Background

- The incidence of revision Total Hip Arthroplasty (rTHA) is an ongoing concern in the United States
  - 13.7% 2009 (J. Drew AAHKS 2013)

<table>
<thead>
<tr>
<th>Year</th>
<th>Hip</th>
<th>Knee</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>2002</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>2003</td>
<td>9</td>
<td>10</td>
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<tr>
<td>2004</td>
<td>8</td>
<td>9</td>
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<tr>
<td>2005</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>2006</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>2007</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>2008</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2009</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2010</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Kaiser Permanente Revision Burden

Purpose

- To identify risk factors associated with the re-revision of a total hip arthroplasty previously revised for aseptic reasons
Methods

- U.S. based Total Joint Replacement Registry was utilized
- 44 medical centers
- 177 surgeons
- 6 U.S. Geographical regions
- Demographically representative of the US Population
  - Slightly older
  - Fewer Hispanics

Inclusion Criteria
- Primary and initial Revision surgery performed within KP and recorded in
- Initial revision performed for aseptic causes

Outcome of Interest
- Re-revision surgery for ANY reason (rTHA)

Exposures of Interest
- Patient factors:
  - Age, Gender, Race, BMI, ASA
  - Diagnosis: Instability as reason for initial revision
- Implant factors:
  - Fixation type, Component(s) replaced, Bearing surface, Head size, use of constrained liner
- Surgeon factors:
  - Average yearly volume of rTHA
  - Running total of rTHA

Statistical Analysis

- Frequencies proportions means and standard deviations were used to describe the study sample
- After using multiple imputation for missing data, a multivariable Cox regression model using the robust standard error approach to account for clustering by surgeon was generated.
- The response variable was time to revision in years, with loss to follow up treated as censored cases
- Significance testing for proportional hazards was performed
- Alpha = 0.05 was used as the threshold for statistical significance
Implant and procedure characteristics

- 97.3% of revision implants were uncemented
- 54.2% involved revision of the femur only
- 60.6% used metal on HXLPE
- 51.3% used heads smaller than 36mm
- 79.8% of revision cases were performed by surgeons doing less than 10 revisions per year

Results

- 629 aseptic revision THAs
- Median f/u of 2.2 years
- Crude re-revision rate 10%
- Infection rate 2.9% (18)
- KM survivorship at 5 years 86.8%
Results

Kaplan Meier Survival for Revision Hip Arthroplasty to Revision Surgery

- 86.8% at 5 years

Cox Regression Significant Results

- **Lower** Risk of re-revision
  - Patient age
    - 10 year increase HR 0.72 (95% CI: 0.58 – 0.90, p=0.004)
  - Surgeon experience
    - 5 case increase in experience HR 0.93 (95% CI: 0.86-0.99, p=0.049)
  - Bearing surface
    - COP vs MOP HR 0.32 (95% CI: 0.11-0.95, p=0.040)
    - Head size NS (end point revision, not dislocation)
  - Cemented stem vs. Uncemented stem HR 3.19 (95% CI 1.22-8.38; p= 0.018)
  - Constrained vs HXLPE HR 3.32 (95% CI 1.16-9.48; p = 0.025)
    - Non const 11% rev rate; Const. 42% rev rate
  - No Patient or Surgeon variables increased risk

Discussion: Strengths & Limitations

- **Limitations**
  - A lack of patient reported outcomes and radiographic outcomes
  - A revision THA may be functioning poorly but has not been re-revised
  - Consistent with other registry data
- **Strengths**
  - Multivariate analysis: patient, implant, and surgeon factors.
  - Using a large cohort of U.S. total joint patients representative of the larger U.S. population
  - Multiple medical centers and multiple community-based joint surgeons increase the applicability of the findings
  - Highly accurate data due to the methodology of data collection and validation through chart review
Conclusions

- The mid term survivorship of revision THA is promising for (86%)
  - Early failures (infection and instability)
- How to improve short term outcomes (10% revision rate)
  - Improve post operative stability (43%)
  - Reduce infection rates (28%)
  - Aseptic loosening (10%)
  - Refer to surgeons with experience (HR 0.93)

