Reduced Wear of Highly Crosslinked Polyethylene Compared to Conventional Acetabular Liners in Young Total Hip Replacement Patients: A Radiostereometric Analysis Study

INTRODUCTION

Polyethylene wear in total hip replacements (THR) contributes to osteolysis, which can lead to premature implant failure. Highly cross-linked ultra high molecular weight polyethylene (UHMWPE) liners were designed to improve the wear properties of the bearing surface of total hip replacements. Characterization of early wear patterns of commonly available acetabular liners in young, active THR patients with high functional demands is needed. Radiostereometric analysis (RSA) provides precise and reproducible measurement of femoral head penetration.

This prospective, randomized, blinded study incorporates RSA technology to investigate the femoral head penetration of UHMWPE acetabular liners (Longevity, Zimmer) in comparison to that of conventional polyethylene. The early clinical outcomes are expected to be similarly excellent regardless of liner used.

METHODS

After informed consent was obtained, 45 patients enrolled in this IRB-approved, prospective, randomized study. Candidates for THR were recruited if they were suffering from severe hip pain secondary to osteoarthritis or AVN, less than 65 years old, able to provide informed consent, and in stable health. Due to the limited availability of RSA-compatible implants, patients were excluded if they required an acetabular shell with an outside diameter less than 48mm or a high-offset femoral component. All patients underwent primary THR performed by a single surgeon (DA) and randomly received either a cross-linked or a conventional liner in a noncemented hemispheric cup (Trilogy). Both liners are prepared from compression-molded GUR 1050 resin without calcium stearate. Longevity liners undergo further e-beam irradiation and heat-annealing. A 28mm femoral head was used in all cases. At the time of surgery, 1.0mm tantalum RSA markers were implanted around the liner periphery and 12 markers were implanted into the patient’s femur and periacetabular bone.

All subjects completed preoperative screening, demographic, and physical exam evaluations. Outcome measures include the SF-12, Harris Hip, WOMAC, and UCLA scores completed at baseline and at 10 days, 6 months, and yearly postoperatively. Standing digitized RSA film pairs were obtained at the above postoperative time points, and descriptive statistics and univariate analyses were completed. Comparisons between randomized groups were analyzed using a two-tailed t-test with a significance level of 0.05.

RESULTS

To date, a total of 45 patients have been enrolled in the study; 41 have hip osteoarthritis, and 4 have avascular necrosis. The average age at enrollment is 58, and 36 (80%) are female. Twenty-one have been randomized to the conventional polyethylene arm, and 24 have received high-crosslinked liners. The randomized groups are comprised of patients of similar age (58 years) and preoperative activity (UCLA score) with an average BMI of 30.

Median femoral head penetration was less among cross-linked compared to conventional liners at all time points (p<0.01). See Fig. 1. Mean UCLA, WOMAC, Harris Hip, and SF-12 PCS and MCS scores were improved compared to preoperative scores at all time points for both groups. There was no significant difference between the cross-linked and conventional liner groups.

One patient had a postoperative deep vein thrombosis. Otherwise no adverse postoperative events have been observed.

DISCUSSION

Young, active total hip replacement candidates present a challenge for surgeons. In contrast to older patients, this population is more susceptible to the consequences of early polyethylene wear, including particle-induced osteolysis and subsequent implant failure. Highly cross-linked polyethylene acetabular liners are more capable of withstanding linear and volumetric wear, and present a good option for this group of patients.

Highly cross-linked liners demonstrated 55% less femoral head penetration compared to conventional liners at 2 years in this population (mean age 58). Notably, overall patient outcomes were improved relative to baseline, and were comparable between groups. The femoral head penetration rates were highest for both groups in the first 6-12 months, consistent with the concept of a “bedding-in” period (1).

Despite improvements in manufacturing processes of conventional UHMWPE (CaStearate-free, sterilization in inert environment), our femoral head penetration rate in this population is unchanged from published historical standards. The overall femoral head penetration rates of both the conventional and UHMWPE liners, is comparable to previously published results (1,2,3,4).

The cross-linking process adversely affects other physical properties including brittleness and resistance to fatigue. There have been reports of early cracking of the liners (5,6). To date, we have seen no such complications using this highly cross-linked polyethylene and acetabular shell combination.

A number of patients are approaching 3 year follow-up, and additional data will be available in coming months. Continued follow-up is necessary to evaluate the medium- and long-term performance of highly cross-linked liners in this challenging patient population.

REFERENCES