Semi-quantitative assessment of retrieved dual mobility liners for total hip replacement

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BACKGROUND

- Dual mobility (DM) THRs (Figure 1) were introduced to reduce the risk of dislocation, which is the most common cause of early (<1 year) THR revision [1].
- DM THRs have shown good overall survivorship and low rates of dislocation [2]. However, the mechanisms which describe how these bearings function and fail in-vivo are yet to be understood.
- The aim of the present study was to geometrically assess retrieved DM liners for wear/deformation.

METHODS

Retrieved DM liners (n=16) were sourced from an IRB-approved retrievals collection program. Liners had a mean time in-vivo of 19.7 months (range: 0.9 to 57). Each liner was assessed using the following methodology:

Geometric assessment of the internal and external surfaces using a Legex 322 coordinate measuring machine

↓ *Import data into Matlab*

Approximation of the unworn reference geometry using a sphere fitting algorithm

↓

Determination of the geometric variance of each point from the reference surface

↓

Production of surface deviation heatmaps to visualise areas of wear/deformation

Figure 1. Schematic illustrating a dual mobility bearing. At extreme ranges of motion, the femoral neck abuts the liner (middle) and thus activates the outer articulation between the liner and acetabular shell (right).

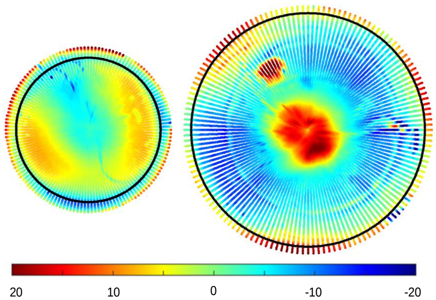

Figure 2. Surface deviation heatmap of the internal (left) and external (right) surfaces of a retrieved DM liner. Surfaces are scaled proportionally to one another with regards to their respective diameters. The colourbar represents the geometric variance (μm), whereby positive variation represents penetration into the reference geometry and negative variation represents protrusion out of the reference geometry.

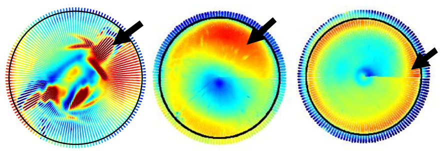

Figure 3. Commonly identified damage patterns from the collection of retrieved DM liners. This includes deep pitting of the external surface (left; n=6), asymmetrical wear/deformation of the internal surface (middle; n=5) and circumferential wear/deformation of the internal surface (right; n=4). Images utilise the same colourbar specified in Figure 2.

REFERENCES

[1] National Joint Registry. 17th Annual Report. 2020.
[2] Darrith et al. *Bone Joint J.* 2018, 100-B, 11-19.

RESULTS

- An example of the surface deviation heatmaps produced by the methodology is shown in Figure 2.
- Highly variable damage patterns were observed amongst the collection of retrieved liners. There were no obvious similarities in the damage patterns when liners were further stratified into sub-groups (e.g., bearing combination, implant design and reason for revision).
- The most commonly identified damage patterns are described in Figure 3.

CONCLUSION

- The described methodology was successfully able to characterise damage on the articulating surfaces of retrieved DM liners using non-destructive geometric measurements. However, it is limited by its inability to distinguish between wear (i.e., material loss) and deformation.
- The high variability in the surface damage may be a result of the complex in-vivo kinematics of DM THRs, which may be influenced by several factors (e.g., patient activity, component positioning, presence of soft tissue fibrosis).
- The mechanics of DM bearings remain unknown and thus warrants further investigation.

iMBE

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