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Wear particle embedded 3D agarose gels for biocompatibility testing of orthopedic medical devices

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Background: We have developed a single method using 3D agarose gels that is suitable to test the biocompatibility of all three types of wear debris (Polyethylene, Ceramic and Metal) simultaneously.

Methodology & Theoretical Orientation: Clinically relevant sterile UHMWPE and CoCr wear particles were generated using methodologies described previously. Commercially available nanoscale and micron-sized silicon nitride (SiN) particles (<50 nm and <1 μm, Sigma UK) were sterilized by heat treatment for 4 hours at 180 °C. Agarose-particle suspensions were prepared by mixing warm 2% (w/v) low-melting-point agarose solution with the particles dispersed by sonication in DMEM culture media. The suspensions were then allowed to set at room temperature for 10 min in 96 well culture plates. Sub-confluent L929 murine fibroblasts were cultured on the prepared gels for up to 6 days in 5% (v/v) CO_2 at 37 °C. After incubation, the viability of cells was measured using the ATP-lite assay; the results were expressed as mean±95% confidence limits and the data was analyzed using one-way ANOVA and Tukey-Kramer post-hoc analysis.

Findings: The gels were observed to ensure uniform distribution of particles and migration of cells into the gel. No significant reductions in viability were observed for nanoscale and microscale SiN particles at low doses (0.5 μm^3 per cell) and high doses (50 μm per cell) or for UHMWPE wear debris at high doses (100 μm^3 per cell). Moreover, the viability was significantly reduced for high doses of CoCr wear debris (50 μm^3 per cell) and the positive control, Camptothecin (2 $\mu g.ml^{-1}$) at day 6. These results are consistent with the literature and therefore validate our 3D agarose cell culture method.

Conclusion & Significance: Biocompatibility of polymer, metal and ceramic wear debris can be tested simultaneously by using 3D particle embedded agarose gels.

Biography

Richard M Hall is a Member of the University of Leeds with an interest in motion preservation devices as well as research in to spinal cord injury and augmentation procedures such as vertebroplasty. He currently coordinates the LifeLongJoints project and is the Director of Postgraduate Research Studies in Engineering.

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