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Evaluation of fretting wear on the femoral stem surface

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ABSTRACT

Fretting wear on polished femoral stems has been well documented in clinical reports, but in vitro simulation to replicate this wear has seldom been attempted and only limited success has been achieved. In the present study, fretting wear was successfully reproduced on the stem surface by incorporating initial stem implantation in a sawbone through bone cement and utilisation of saline solution to mimic in vivo conditions, figure 1.

With the assistance of a grid coordinate system to relocate the position on the stem surface, figure 2, it has been possible to carry out comparison of the stem pre and post simulation using a Talysurf CCI interferometer. Selected 3D surface parameters, Sq, Sz, Sdq, Sdr, were introduced to quantitatively evaluate fretting wear. Additionally, a technique was developed to identify fretting wear based on grey scale threshold, which enabled calculation of coverage of fretting wear in each Gruen zone on the stem surface, figure 3. Furthermore, the stem was cut into small pieces to facilitate investigation of surface morphology through a scanning electron microscope. The typical pitting and crater surface features further confirmed generation of fretting wear on the femoral stem, figure 4.

This study gave scope for comparative investigation concerning the influence of stem design, cement brand on generation of fretting wear.

Key words: Fretting wear, femoral stem, simulation, evaluation

Topic: Biometrology



Figure 1: Reproduction of fretting wear on a polished Exeter stem

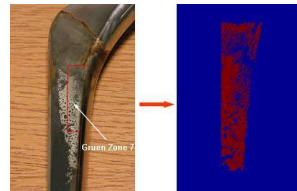


Figure 3: Detection of fretting wear

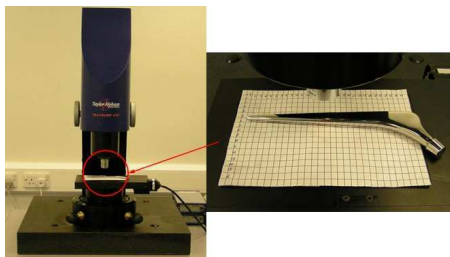


Figure 2: Relocation of the position on the stem surface

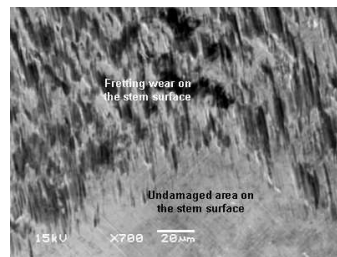


Figure 4: Fretting wear and undamaged area on the stem