Characterisation of Wear Morphology at the Head Cup Bearing Interface in Retrieved Metal-on-Metal Hip Replacements

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Abstract

Background The changes in surface roughness occurring during the wear process at the bearing surface are of great importance in trying to understand the failure mechanism of large head metal-on-metal hip replacements. The aim of the study is to identify and characterise the areal surface parameter variation between the worn and unworn areas. Surface topography variations at the bearing surface have an effect on the lubrication regime [1]. In vitro tests of these components have suggested a “self-polishing” of the surface [2]. Traditionally *Ra* has been used as a descriptor of surface texture. Considering the high standard of manufacturing to which these components are produced, Ra is not sufficient to describe surface morphology which requires spatial information which can only be achieved through the use of areal parameters.

Methods A total of 50 retrieved metal-on-metal hip replacements were assessed using white light scanning interferometry (Talysurf CCI, Ametek, UK) to determine the difference in the areal surface topography parameters between the worn and unworn regions of the bearing surface. The worn area was identified by use of a previously described method [3] to produce a wear map

of the bearing surface, this allows the identification of the regions of interest. A series of six measurements were taken on each component (figure 1) comprising of: 2 measurements at the equator of the head representing the unworn region, one measurement at the pole and just off centre from the pole and the rest of the measurements were taken inside and at the boundary of the wear area. Each measurement covered an area of 1 mm^2 therefore it is crucial that the location of the measurement be established as accurately as possible.

Data was analysed to determine the most relevant parameters that could be used to describe and highlight the changes in surface roughness that occur during the wear process.

Discussion The measurement methodology developed shows a clear correlation between the areal surface parameters and the wear regions. The parameters show that areas of wear can be identified when the correct suite of parameters are utilised.

This information is invaluable in developing a more advanced model of change in the lubrication regimes due to morphological changes during wear.