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The reliability of a semi-quantitative scoring method for taper corrosion and fretting, and its usefulness for predicting the volume of material loss

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Disclosures

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(contract allows freedom to publish all information)

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Received 4700 components from 22 countries
www.lirc.co.uk
High revision rates of LD-MOM-THAs increasingly reported.

These revision rates are higher than equivalent resurfacings.
Background

• Multiple mechanisms may lead to differences in failure rates.
• Material loss at the head-stem taper junction may be significant.

- Material loss may be due to: - mechanical wear
  - corrosion
  - fretting
Corrosion and Fretting scoring

- Visual scoring system for the appearance of corrosion and fretting
- Used in numerous publications examining taper surfaces
Corrosion and Fretting scoring

Adverse Local Tissue Reaction Arising from Corrosion at the Femoral Neck-Body Junction in a Dual-Taper Stem with a Cobalt-Chromium Modular Neck

H. John Cooper, MD, Robert M. Urban, PhD, Richard L. Winson, MD, R. Michael Meneghini, MD, and Joshua J. Jacobs, MD

The Journal of Arthroplasty Vol. 24 No. 7 2009

Corrosion of a Hip Stem With a Modular Neck Taper Junction

A Retrieval Study of 16 Cases

Alan M. Kop, PhD, MSc, and Eric Swarts, BAppSc

Corrosion and Fretting Changes in Modular Total Hip Arthroplasty

Michael B Cross, Christina Esposito, Anna Sokolova, Reza Jenabzadeh, Dennis Molloy, Selin Munir, Bernard Zicat, William K Walter and William L Walter

Taper Corrosion Update: What is the Role of Ceramic Femoral Ball Heads?

by Steven M. Kurtz, MD, PhD

Retrieval Analysis of Metal-on-Metal Total Hip Prostheses: Characterizing Fretting and Corrosion at Modular Interfaces

Genymphas Higgs, Steven Kurtz, Josa Hanzlik, Daniel MacDonald, William M Kane, Judd Day, Gregg Roger Klein, Jay Parvizi, Michael Mont, Matthew Kraay, John Martell, Jeremy Gilbert and Clare Rimmac
## Corrosion and Fretting scoring

<table>
<thead>
<tr>
<th>Score</th>
<th>Corrosion Criteria</th>
<th>Fretting Criteria</th>
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<tr>
<td>1 (None)</td>
<td>No visible corrosion</td>
<td>No visible signs of fretting</td>
</tr>
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<td>2 (Mild)</td>
<td>&lt;30% surface discoloured/dull</td>
<td>Band(s) for fretting scars across ≤3 machine lines</td>
</tr>
<tr>
<td>3 (Moderate)</td>
<td>&gt;30% surface discoloured/dull or &lt;10% containing black debris, pits or etch marks</td>
<td>Band(s) involving &gt;3 machine lines on taper surface</td>
</tr>
<tr>
<td>4 (Severe)</td>
<td>&gt;10% of surface containing black debris, pits or etch marks</td>
<td>Several bands of fretting scars involving several machine lines or flattened areas with nearby fretting scars</td>
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Corrosion and Fretting scoring

None (1)  Mild (2)  Moderate (3)  Severe (4)

Increasing severity of corrosion
Corrosion and Fretting scoring

Large amount of discolouration and black deposits on head taper

SEM showing (a) fretting scars and (b) imprinting of stem taper screw thread

- **Metrology is gold standard** but scoring is a quick method taper assessment.
- However the reproducibility of this system is unknown.
- Relationship between corrosion/fretting scores and taper material loss unclear.
Aims

1. What is the strength of the **reliability** and **repeatability** of visual taper corrosion and fretting assessments?
Aims

1. What is the strength of the **reliability** and **repeatability** of visual taper corrosion and fretting assessments?

2. Is there a correlation between corrosion and fretting scores and the actual volume of material lost at the taper junction?
Methods

150 MOM-THA head tapers

Corrosion and Fretting scoring by 2 examiners

Taper surface material loss

Scoring repeated

Repeatability?

Inter-observer Reliability?

