

Effect of Head Size and Liner Thickness on the Wear of Crosslinked, Thermally-Remelted UHMWPE

¹Corey Laukhuf; ¹Yen-Shuo Liao; ²Cath Hardaker

¹DePuy Orthopaedics, Warsaw, IN; ²DePuy International, Leeds, United Kingdom.

STATEMENT OF PURPOSE:

The benefits of using larger heads in hip arthroplasty include increased range of motion and enhanced stability from hip joint dislocation. This study evaluates the wear of Marathon™ and AltrX® using 32 and 36 mm heads of cobalt-chrome alloy and compares it to previous studies using 28 and 48 mm heads.

MATERIALS AND METHODS:

The AltrX liners (see Table 1 below) were machined from GUR 1020 ram extruded bar (REB) and crosslinked with gamma radiation at a dose of 7.5Mrads. The Marathon liners were machined from 1050 REB and crosslinked with a gamma radiation dose of 5Mrads.

Table 1. Summary of the Four Test Groups

I.D.	Description	Liner Thickness (at dome)
A	AltrX 32x48mm, Neutral	5.9 mm
B	AltrX 36x52mm, Neutral	5.5 mm
C	AltrX 36x52mm, Neutral +4	7.5 mm
D	Marathon 36x52mm, Neutral +4	7.5 mm

The femoral components used in Group A were CoCrMo with a nominal diameter of 32 mm. The femoral components used in groups B, C, and D were CoCrMo with a nominal diameter of 36 mm. The test was performed on a 12-station orbital bearing machine hip simulator (Shore Western, Monrovia, CA). Acetabular inserts were mounted with the liner below the head at 23° to the horizontal plane and rocked about a vertical axis using an anti-rotation bar. Normal gait was simulated using the Paul loading curve, with a maximum load of 2000N applied axially through the acetabular cup base assembly. Both the load and rotation were synchronized at a frequency of approximately 1 Hz. Test length was 5-million cycles (MC). All parts were tested in 90% bovine serum (HyClone Laboratories Inc., Logan UT) with 0.2% sodium azide added as a preservative and 20mM EDTA to prevent calcium phosphate precipitation. Serum was changed every 250K cycles. Liners were cleaned and weighed every 500K cycles. Wear was determined from the weight loss of each liner with compensation for fluid uptake assessed using control test liners that were cyclically loaded and soaked in the same solution but not rotated. Wear rates were determined by linear regression. A two-tailed equal variance t-test was utilized to analyze differences in wear rates between groups.

RESULTS & DISCUSSION

The three AltrX groups (A, B & C) had comparable wear rates ($p > 0.05$) suggesting that the liner thickness did not affect total wear (see Table 2). This is consistent to the previous findings on Marathon liners [1].

AltrX (Group C) showed a 59% wear reduction ($p=0.00$) when compared to Marathon (Group D), which was similar with previous study using different head sizes [2]. Table 3 and Figure 1 below show the effect of head size on UHMWPE wear rates from both the previous study and current test results.

Table 2. Wear Results

I.D.	Description	Wear Rate (mg/MC) ± std dev
A	AltrX 32x48mm, Neutral	5.8 ± 1.3
B	AltrX 36x52mm, Neutral	5.5 ± 1.3
C	AltrX 36x52mm, Neutral +4	4.0 ± 0.4
D	Marathon 36x52mm, Neutral +4	9.8 ± 0.8

Table 3. Effect of Head Size on UHMWPE Wear Rates

Head Size	Marathon (mg/MC) ± std dev	AltrX (mg/MC) ± std dev
28 mm [2]	7.3 ± 0.9	3.3 ± 0.2
32 mm	N/A	5.8 ± 1.3
36 mm	9.8 ± 0.8	4.8 ± 0.9*
48 mm [2]	15.7 ± 3.8	8.0 ± 2.1

*Average wear and std dev of both Groups B and C

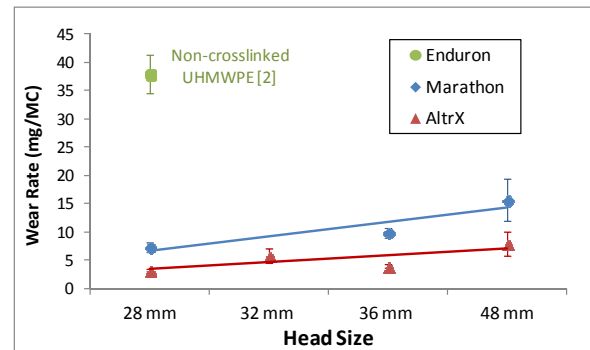


Figure 1. Wear Rate vs Head Size (error bars ± 1 SD)

CONCLUSION

The lower wear rates associated with AltrX have several benefits. First, larger size heads can be used since the wear rate of 48 mm AltrX was comparable to that of 28 mm Marathon ($p=0.65$) [2]. Secondly, for patients with smaller acetabulums, maximizing head to shell ratios are able to offer greater stability and increased range of motion [1]. Thirdly, the volumetric wear rates observed in the present study are well below the osteolysis threshold of volumetric wear of 80 mm³/y [3].

REFERENCES [1] Shen et al, CORR, September 2010. [2] Liao et al, ORS, p2333, 2008. [3] Dumbleton et al, J Arthroplasty 2002; 17:649.