

Does Manufacturing Method, Patient Age or Articulation Size Affect the Long-Term Wear Rate Of Highly Cross-Linked Polyethylene Liners In Total Hip Arthroplasty?

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INTRODUCTION: Radiostereometric analysis (RSA) is the most accurate method to measure in-vivo wear of highly cross-linked polyethylene (XLPE) liners [1]. Less sensitive measurement methods from plain radiographs often report higher than expected wear rates and the variation within results inhibits correct clinical interpretation. RSA studies have confirmed the very low wear rate of XLPE liners at mid-term follow-up [2] however, there is a paucity of long-term (>10 years) studies. Previously used polyethylene implants wear rate has been affected by three factors including, manufacturing method, articulation size and patient age. Hence the aim of this study was to measure the long-term wear of different designs of XLPE liners against larger articulations and in patients of varying age groups.

METHODS: 153 patients previously enrolled in six specific cohorts underwent further RSA examinations at 7-, 10-, and 14-years follow-up (Table 1). The proximal femoral head penetration (FHP) was calculated between the day 2 RSA exam and latest follow-up. The proximal wear rate was calculated as the slope of the FHP between one year and latest follow-up. Institutional Ethics Approval was obtained (CALHN R2003114 and R20080801).

RESULTS SECTION: The mean proximal wear rate of one XLPE liner manufactured with a low radiation dose (5Mrad) was significantly higher than two liners irradiated with 9- and 10-Mrad ($p<0.001$, Figure 1). Non-inferiority of XLPE wear rates against larger articulations (36/40mm) was supported when compared to standard articulations (28/32mm, Figure 2). Non-inferiority of XLPE wear rates in younger patients (40-64years) was supported when compared to older patients (65-74years).

DISCUSSION: The low long-term wear rates ($<0.02\text{mm/year}$) are encouraging for the continued excellent survivorship of XLPE implants in their second decade of use. Companies introducing new designs of XLPE liners need to be aware that larger radiation dose does result in a decreased long term wear rate.

SIGNIFICANCE/CLINICAL RELEVANCE: The increased wear rate of a XLPE liner manufactured with a low radiation dose provides important information for manufacturers optimizing the radiation dose to be used in future XLPE liner designs. The findings of our long-term wear studies support the use of larger femoral heads to reduce the risk of dislocation and the continued use of these implants in young patients who have longer life expectancy and require implant longevity.

REFERENCES: [1] Callary S, et al., J Ortho Res. 35:988-996, 2017; [2] Callary S, et al., Acta Ortho. 86:159-168, 2015.

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IMAGES AND TABLES:

Table 1: Patient and implant details for the six cohorts

| Cohort | XLPE Type | Manufacturing Irradiation Dose | Age (yrs) | Head Size (mm) | M:F | Patients Recruited | Time Points (yrs) |
|--------|------------|--------------------------------|-----------|----------------|-------|--------------------|--------------------|
| A | Marathon™ | 5 Mrad | 55-80 | 28 | 10:16 | 29 | 1, 6 & 14 |
| B | Longevity™ | 10 Mrad | 65-74 | 28 | 13:14 | 27 | 1, 2, 3, 5, 7 & 10 |
| C | Longevity™ | 10 Mrad | 65-74 | 36 | 15:14 | 29 | 1, 2, 3, 5, 7 & 10 |
| D | Longevity™ | 10 Mrad | 40-64 | 28 | 15:13 | 28 | 1, 2, 3, 5, 7 & 10 |
| E | X3™ | 3 x 3 Mrad | 47-76 | 32 | 11:10 | 21 | 1, 5 & 10 |
| F | X3™ | 3 x 3 MRad | 55-76 | 36/40 | 13:6 | 19 | 1, 5 & 10 |

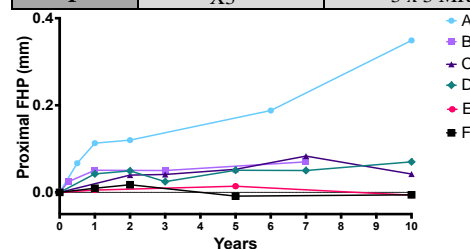


Figure 1. The median FHP for each cohort up to 10 years

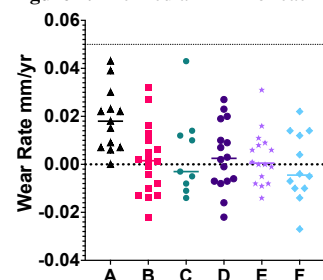


Figure 2. The median proximal wear rate of all cohorts. No individual was above the threshold associated with osteolysis (0.05mm/yr, dotted line)