Conclusions Multivariate

- Exposures of Interest

  Patient factors:
  - Age, Gender, Race, BMI, ASA
  - 10 years = HR 0.72

  Diagnosis
  - Instability as reason for initial revision

  Implant factors:
  - Fixation type, Component(s) replaced, Bearing surface, Head size, use of a constrained liner
  - Cement = HR 3.19
  - COF = HR 0.32
  - Constrained = HR 3.32

  Surgeon factors:
  - Average yearly volume of rTHA
  - Running total of rTHA
  - 5 cases = HR 0.93

Results: Reasons for Revision

<table>
<thead>
<tr>
<th></th>
<th>Revision (N=629)</th>
<th>Re-Revision (N=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instability</td>
<td>315 (50.1)</td>
<td>27 (42.9)</td>
</tr>
<tr>
<td>Aseptic Loosening</td>
<td>90 (14.3)</td>
<td>6 (9.5)</td>
</tr>
<tr>
<td>Peri-prosthetic Fracture</td>
<td>70 (11.1)</td>
<td>2 (3.2)</td>
</tr>
<tr>
<td>Other</td>
<td>69 (11.0)</td>
<td>2 (3.2)</td>
</tr>
<tr>
<td>Femoral Fracture</td>
<td>36 (5.7)</td>
<td>1 (1.6)</td>
</tr>
<tr>
<td>Polyethylene Insert</td>
<td>26 (4.1)</td>
<td>1 (1.6)</td>
</tr>
<tr>
<td>Wear</td>
<td>22 (3.5)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Leg Length Inequality</td>
<td>22 (3.5)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

References

Conclusions
Univariate

- The risk of re-revision of a revised THA at an average 2 year follow up is approximately 10%.
- Instability is the most common cause of revision (50%)
- Instability is the most common cause of re-revision (43% of all re-revisions, 60% of aseptic re-revisions)
  - Infection: 28% (2.8% risk of infection following revision)

Results: Reasons for Revision

<table>
<thead>
<tr>
<th>Reason</th>
<th>Revision (N=629)</th>
<th>Re-Revision (N=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene Insert Wear</td>
<td>26 (4.1)</td>
<td>1 (1.6)</td>
</tr>
<tr>
<td>Leg Length Inequality</td>
<td>22 (3.5)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Osteolysis</td>
<td>11 (1.7)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Component Fracture</td>
<td>10 (1.6)</td>
<td>2 (3.2)</td>
</tr>
<tr>
<td>Cup Malposition</td>
<td>9 (1.4)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Metallosis</td>
<td>8 (1.3)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Hematoma</td>
<td>8 (1.3)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Acetabular Fracture</td>
<td>6 (1.0)</td>
<td>3 (4.8)</td>
</tr>
<tr>
<td>Wound Drainage</td>
<td>3 (0.5)</td>
<td>3 (4.8)</td>
</tr>
<tr>
<td>Seroma</td>
<td>1 (0.2)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Wound Dehiscence</td>
<td>1 (0.2)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Infection</td>
<td>0 (0.0)*</td>
<td>18 (28.6)</td>
</tr>
</tbody>
</table>

*Only aseptic revisions were included in the sample.

Results: Patient Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>HR</th>
<th>95% LB</th>
<th>95% UB</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female vs. Male</td>
<td>1.54</td>
<td>0.84</td>
<td>2.82</td>
<td>0.156</td>
</tr>
<tr>
<td>Age (per 10 year increment)</td>
<td>0.72</td>
<td>0.58</td>
<td>0.93</td>
<td>0.0004</td>
</tr>
<tr>
<td>Race: White vs. All Others</td>
<td>1.65</td>
<td>0.69</td>
<td>3.78</td>
<td>0.262</td>
</tr>
<tr>
<td>ASA: ≥3 vs. ASA&lt;3</td>
<td>1.24</td>
<td>0.65</td>
<td>2.36</td>
<td>0.519</td>
</tr>
<tr>
<td>BMI, kg/m² (per 1 unit increment)</td>
<td>1.03</td>
<td>0.98</td>
<td>1.07</td>
<td>0.214</td>
</tr>
<tr>
<td>Instability reason for 1st revision (Yes vs. No)</td>
<td>0.79</td>
<td>0.41</td>
<td>1.54</td>
<td>0.493</td>
</tr>
</tbody>
</table>
Discussion

