British Scoliosis Research Foundation

Title of project: What might be the effects of titanium debris around the spines of children with scoliosis?

P.I.: Alison Tyson-Capper: Researcher: Benjamin Hunt .

Final Report

The key aims of this project are to: generate Titanium wear debris using our in house wear testing rigs, to analyse this debris in terms of particle size and distribution, and to test the biological responses to the debris.

Samples of medical grade Titanium (Ti6Al4V) were sourced and machined to the appropriate dimensions for wear testing. This included pins and plates for use with the pin-on-plate rigs in the School of Engineering. Pre-test analysis was performed, including hardness testing and surface analysis. Two wear tests were completed, one test using deionised water as the lubricant in which the pins and plates articulated, and a second test in which the pins and plates articulated in diluted bovine serum. Diluted bovine serum is used to mimic the biological fluids that an implant will be operating in. For both tests the wear was high and the wear mechanisms were consistent with abrasive wear. When using deionised water the wear of the pins was observed to be $45.1 \pm 4.4 \times 10^{-6}(mm^3/Nm)$ while that of the corresponding plates was $206.8 \pm 18.8 \times 10^{-6}(mm^3/Nm)$ totalling $251.9 \pm 23.2 \times 10^{-6}(mm^3/Nm)$ for the combination. When using diluted bovine serum the wear of the pins was observed to be $44.1 \pm 1.4 \times 10^{-6}(mm^3/Nm)$ while that of the plates was observed to be $231.6 \pm 24.3 \times 10^{-6}(mm^3/Nm)$ totalling $275.7 \pm 25.7 \times 10^{-6}(mm^3/Nm)$ for the combination.

The wear debris from testing has been fully analysed. The Titanium particles were examined using the available Nanosight, however the procedure for the use of Titanium particles and the equipment required refinement. The larger Titanium particles tended to adhere to one another and precipitated early in the data capture; multiple methods to mitigate this were investigated. An alternative method of particle analysis using the TEM in the Electron Microscopy Research Services was undertaken.

The biological responses to the Titanium particles were tested using clinically relevant cell lines using THP1 monocyte cells and Monomac 6 cells. The cells were treated with a range of different concentrations of particles for different time points to investigate biological changes and cellular reactions at both the molecular and protein level. Quantitative PCR (Polymerase Chain Reaction) was used to determine any changes in gene expression of key biomarkers including IL8 and TNFa. ELISA was developed to test protein secretion.

The key aims of this pilot study were achieved. Titanium wear debris was successfully generated and analysed for its particle size and distribution for biological studies. Cell culture assays were developed and initial experiments indicate that titanium debris may have alter expression of 1L8. Our pilot work puts us now in a stronger position to apply for future funding and we thank the BSRF for your financial support.