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The Wear of Ceramic Total Disc Replacements

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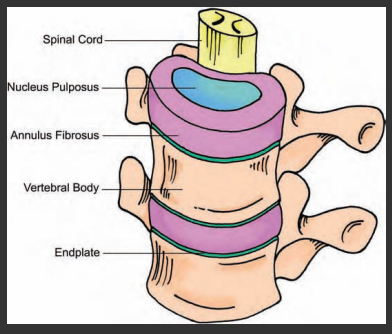
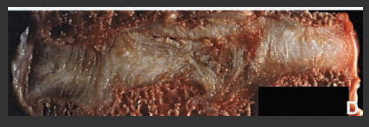
Background to Research

- Back pain is a debilitating condition
- Costs UK economy billions of pounds a year in treatment and lost working days



Anatomy of a Spinal Segment [1]

Healthy Disc [1]



Extreme Degeneration [1]

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[1]: S Kurtz, A Edidin, Spine Technology Handbook

Total Disc Replacements

- Total Disc Replacement (TDR) possible treatment
- Intervertebral disc is removed and replaced with TDR
- Issues with devices and debate over clinical outcomes
- Ceramic materials may improve devices

Synthes Spine ProDisc II: Total Disc Replacement [1]

Medtronic MAVERICK: Metal on Metal TDR [1]

Scient'x Discocerv: Ceramic on Ceramic TDR [2]

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[1]: S Kurtz, A Edidin, Spine Technology Handbook,
[2] http://www.scientx.com/product_nonfusion_discocerv.php 2006

Aims

- Overall aims:
  - Investigate the use of ceramics in cervical Total Disc Replacements and their wear behaviour
  - Manufacture ceramic implants using novel grinding methods
  - Develop a new method for measuring low wear rates for implants

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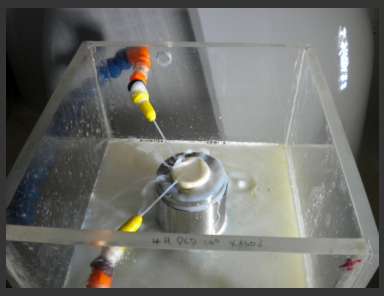
Implant Manufacture

- Universitas 21 Scholarship to study at University College Dublin, Ireland
- Collaborative study of the grinding of ceramic TDRs using novel diamond tool to achieve desired surface finish



Manufacture of Implant

Upper and Lower Alumina Implants in Fixtures

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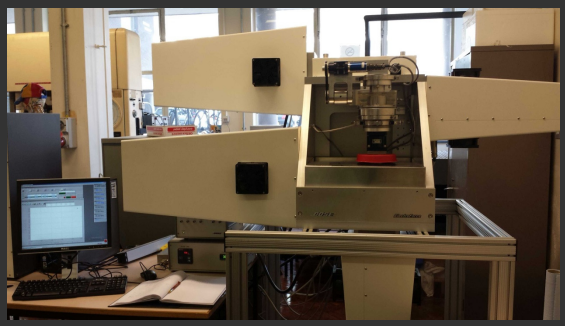
Wear and Friction Testing

- Major mode of failure for an implant is wear
- TDRs are tested on spinal simulators to the international standard ISO 18192-1 [3] to determine wear rates



Bose SDWS-1 Spine Simulator

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[3] ISO 18192-1:2011 Implants for surgery — Wear of total intervertebral spinal disc prostheses Part 1

Measuring Wear Rates

- Normal method for measuring wear rates of implants is the gravimetric method
- Change in mass is used to determine volume loss
- When wear rates are low it is difficult to measure the change in mass of the sample accurately
- Alumina cervical implants are expected to have low wear rates
- Alternative method is required
- Use non-contacting optical method, Alicona Infinite Focus, to scan surface of the implant
- Can measure form and surface roughness parameters in one scan

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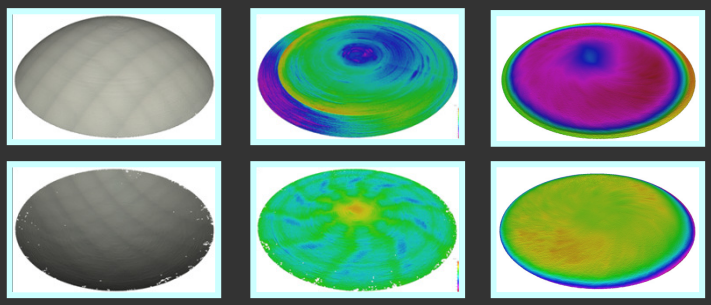
Implant Wear Measurement

- Form and roughness measurements taken before start of wear test and at every 0.5 million cycles
- Matlab code has been developed which finds volume difference between the unworn and worn surfaces



Images of the Functional Surfaces Before and After Testing

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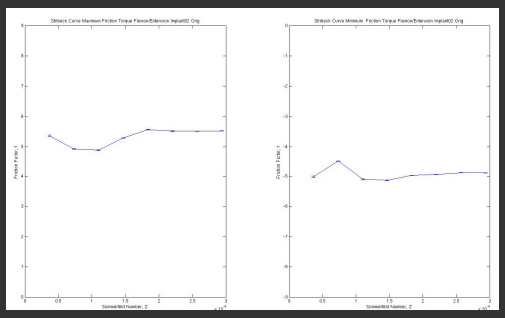
Friction Measurements

- Short 100 cycle tests
- Measure frictional torque against frequency
- Produce Stribeck Curves
- Gradient of the line gives information about lubrication regime



Example Stribeck Curve

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Future Work

- Complete final scans of implant
- Analyse data
  - Calculate wear rates
  - Compare gravimetric method with optical method
  - Surface roughness changes with wear
- Publish journal papers
- Write thesis
- Graduate ?!?

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