Correlation?
Methods

- Scores assigned to the proximal and distal halves of taper surface.
- Overall scores assigned following assessment of surface as a whole
Methods

Taper surface material loss measurements

Roundness Measuring Machine (Taylor Hobson 365)

- 360 vertical traces
- 2.5 million data points

Cohen’s weighted Kappa statistic (κ) measures the **repeatability** and **reliability** of the scores.

<table>
<thead>
<tr>
<th>Kappa Value</th>
<th>Repeatability/Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 0</td>
<td>poor</td>
</tr>
<tr>
<td>0.01 to 0.20</td>
<td>slight</td>
</tr>
<tr>
<td>0.21 to 0.40</td>
<td>fair</td>
</tr>
<tr>
<td>0.41 to 0.60</td>
<td>moderate</td>
</tr>
<tr>
<td>0.61 to 0.80</td>
<td>substantial</td>
</tr>
<tr>
<td>0.81 to 1</td>
<td>almost perfect</td>
</tr>
</tbody>
</table>

The Spearman Rank test was used to determine the strength of correlation between the scores and the measured material loss.
Results

1. What is the strength of the reliability and repeatability of visual taper corrosion and fretting assessments?

2. Is there a correlation between corrosion and fretting scores and the actual volume of material lost at the taper junction?
Results

Inter-observer reliability

<table>
<thead>
<tr>
<th></th>
<th>Observed Agreement</th>
<th>Kappa</th>
<th>95% CI for Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosion Proximal</td>
<td>92%</td>
<td>0.52</td>
<td>0.42 to 0.66</td>
</tr>
<tr>
<td>Corrosion Distal</td>
<td>94%</td>
<td>0.70</td>
<td>0.45 to 0.69</td>
</tr>
<tr>
<td>Corrosion Overall</td>
<td>95%</td>
<td>0.64</td>
<td>0.52 to 0.73</td>
</tr>
<tr>
<td>Fretting Proximal</td>
<td>85%</td>
<td>0.14</td>
<td>0.01 to 0.46</td>
</tr>
<tr>
<td>Fretting Distal</td>
<td>84%</td>
<td>0.13</td>
<td>0.11 to 0.51</td>
</tr>
<tr>
<td>Fretting Overall</td>
<td>84%</td>
<td>0.18</td>
<td>0.14 to 0.51</td>
</tr>
</tbody>
</table>

• Better observed agreement for all corrosion scores than fretting.
• The reliability of the corrosion scores was moderate to substantial.
• The reliability of the fretting scores was slight.
### Results

#### Examiner repeatability

<table>
<thead>
<tr>
<th></th>
<th>Observed Agreement</th>
<th>Kappa</th>
<th>95% CI for Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Examiner A</td>
<td>Examiner B</td>
<td>Examiner A</td>
</tr>
<tr>
<td><strong>Corrosion Proximal</strong></td>
<td>93%</td>
<td>91%</td>
<td>0.65</td>
</tr>
<tr>
<td><strong>Corrosion Distal</strong></td>
<td>95%</td>
<td>92%</td>
<td>0.77</td>
</tr>
<tr>
<td><strong>Corrosion Overall</strong></td>
<td>94%</td>
<td>95%</td>
<td>0.71</td>
</tr>
<tr>
<td><strong>Fretting Proximal</strong></td>
<td>89%</td>
<td>88%</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>Fretting Distal</strong></td>
<td>88%</td>
<td>90%</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>Fretting Overall</strong></td>
<td>89%</td>
<td>87%</td>
<td>0.31</td>
</tr>
</tbody>
</table>

- Better observed agreement for all corrosion scores than fretting.
- The repeatability of the corrosion scores was substantial.
- The repeatability of the fretting scores was fair.
Results

1. What is the strength of the reliability and repeatability of visual taper corrosion and fretting assessments?

2. Is there a correlation between corrosion and fretting scores and the actual volume of material lost at the taper junction?
The taper corrosion score was significantly and moderately correlated with the volume of material loss measured.

The fretting score was also significantly correlated with the volume of material loss, but the correlation was weak.
Conclusions

1. Detailed visual examination of taper surfaces for the appearance of corrosion can produce reliable data.

2. Visual examination may be able to predict the severity of material loss but is not a substitute for complex metrology methods.
Thank you for your attention

For Further Information contact:

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