumina ceramic–ceramic bearings have a stronger scientific basis for use than cross-linked polyethylene based on laboratory wear data, retrieval analysis, and clinical studies. Alumina–alumina bearings are a new standard by which all other bearings must be judged.

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