Incidence & Prevalence of Surgery at Segments Adjacent to a Previous Posterior Lumbar Arthrodesis.

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Disclosures

• Sears
  o Consultant: Medtronic, Paradigm Spine
  o Royalties: Medtronic – interbody fusion device

• Sergides
  o Fellowship support: Medtronic

• White
  o Consultant: Medtronic
Background
Lumbar Adjacent Segment Disease

Fusion disease... or natural history?
Background

Lumbar Adjacent Segment Disease
Background

Published Literature – *Biomechanical*

- ⬆ stresses at levels adjacent to a fusion
  - Chen *et al.* Med Eng Phys 2001,
  - Chow *et al.* Spine 1996,
  - Cunningham *et al.* Spine 1997,
  - Eck *et al.* Am J Orthop 1999,
  - Lee *et al.* Spine 1984,
  - Oda *et al.* Spine 2000,
  - Umehara *et al.* Spine 2000
  - Rao *et al.* Spine 2005
  - Sudo *et al.* J Neurosurg Spine 2006
Background

Published Literature – *Clinical*

- Controversial – fusion disease or natural history?
- Prevalence:
  - Radiological degeneration: 5.2% - 100%
  - Symptomatic disease: 5.2% - 18.5%  (Harrop *et al*, *Spine* 2008)
  - Relatively small series: n = 21-215
- Annual Incidence:
  - Cervical –
    * Hilibrand *et al*, *JBJS* 1999 – 2.9%
  - Lumbar –
    * Ghiselli *et al*, *JBJS* 2004 – 3.9% (n=215)
- Risk factors? – esp. Number of levels fused
Aims

1. Determine
   - Annual incidence
   - Prevalence
   - Surgical intervention for ASD following lumbar arthrodesis

2. Examine
   - Relative risk factors
Methodology

- Retrospective cohort analysis

- End points:
  - Further surgical intervention - at adjacent level
  - Death / loss to F/U

- Postal & telephone survey:
  - “Have you had further surgery?”
  - If so:
    - when?
    - what type?
    - where/by whom?
Study Population

- 912 patients, 1000 consecutive PLIF procedures
  - October 1993 – November 2009
  - Mean age: 63 yrs (range: 14-92)
  - Female : Male – 1.4 : 1

- Inclusion criteria:
  - Lumbar degenerative pathology
  - Failed conservative management
  - Clinical symptoms and radiological signs ➔ fusion levels

- Exclusion criteria:
  - Acute fracture/dislocation or malignancy

- Follow-up:
  - 91% patients, 92% procedures
Surgical Technique

- Posterior lumbar interbody fusion (PLIF)
  - Insert & rotate interbody spacers
  - Pedicle screw instrumentation
- Attempted restoration of coronal and sagittal balance
Numbers of Levels fused
Levels fused

'Floating'
L4/5
Indications

- Foraminal stenosis
- Likely post op instability
- Correct painful deformity
- Non-union
- Large or Recurrent disc herniation
- Discogenic back pain
- Instability

Bar chart showing:
- NNL
- Lytic Spondy
- Scoliosis 15 degs
- Scoliosis 30 degs
- Kyphosis
- Flat back
Statistical analysis

- Kaplan-Meier survivorship analysis –
  - Prevalence & annual Incidence

- Cox proportional-hazards regression –
  - Multivariate analysis of risk factors

- Xlstat version 2009.6.03 & Medcalc version 11.2.1.0

- Significance set at $p < 0.05$
Results

• Prevalence:
  o 130 / 1000 procedures – 13%  \((mean\ f/u: 63\ months)\)
    • 12 laminectomy
    • 118 further fusions

• Mean time to further surgery – 43 months \((range: 2.3–162)\)

• Annual incidence \((all\ patients)\) – 2.5% \((95\%CI: 1.9-3.1)\)
Kaplan Meier Survivorship Analysis

Age groups: <45, 45-60, >60 years

p<0.001
Kaplan Meier Survivorship Analysis

Number of Levels Fused: 1, 2, 3 & 4

Time from index surgery (months)

Survival

p<0.0001
## Annual Incidence & Prevalence vs. Number of Levels Fused

<table>
<thead>
<tr>
<th>No. of Levels Fused</th>
<th>Annual Incidence (95%CI)</th>
<th>Prevalence 5 year</th>
<th>Prevalence 10 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed (all patients)</td>
<td>2.5% (1.9-3.1)</td>
<td>14%</td>
<td>22%</td>
</tr>
<tr>
<td>1</td>
<td>1.7% (1.3-2.2)</td>
<td>9%</td>
<td>16%</td>
</tr>
<tr>
<td>2</td>
<td>3.6% (2.1-5.2)</td>
<td>17%</td>
<td>31%</td>
</tr>
<tr>
<td>3 &amp; 4</td>
<td>5.0% (3.3-6.7)</td>
<td>29%</td>
<td>40%</td>
</tr>
</tbody>
</table>
Kaplan Meier Survivorship Analysis

Lytic \((n=103)\) vs. Degenerative Spondylolistheses \((n=221)\)

\(p=0.04\)
# Annual Incidence & Prevalence

Lytic (n=103) vs. Degenerative Spondylolistheses (n=221)

