Five Year In Vivo Wear Rates For Cemented Cross Linked All-Polyethylene Acetabular Cups

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Disclosures:

Introduction: Concerns always exist with the introduction of new materials and devices that show great promise following in-vitro testing. Crosslinked polyethylene demonstrated an ~80% reduction in wear rate, further associated with a decrease in the predicted biological response [1]. Crosslinked polyethylene is now popular clinically, particularly when a large diameter head is desired that may be associated with a larger sliding distance and associated wear. In the United States, it is estimated that 175,000 hip replacements each year will use cross linked polyethylene as a bearing surface. Marathon (Depuy, Leeds, UK) cross linked polyethylene has been used as an un-cemented liner against metal or ceramic femoral heads for over 15 years successfully. Both Engh and Devane have shown significant wear reduction of the Marathon liner versus Enduron (Depuy, Leeds, UK) ultra high molecular weight polyethylene cup (UHMWPE) by 95% and 82% respectively [2,3]. In 2008 the Marathon crosslinked cup was introduced into the worldwide market for all polyethylene cemented designs. As wear rate differences have been noted previously between some metal backed and all polyethylene cups the aim of this study was to report on the in-vivo penetration wear of Marathon polyethylene in the cemented all-polyethylene format in comparison to the traditional material.

Methods: Chapel Allerton Hospital Orthopaedic Centre in Leeds, United Kingdom was one of three centres worldwide to receive the all polyethylene Marathon cup for use in patients in July 2008 prior to its general release in the September later in the year. Retrospectively using the theatre planning diary for 2008, we identified the first 30 Marathon cups implanted following this date which met both the inclusion and exclusion criteria. In addition, we identified the last 30 Enduron cups prior to this date which again met inclusion and exclusion criteria. The same Moore-Southern posterior approach to the hip was utilized with a standardized technique. All implants were 28mm in diameter and incorporated an all polyethylene cemented cup fixed with Palacos R (Heraeus Medical, Wehrheim, Germany) high viscosity bone cement. All patients had standardized radiographic monitoring with an anteroposterior radiograph of the pelvis centered on the pubic symphysis two days post operatively, at one year and we are currently reviewing the first of the cohort to reach five years. Wear rate analysis was performed utilizing ‘Roman’ digital processing software developed by Frank Cook, Institute of Orthopaedics, Oswestry, United Kingdom, based on the assessment of femoral head penetration; the wire marker was not used as a reference due to potential imaging errors.

Results: There were no catastrophic failures observed in any cases for any of the implants or materials. The 1 year follow up radiographs (n=30 for each material) revealed a mean of 0.16mm linear wear with the Enduron Cup and 0.15mm wear with the Marathon cup. Preliminary results from the first patients to reach five years (n=8) show a continual linear increase in penetration wear (0.16mm/yr) for the Enduron material over the 5 year period for a total penetration of 0.81mm. Preliminary results for the Marathon material (n=6) has shown a slowing in the rate of penetration to a mean of 0.062mm/yr with a total penetration of 0.28mm.

Discussion: Most orthopaedic companies have introduced their crosslinked polyethylene technology into liners for metal shells. Hence the majority of in vivo studies so far published have been targeted at this sector of the market rather than all polyethylene cross linked acetabular cups. Marathon is considered a moderately crosslinked polyethylene as it has 5 MRad of gamma radiation to induce cross linking, compared to some others whom use 10 MRad. Marathon is additionally heat treated to remove free radicals and subsequently sterilization using gas plasma. The production technique for cross linked UHMWPE differs between manufacturers therefore, hence it is difficult to draw general conclusions. Clinical results presently seem to be following the general trends of reduced wear rates as seen in in-vitro studies [1]. Additionally, initial penetration at 1 year would typically include a contribution of creep that would subsequently reduce leaving only wear to be significant in the following years. The wear rates measured in the present results at 1 year and in our early observations at 5 years are very low for Marathon liners suggesting that the material is performing very well.

Concerning digital image resolution and therefore degree of accuracy in wear rate measurement, Agfa has two main radiographic plates which are utilized for digital imaging. One provides resolution of 6.6 pixels per millimeter and the other is set at 10 pixels per millimeter. Assuming the highest resolution images were used, the maximum possible resolution for any measurement method would be 0.1mm. Ultimately, the resolution and degree of measurement error were limited by using a radiograph showing a composite three dimensional structure in two dimensions. A suggestion for improvement in accuracy of measurement would be a similar study using CT images. However the radiation exposure for this would be much higher than
that received by the patients in our study and in the absence of a clinical indication, we did not feel there was sufficient justification for this.

Engh published a prospective single blinded randomised 5.7 year study of 236 hips comparing the two groups utilizing Marathon and Enduron liners in Duraloc cups. Engh noted linear and volumetric wear reduction of 95%, 0.19mm/yr to 0.01mm/yr from Enduron to Marathon [2]. Similarly, Calvert and Devane performed a double blind prospective trial comparing in vivo wear rates of 60 Enduron polyethylene with 59 Marathon liners at a minimum of 3 years in uncemented cases. Clinical outcome measures were comparable (Harris Hip Score). Following initial run in wear, linear wear between 6 months and four years reduced from 0.1276mm/yr with Enduron to 0.0239mm/yr with Marathon [3]. Our early data confirm that the Marathon liners are also performing well when cemented.

**Significance:** The authors report for the first time, penetration wear rates at 1 and preliminary results at 5 years for hip prostheses utilizing cemented Marathon all polyethylene acetabular cups. The cemented crosslinked all-polyethylene marathon cups showed a comparable penetration at 1 year and to date have shown a reduced penetration at 5 years compared to traditional polyethylene.

**Acknowledgments:** This work was supported by the National Institute for Health Research through funding of the Leeds Musculoskeletal Biomedical Research Unit. This work was partially funded by the Welcome Trust and EPSRC, under grant number WT 088908/Z/09/Z.

**References:**

**ORS 2014 Annual Meeting**
Poster No: 0888