**Patient Factors**

- **Age:** every 10 years increasing age had a HR of 0.72 (95%CI: 0.58-0.90)
  - Younger age has been attributed to greater activity levels leading to higher revision rates (1)
  - Higher complications rates in the elderly have been reported which would affect the indication for re-revision in some cases (2)
- **Gender, race, BMI and ASA** were not shown to be associated with re-revision


### Results: Implant Factors

<table>
<thead>
<tr>
<th></th>
<th>HR</th>
<th>95% LB</th>
<th>95% UB</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixation: Hybrid/cemented vs. Uncemented</td>
<td>3.19</td>
<td>1.22</td>
<td>8.38</td>
<td>0.018</td>
</tr>
<tr>
<td>Component Replaced: Acetabular only vs. Femoral &amp; Acetabular</td>
<td>2.47</td>
<td>0.73</td>
<td>8.38</td>
<td>0.148</td>
</tr>
<tr>
<td>Component Replaced: Femoral only vs. Femoral &amp; Acetabular</td>
<td>1.57</td>
<td>0.76</td>
<td>3.21</td>
<td>0.222</td>
</tr>
<tr>
<td>Component Replaced: Head/Liner only vs. Femoral &amp; Acetabular</td>
<td>0.53</td>
<td>0.05</td>
<td>5.56</td>
<td>0.593</td>
</tr>
<tr>
<td>Bearing Surface: Other vs. Metal on HXLPE</td>
<td>0.28</td>
<td>0.04</td>
<td>2.18</td>
<td>0.223</td>
</tr>
<tr>
<td>Bearing Surface: Ceramic on HXLPE vs. Metal on HXLPE</td>
<td>0.32</td>
<td>0.11</td>
<td>0.95</td>
<td>0.040</td>
</tr>
<tr>
<td>Bearing Surface: Metal on Constrained vs. Metal on HXLPE</td>
<td>3.32</td>
<td>1.16</td>
<td>9.48</td>
<td>0.025</td>
</tr>
<tr>
<td>Bearing Surface: Metal on Conventional vs. Metal on HXLPE</td>
<td>1.88</td>
<td>0.51</td>
<td>6.93</td>
<td>0.341</td>
</tr>
<tr>
<td>Femoral Head Size, mm: &gt;36 vs. &lt;36</td>
<td>1.44</td>
<td>0.67</td>
<td>3.07</td>
<td>0.348</td>
</tr>
</tbody>
</table>

**Discussion**

**Implant Factors**

- **Fixation:**
  - **Cemented femurs** were associated with an increased re-revision rate with a HR of 3.19 (95%CI: 1.22-8.38)
- **Bearing Surface:**
  - **Ceramic on XLPE** was associated with a reduced rate of re-revision by a HR of 0.32 (95%CI: 0.11-0.95)
    - This is a novel finding and warrants further investigation
  - Metal on **Constrained Liners** increases the HR relative to metal on XLPE by a factor of 3.32 (95%CI: 1.16 -9.48)
- **Femoral head size** did not have an association with the re-revision
  - We used re-revision as the outcome instead of dislocation/instability

### Results: Surgeon Factors

<table>
<thead>
<tr>
<th></th>
<th>HR</th>
<th>95% LB</th>
<th>95% UB</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgeon Volume (per 5 unit increment)</td>
<td>1.10</td>
<td>0.87</td>
<td>1.41</td>
<td>0.430</td>
</tr>
<tr>
<td>Running Total of Surgeries (per 5 unit increment)</td>
<td>0.93</td>
<td>0.86</td>
<td>0.99</td>
<td>0.050</td>
</tr>
</tbody>
</table>
Discussion

- Surgeon Factors
  - Surgeon yearly volume was not found to be associated with increased risk of re-revision
    - however the majority of these procedures were done by lower volume revision surgeons and there may not be enough of a spread in volume to detect a difference
  - Surgeon cumulative experience at the time of the index operation
    - Surgeon experience revealed an association with a lower risk of re-revision with a HR of 0.93 (95% CI: 0.86-0.99) for every 5 unit increase in the number of revision surgeries performed by the surgeon
    - Experience has been shown to be a factor in outcome with other technically demanding Orthopaedic procedures (namely Hip Resurfacing) (5,6)