<table>
<thead>
<tr>
<th>Spondy Type</th>
<th>Annual Incidence (95%CI)</th>
<th>5 year Prevalence</th>
<th>10 year Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lytic</td>
<td>1.1% (0.3-1.8)</td>
<td>6%</td>
<td>8%</td>
</tr>
<tr>
<td>Degen.</td>
<td>2.4% (0.7-4.1)</td>
<td>11%</td>
<td>27%</td>
</tr>
</tbody>
</table>

p=0.04
### Multivariate Risk Factor Analysis

*(Cox proportional-hazards regression)*

- **Age** –
  - < 45 (n=130)
  - 45-60 (n=199)
  - > 60-years (n=671)

- **Number of levels fused** –
  - 1-level (n=593)
  - 2-levels (n=216)
  - 3 or 4 levels (n=117) and 5+ levels (n=60)

- **Sex** – male or female

- **Previous surgery** – 0 - 6

- **Laminectomy adjacent** (to the index fused levels)

- **Level of the Distal fused vertebra** – L1, L2, L3, L4, L5 or S1

- **Deformity** – Nil, degen spondy, lytic spondy, scoliosis < 15degs, scoliosis > 15degs, kyphosis/flat-back

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<table>
<thead>
<tr>
<th>Covariate</th>
<th>b</th>
<th>SE</th>
<th>P</th>
<th>Exp(b)</th>
<th>95% CI of Exp(b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age = 45-60yrs</td>
<td>-0.587</td>
<td>0.24</td>
<td>0.012</td>
<td>0.55</td>
<td>0.34 to 0.87</td>
</tr>
<tr>
<td>Age = &lt;45yrs</td>
<td>-1.364</td>
<td>0.47</td>
<td>0.003</td>
<td>0.25</td>
<td>0.10 to 0.63</td>
</tr>
<tr>
<td>Levels_fused = 3 or 4</td>
<td>1.121</td>
<td>0.24</td>
<td>&lt;0.0001</td>
<td>3.0</td>
<td>1.89 to 4.86</td>
</tr>
<tr>
<td>Levels_fused = 2</td>
<td>0.775</td>
<td>0.21</td>
<td>0.0003</td>
<td>2.1</td>
<td>1.42 to 3.25</td>
</tr>
<tr>
<td>Lowest_lev = L5</td>
<td>0.498</td>
<td>0.19</td>
<td>0.007</td>
<td>1.7</td>
<td>1.15 to 2.41</td>
</tr>
<tr>
<td>Additional Laminectomy</td>
<td>0.870</td>
<td>0.40</td>
<td>0.03</td>
<td>2.4</td>
<td>1.09 to 5.17</td>
</tr>
</tbody>
</table>
### Multivariate Risk Factor Analysis

*(Cox proportional-hazards regression)*

<table>
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<tr>
<th>Covariate</th>
<th>Relative Risk (95%CI)</th>
<th>P value</th>
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<tr>
<td>Age = &lt;45yrs</td>
<td>x 0.25 (0.10 to 0.63)</td>
<td>0.003</td>
</tr>
<tr>
<td>Age = 45-60yrs</td>
<td>x 0.55 (0.34 to 0.87)</td>
<td>0.01</td>
</tr>
<tr>
<td>2 levels fused</td>
<td>x 2.1 (1.42 to 3.25)</td>
<td>0.0003</td>
</tr>
<tr>
<td>3 or 4 levels fused</td>
<td>x 3.0 (1.89 to 4.86)</td>
<td>&lt;0.0001</td>
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<tr>
<td>Lowest level fused = L5</td>
<td>x 1.7 (1.15 to 2.41)</td>
<td>0.007</td>
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<tr>
<td>Adjacent level laminectomy</td>
<td>x 2.4 (1.09 to 5.17)</td>
<td>0.03</td>
</tr>
</tbody>
</table>
Discussion

• Methodology:
  o Single surgeon
  o Single technique
    • His/her indications
  ➔
    • Advantages
      ✤ Reduction in confounding variables
      ✤ Facilitates multi-variant analysis
    • Disadvantages
      ✤ Care required in applying to other surgeons/techniques

• End-point of further surgery may underestimate true incidence
Further study

- Examine role of pre-existing adjacent segment disease
- Examine role of sagittal and coronal balance
- Larger cohorts of specific pathologies
- ???
Conclusions

- Average annual incidence further surgery for ASD: 2.5%

*but*... incidence is not uniform
Conclusions

- **ASD risk factors:**
  - **Number of levels fused**  \((p<0.0001)\)
    - Risk –
      - 1.7% for one level
      - \(\times 2\) for two levels – 3.6%
      - \(\times 3\) for \(3/4\) levels – 5%
        - (10-year prevalence of 40%)
Conclusions

- ASD incidence factors:
  - Number of levels fused \((p<0.0001)\)
    - Risk –
      - 1.7% for one level
      - \(x 2\) for two levels – 3.6%
      - \(x 3\) for 3/4 levels – 5%
      - (10-year prevalence of 40%)
  - Age \((p<0.001)\)
    - especially < 45 years – risk: \(x 0.25\) (cf. 60+yrs)
Conclusions

• ASD incidence factors:
  o Number of levels fused \((p<0.0001)\)
    • Risk –
      ✤ 1.7% for one level
      ✤ \(x 2\) for two levels – 3.6%
      ✤ \(x 3\) for 3/4 levels – 5%
      ➢ (10-year prevalence of 40%)
  o Age \((p<0.001)\)
    • especially < 45 years – risk: \(x 0.25\) (cf. 60+yrs)

• Take care when interpreting ASD rates - especially following single level surgery in young patients – e.g. in US IDE disc prosthesis studies