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WHAT IS REQUIRED TO MEASURE THE WEAR OF EXPLANTED METAL-ON-METAL HIPS?

P Bills1, R J Underwood2, P M Cann2, A Hart3, X Jiang1, L Blunt1

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WHAT IS REQUIRED TO MEASURE THE WEAR OF EXPLANTED METAL-ON-METAL HIPS?

Presented at
BORS Annual Meeting
Cardiff
12 – 13 July, 2010

Background

- Worldwide interest in failure of Metal-on-Metal (MoM) hips
- 150,000 large diameter MoM hips implanted in UK
- Failure rate of resurfacings is 7.6%, compared to 3% for cemented hips
- Three designs of MoM hips have been removed from the market in past 4 years
- NJR data suggests 43% of hip failures are unexplained

Measurement Requirements

- No British Standard to measure wear of explanted hip joints
- No validated measurement protocol in the literature
- Typical linear wear rates for explanted hips are:
  - Cup 0 – 180 μm/year
  - Head 0 – 750 μm/year
- Accuracy required ~ 1 μm

Wear and Form

- Hip joints are not perfectly spherical as manufactured – the deviations are referred to as “Form”
- The manufactured shape of the components is unknown
- Form errors can be up to 30 μm
- Wear may be smaller than form errors
- Need to be able to separate wear and worn when analysing data

Comparison of Talyrond & CMM

The Talyrond 365 is a stylus based roundness machine. Hip located on a rotating table and the stylus measures the deviation from a perfect circle. Single profile measured to an accuracy of 30 nm and up to 72,000 data points per rev. Accuracy: Gauge > 12 nm Spindle <0.02 µm Individual roundness profiles can be stitched together to build up 3D maps

The Zeiss PRISMO is a co-ordinate measuring machine. Hip located in a chuck, probe measures grid of points, scanning whole surface to determine extent of ‘unworn area’. Unworn area scanned to create a reverse engineered 3D CAD surface which represents the component ‘pre-wear’ surface. Whole surface scanned and deviation is mapped. The maximum linear wear and wear volume are then calculated directly.

Co-ordinate measuring machine (CMM)

The CMM and Talyrond are both instruments suited to measuring wear of explanted hips.

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Conclusion

- The CMM and Talyrond are both instruments suited to measuring wear of explanted hips.
- Development of robust measurement protocol and standard required including:
  - Comprehensive study of good practice.
  - Verifiable uncertainty statements.

AFM

Optical

Stylus

CMM

MoM retrieval wear

Wear scar

Unworn area of bearing

Wear scar depth

CMM Talyrond

Cost ~£25 - 250k ~£10 - 80k
Resolution 0.02 – 2 µm 1 – 10 nm
Total Uncertainty Probing 0.7 µm Scanning 1.3 µm U3 ~ 4 µm
No of data points 10,000 + Up to 72,000 points per revolution
Time 15-30 minutes per component dependent on point density
Up to 1.5 hrs per component for 3D map, 2D profile in <1 minute
Absolute or Relative Measurement Traceable Calibration Calibrated from traceable standard

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