POLYETHYLENE WEAR WITH ZIRCONIA FEMORAL HEADS IN TOTAL HIP ARTHROPLASTY


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**Introduction**

Zirconia femoral head has been used as an alternative to a metal femoral head in total hip arthroplasty for its high wear resistance. However, several reports (1.2) on poor wear characteristic with zirconia have been noted and one cause has been thought to be the phase transformation of zirconia in vivo (3). The purpose of this study was to compare the polyethylene wear and the prevalence of the periprosthetic osteolysis with zirconia femoral head versus alumina heads and to quantify the phase transformation and surface roughness of retrieved zirconia heads.

**Methods**

**Patients:** A retrospective matched pair analysis at minimally 9 years follow-up after primary total hip arthroplasty was performed. Thirty hips in each group (Zirconia or Alumina) were matched for age, sex, weight, hip disease and duration of follow up. The mean follow up periods were 9.8 years for Zirconia and 10.2 years for Alumina.

**Implants:** The identical uncemented total hip prostheses except femoral heads (PerFix HA series, Japan medical Materials, Osaka, Japan) were used for both groups. The femoral head in both groups was 22mm in diameter. Polyethylene liners used were the conventional ultra high molecular weight polyethylene and sterilized with ethylene oxide gas.

**Wear measurement:** Linear and volumetric wear were measured, with use of the CAD soft ware (Vector Works J, Tokyo, Japan). Wear, defined as the penetration of the head into the liners, was measured from anteroposterior pelvic radiographs. The radiographs made at 2 years postoperatively were considered to be “zero position” to measure the true polyethylene wear rates.

**Analysis of retrieved zirconia heads:** Six zirconia heads were retrieved at the revision surgery due to aseptic loosening or periprosthetic osteolysis. The measurement of monoclinic phase fraction and surface roughness were carried out using X-ray diffraction; XRD (PANalytical, Tokyo, Japan) and a laser scanning microscope (Olympus co., Tokyo, Japan).

**Statistics:** For univariate analysis of the two groups, Fischer’s exact test or Mann-Whitney U test was used.

**Results**

**Wear:** The mean linear wear rates were 0.160 mm/year for Zirconia and 0.083 mm/year for Alumina (Figure 1). Zirconia showed significantly higher linear wear rate than Alumina. The mean volumetric wear rates were 53.2mm³/year for Zirconia and 27.6 mm³/year for Alumina (Figure 2). Zirconia also showed significantly higher volumetric wear rate than Alumina.

**Osteolysis:** Focal osteolysis was observed in 8 hips (26.7%) in Zirconia and 2 hip (6.7%) in Alumina. The acetabular osteolysis was noted in 8 hips and the femoral osteolysis was noted in 4 hips. Significant correlations were noted between the prevalence of osteolysis and polyethylene linear and volumetric wear rate.

**Discussion**

Although Zirconia femoral head showed the better wear resistance in vitro than CoCr metal head and alumina head, several reports (1.2) on total hip arthroplasty with a zirconia head have noted poor wear characteristics. Our in vivo findings also showed that the zirconia femoral head resulted in the higher rates of polyethylene wear and subsequent more prevalence of osteolysis. One cause has been thought to be the phase transformation of zirconia in vivo (3). Zirconia ceramic has three phases of crystalline structure (monoclinic, cubic, and tetragonal), which vary with temperature. Such phase transformation can be accompanied by the change in the volume of the ceramic head and may cause an increase in its surface roughness. However, although zirconia showed the more phase transformation with the longer implantation time, there were no correlation between the percent monoclinic fraction and surface roughness of the retrieved zirconia head in this study. Since the analysis was made on the only six zirconia heads in this study, further study is needed.

In conclusion, the combination of zirconia femoral head and the conventional polyethylene resulted in the higher rates of the polyethylene wear and more prevalence of the periprosthetic osteolysis although the exact role of the phase transformation was still unclear.

**References**

(3) Haraguchi K, Sagano N, Nishii T, Miki H, Oka K, Yoshikawa H: Phase transformation of zirconia ceramic head after total hip arthroplasty. J