

Particles from Vitamin-E-Diffused HXL UHMWPE Induce Less Osteolysis Compared to Virgin HXL UHMWPE in a Murine Calvarial Bone Model

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Introduction: Recent in vitro findings have suggested that UHMWPE wear particles containing vitamin-E (VE) may have reduced functional biologic activity and decreased potential to cause osteolysis (Bladen C.L. 2012-2013). We hypothesized that particles from VE-stabilized HXL-UHMWPE (VE-UHMWPE) would cause reduced levels of osteolysis in a murine calvarial bone model when compared to virgin HXL-UHMWPE.

Methods: Study groups: 1). VE-UHMWPE diffused after 100 kGy; 2). Virgin UHMWPE; 3). Shams. Particle generation and implantation: UHMWPE particles were generated at Bioengineering Solutions. C57BL/6 mice (n=12 for each group) received equal amounts of particulate debris overlying the calvarium and euthanized after 10d. Micro-CT scans: done using a set voltage of 70 kV and current of 70 μ A. Topographical Osteolysis Scale: Each calvarial bone was blindly scored using a scale ranging from 0 (no osteolysis) to 3 (completely osteolytic bone).

Histology: H&E and TRAP staining was done on tissue to confirm micro-CT findings and quantify osteoclasts.

Statistics: Inter-rater analysis was done using Cohen's kappa analysis. An inter-rater coefficient >0.65 was considered as high inter-rater agreement. Comparison between groups was made using one-way ANOVA with post hoc Bonferroni correction for multiple comparisons. Correlations are reported as Spearman's rho. P-value <0.05 was considered significant.

Results: More than 83% of the VE-UHMWPE and more than 85% of the virgin UHMWPE particles measured less than 1 μ m (mean particle size). A statistically significant greater level of osteolysis visualized on the topographical grading scale in calvaria implanted with virgin UHMWPE wear particles. Micro-CT findings were confirmed histologically (Fig. 1). Post hoc analysis revealed significant difference between VE-UHMWPE and virgin UHMWPE for the topographical osteolysis grading score ($p=0.002$) but no difference in osteoclast counts ($p=0.293$).

Conclusion: VE-UHMWPE particles have reduced osteolysis potential in vivo in a murine calvarial bone model. Arthroplasty procedures using VE-UHMWPE might be less susceptible to peri-prosthetic loosening caused by wear debris.