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Fixation and Wear With Contemporary Acetabular Components and Cross-Linked Polyethylene at 10-Years in Patients Aged 50 and Under

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ABSTRACT

We evaluated the mid-term performance of a moderately cross-linked polyethylene THA bearing in younger patients. One hundred consecutive THAs performed in patients 50 years of age and under using the same cementless acetabular component and moderately cross-linked polyethylene were evaluated at minimum 10 year follow-up. At final follow-up 75 patients (89 hips) were living, 7 patients (7 hips) were deceased and 4 patients (4 hips) were lost to follow-up. Average Tegner and UCLA scores were 3.7 and 5.8, respectively. Average steps per year were 1.84 million. The average linear wear rate was 0.05 mm/y and steady state wear rate was 0.033 mm/y. There was no detectable osteolysis. Minimum 10 year follow-up demonstrated durable fixation and reduced wear ($P < 0.001$) when compared to our historical controls.

With the improvement in the durability of fixation with cementless components over the last two decades [1–3] bearing surface wear became the major long-term problem associated with total hip arthroplasty (THA) [1–6]. The use of moderately and highly cross-linked polyethylene was introduced fifteen years ago to address bearing surface wear with the hope of minimizing osteolysis and enhancing implant survivorship through the increased wear resistance gained through the cross-linking process. Numerous reports have demonstrated the efficacy in wear reduction, and the subsequent decreased incidence of osteolysis, with this material in the general population at the 10-year follow-up interval (Table 1) [7–23]. However, as younger patient populations continue to undergo THA, factors unique to this cohort such as increased activity levels, higher wear rates, more years expected of the THA construct become very important especially at the longer term follow-up interval. Perhaps Charnley stated it best, "The challenge comes when patients between 45 to 50 years of age are to be considered for the operation, because then every advance in technical detail must be used if there is to be a reasonable chance of 20 or more years of trouble free activity." [24].

Very few studies have been reported at the 10 year follow-up interval in patients 50 and under where moderately or highly cross-linked polyethylene was utilized [7,25–27]. None of these studies had an institutional historical control of younger patients with conventional polyethylene (Table 2). Analysis of bearing surface performance specifically in the younger population becomes of upmost importance to evaluate whether increased wear resistance seen with moderately and highly cross-linked polyethylene in the general population holds true in these younger patients and whether any of the complications associated with reduced physical properties (decreased tensile strength, fatigue strength and elongation to failure) resulting from the crossing-linking process become more prevalent in this younger and more active cohort.

The purpose of this study was to evaluate the minimum ten-year results of a third generation cementless modular acetabular component using moderately cross-linked polyethylene liners in patients age 50 and under radiographically in terms of wear, osteolysis and loosening; and clinically in terms of revision, activity levels and standardized outcome scores. Additionally, the durability of this acetabular construct will be compared to our previous report of cementless acetabular components paired with conventional polyethylene in this same age group. The authors hypothesized that this third generation cementless acetabular component with a moderately cross-linked polyethylene liner would demonstrate reduced radiographic polyethylene liner wear when compared to a historical control and have improved clinical and radiographic outcomes in terms of reducing revision and osteolysis.

Materials and Methods

Patients and Components

Between August 25, 2000 and July 16, 2003, two authors (JJC and DDG) performed 100 THAs in 86 patients age 50 and under at the time of surgery, who all received the Pinnacle® (DePuy, Warsaw, IN)

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Table 1
Studies of Cross-Linked Polyethylene at 7 to 10 Year Follow-Up in the General Population.[a]

	Hips/Patients	Mean Age at Index THA (y)	Length of Follow-Up (y)	Hips Lost to Follow-Up (% of Entire Cohort)	Percent of Living Patients With Complete Radiographic Data at Final Follow-Up	Acetabular Component	Method of Cross-Linking Polyethylene	Femoral Head/Size	Revisions of Acetabular Shell for Any Reason	Re-operation for Femoral Head Penetration Issues	Femoral Head Penetration Rate (mm/y)
Cementless acetabular components											
Bedard et al [8]	150/139	55.6	10	5 (3.3%)	84% with minimum 8.5 y radiographs	Pinnacle: 149 hips, multi-hole 1 hip	5 Mrad of gamma irradiation and heat treated; sterilized with gas plasma (Marathon, DePuy)	Cobalt–chrome femoral head 28-mm in 148 hips, 32-mm in 2 hips	0	0	Min 10 y follow-up: 0.05 mm/y (includes bedding-in period)
Bragdon et al (Study 1) [9]	174/159	60	7 to 13	None, given study design	100%, given study design, with minimum 7 y radiographs	Metal backed Centerpulse Inc or Zimmer Inc	10 Mrad of electron beam-irradiated and melted	Cobalt–chrome femoral heads 28-mm in 100 hips, 32-mm in 74 hips	Not reported	0	Min 7 y follow-up: 0.018 ± 0.079; min 10 y follow-up: 0.01 ± 0.0562 (excludes 1 y bedding-in period)
Engh et al [10]	116/116	62.5	10.0 ± 1.8	7 (6.0%)	80% with minimum 9 y radiographs	Duraloc 100 (Depuy)	5 Mrad of gamma irradiation and heat treated; sterilized with gas plasma (Marathon, DePuy)	28-mm cobalt–chrome	1—Liner and head exchange for recurrent dislocation at 8.3 y	0	0.06 ± 0.05 (includes bedding-in period)
Lee et al [11]	150/139	58	7.9 (7 to 10.5)	13 (8.6%)	82% with minimum 7 y radiographs	Cementless modular titanium shell (Trilogy; Zimmer)	10 Mrad of electron-beam irradiation and heat treated; sterilized with gas plasma (Longevity; Zimmer)	28-mm cobalt–chrome	1	0	0.031 ± 0.012 (0.085 mm in the first year; 0.006 mm/y excluding 1 y bedding-in period)
Thomas et al [12]	27/27	68	7 to 7.8	2 (7.4%)	81% with minimum 7 y radiographs	Uncemented acetabular component (Trilogy: Zimmer)	10 Mrad of electron-beam irradiation and heat treated; sterilized with gas plasma (Longevity; Zimmer)	28-mm cobalt–chrome	0	0	0.32 mm in the first year; 0.005 ± 0.015 mm/y excluding 1 y bedding-in period
Capello et al [13]	57/48	55.8	8.6 (7 to 10.3)	15 (26.3%)	Not reported	Secur-Fit HA PSL (Stryker)	7.5 Mrad irradiation and heat treated; gamma sterilized to 3 Mrad in nitrogen (Crossfire; Stryker)	28-mm cobalt–chrome	0	0	0.123 mm in the first year; 0.031 ± 0.014 mm/y excluding 1 y bedding-in period
Geerdink et al [14]	22/22	64	8 (7 to 9)	3 (6.3% of all 48 hips in study, but specific CLP cohort data not reported)	77% with minimum 8 y radiographs	ABG II stem (Stryker)	30 kGy gamma irradiation in nitrogen, annealing (Duration; Stryker)	28-mm cobalt–chrome	Not reported	Not reported	0.088 ± 0.03 (includes bedding-in period)
Garcia-Rey et al [15]	45/45	67.4	Min 10	3 (6.7%)	Not reported	Allofit (Zimmer)	95 kGy gamma irradiation and heat treated; sterilized with ethylene oxide (Durasul, Zimmer)	28-mm cobalt–chrome	0	0	0.02 ± 0.016 (includes bedding-in period)