

The Royal Academy  
of Engineering

## Research Fellowship

### A biotribology simulation system for pre-clinical evaluation of novel cartilage repair systems

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#### Need for hip replacements (UK)

- 650,000 patients have painful osteoarthritis in one/both hips, over 30% are <65yrs
- 95% of hip replacements are due to osteoarthritis [55,352 in 2006]
- Osteoarthritis causes cartilage degeneration, leading to loss of motion and pain
- Patient anxiety often due to perception that “nothing can be done”
- Currently, few interventions to bridge gap between pain relief and hip replacement

#### Drivers for more conservative interventions

- Desire for “50 more years at 50” (increased longevity and life quality expectations)
- Imaging techniques now allow earlier diagnosis of OA
- Clinical need for more tissue preserving surgery → surgical and economic drivers

#### Need for simulation system

- Hip simulators have rapidly advanced hip replacement development (materials and design) and understanding of optimum surgical envelope
- No such system for more conservative interventions, requires a whole joint model which maintains the functional biotribological properties of cartilage

#### Aims

1. Develop an *in vitro* biotribology simulation system to study degradation and wear of articular cartilage in hip joints
2. Investigate the degradation and wear of cartilage when existing treatment modalities are applied
3. To work collaboratively to develop novel solutions to repair hip cartilage degeneration (e.g. novel surgical interventions)

#### Approach

- Generate a simulator system to assess medium-term functional biotribology of the natural hip joint and validate with comparisons to clinical samples
- Characterisation of the natural hip joint and assessment of variations on joint tribology
- Develop bioreactor technology to extend cartilage viability to 28 days
- Surgeon collaborations to investigate novel interventions

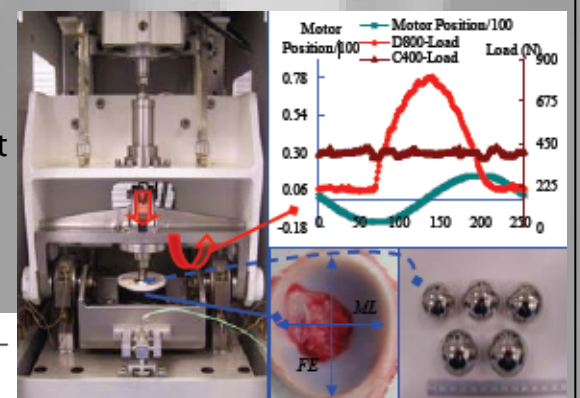
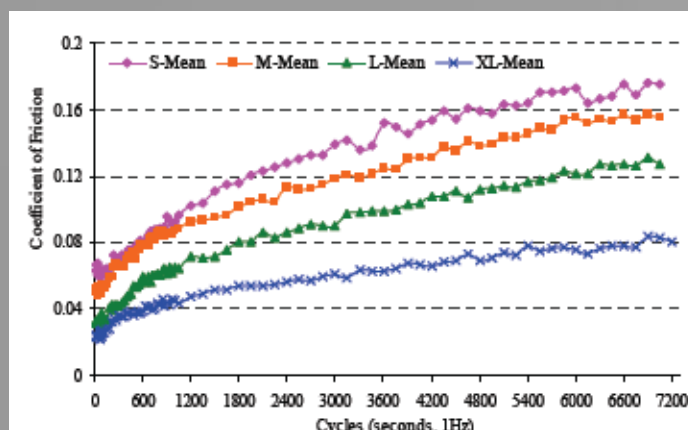
#### Investigation of existing treatment with short-term simulation system

Hemi-arthroplasty (replacing only the femoral head) has been used historically to repair femoral neck fractures

Study in literature (n=290),

- >65 yr patients displaced sub-capital femur fracture
- Treated with hemi-arthroplasty, or THR
  - Dislocation rates; 13% hemi-arthroplasty / 20% THR
  - THR resulted in least pain, most mobility and revision of 6.25% (compared to HA 24%) at 13 years
- Hemi-arthroplasty patients demonstrated an association between pain and head size  
Sharif and parker, Injury 2002; 33: 419-422; Ravikumar and Marsh, Injury 2000; 31: 793-797

Short-term (2hr) pendulum simulation system, porcine acetabulae articulated against CoCr femoral heads with different head / cup clearances, cartilage degeneration and friction studied



As clearance increased; friction decreased, however, cartilage degeneration increased. Larger clearances decreased contact area and increased contact stress

Lizhang et al., ICRS 2009