A minimally invasive surgical approach reduces cranial adjacent segment degeneration in patients undergoing posterior lumbar interbody fusion


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In the midline approach, to expose the L4 pedicle screw entry point, (1) the origin of the L3 MF needs to be detached from the inferior border of the L3 lamina and (2) the insertion of the cranial MF needs to be detached from the mamillary process of the L4 superior auricular process.
All procedures, including decompression, cage insertion into the intervertebral space, and pedicle screw insertion, are performed through the Wiltse approach.

This procedure does not require detaching the MF from the cranial adjacent facet joints and lamina; this has the theoretical advantage of reducing iatrogenic cranial adjacent segment degeneration (ASD) in conventional open PLIF.

(Wiltse et al., JBJS-A 1968)
Postoperative MF atrophy after L4-5 PLIF

A, Box plots showing atrophy ratios (MF-cross-section area at 1-year postoperation [postop]/preoperation [preop]) at each level in the open (n = 10) and MIS (n = 10) groups. The median value is shown as a horizontal line in the box. The vertical limits of the box define the 25th and 75th percentiles, and the error bars denote the 10th and 90th percentiles. B, Representative T2 axial images at the L3-4 level in the 2 groups.

(Tsutsumimoto, *Spine* 2009)
Purpose

We compared our MIS-PLIF with open PLIF, focusing on the incidence of cranial ASD.
The surgical procedure of PLIF

Before 2004, conventional open PLIF
- Midline approach
- M8, Novus cage

Since 2004, MIS-PLIF
- Bilateral paramedian incision (3 cm)
- Wiltse approach
- X-tube, Quadrant
- M8, Legacy, Telamon cage
Patients

- Retrospective analysis

- Inclusion criteria:
  1. Degenerative (grade II) or lytic spondylolisthesis at the L4-5 level
  2. No previous lumbar surgery
  3. L4-5 single-level decompression and PLIF with bilateral facetectomy

<table>
<thead>
<tr>
<th></th>
<th>MIS Group (n = 22)</th>
<th>Open Group (n = 19)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age at surgery (range), y</td>
<td>61.2 (39–74)</td>
<td>62.6 (46–76)</td>
<td>0.80</td>
</tr>
<tr>
<td>Sex (female/male)</td>
<td>15/7</td>
<td>16/3</td>
<td>0.29</td>
</tr>
<tr>
<td>Degenerative/lytic spondylolisthesis</td>
<td>19/3</td>
<td>17/2</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Follow-up period (range), y</td>
<td>5.7 (2–8.5)</td>
<td>5.9 (4–9)</td>
<td></td>
</tr>
</tbody>
</table>
Methods

Study 1: Assessment of surgical outcomes
- The Japanese Orthopaedic Association (JOA) scores
- The modified MacNab criteria

Study 2: Assessment of radiological changes in the cranial adjacent segment
- Plain radiography (every 6 mo) and magnetic resonance imaging (MRI)
- University of California at Los Angeles (UCLA) Grading Scale for Intervertebral Space Degeneration
  - Postoperative spondylolisthesis or instability
  - Postoperative stenosis, herniation, or vertebral compression fractures
- Kaplan-Meier survival analysis; the survival rates of the MIS and open groups were compared using the log-rank test
Outcomes of MIS-PLIF (2–8.5 years)

- Solid fusion was achieved in all patients.

- The mean JOA score in the MIS group was 16.4 points before the surgery and 25.9 points at the last follow-up, with an improvement of 71.9%.

- According to the modified MacNab criteria, excellent or good outcomes were achieved in 86% (19/22) of the MIS group patients at the last follow-up.

- One patient required reoperation during the follow-up period.

- Postoperative segmental angle at the L4-L5 level was not significantly different between the 2 groups (MIS: 16.3 degree; Open: 13.6 degree; P = 0.2).
Details of the patients with postoperative ASD

**MIS group: 3/22 (13.6%)**

<table>
<thead>
<tr>
<th>Case</th>
<th>Age/sex</th>
<th>ASD</th>
<th>Time after surgery (y)</th>
<th>JOA score at final follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65/M</td>
<td>Listhesis/Instability</td>
<td>3</td>
<td>18  (8.5 y)</td>
</tr>
<tr>
<td>2</td>
<td>53/F</td>
<td>Disc space narrowing</td>
<td>4</td>
<td>27  (6.5 y)</td>
</tr>
<tr>
<td>3</td>
<td>54/M</td>
<td>Herniation</td>
<td>6</td>
<td>Reoperation  (6 y)</td>
</tr>
</tbody>
</table>

**Open group: 9/19 (47.4%)**

<table>
<thead>
<tr>
<th>Case</th>
<th>Age/sex</th>
<th>ASD</th>
<th>Time after surgery (y)</th>
<th>JOA score at final follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>72/F</td>
<td>Compression fracture</td>
<td>2</td>
<td>19  (9 y)</td>
</tr>
<tr>
<td>2</td>
<td>73/F</td>
<td>Listhesis/instability</td>
<td>3</td>
<td>Reoperation  (5.5 y)</td>
</tr>
<tr>
<td>3</td>
<td>53/F</td>
<td>Listhesis/instability</td>
<td>3</td>
<td>Reoperation  (4 y)</td>
</tr>
<tr>
<td>4</td>
<td>65/F</td>
<td>Listhesis/instability</td>
<td>1</td>
<td>18  (5.5 y)</td>
</tr>
<tr>
<td>5</td>
<td>63/F</td>
<td>Stenosis</td>
<td>5</td>
<td>Reoperation  (7.5 y)</td>
</tr>
<tr>
<td>6</td>
<td>57/F</td>
<td>Listhesis/instability</td>
<td>5</td>
<td>29  (5 y)</td>
</tr>
<tr>
<td>7</td>
<td>48/F</td>
<td>Listhesis/instability</td>
<td>5</td>
<td>29  (5 y)</td>
</tr>
<tr>
<td>8</td>
<td>76/F</td>
<td>Listhesis/instability</td>
<td>3</td>
<td>24  (5.5 y)</td>
</tr>
<tr>
<td>9</td>
<td>46/F</td>
<td>Stenosis</td>
<td>3</td>
<td>17  (4 y)</td>
</tr>
</tbody>
</table>
Kaplan-Meier survival analysis results for ASD

Freedom from ASD (%)

Time since surgery (y)

- MIS group
  - 94% at 4 y
  - 88% at 6 y
  - 81% at 8 y
  - P = 0.04

- Open group
  - 68% at 2 y
  - 51% at 8 y
Conclusion

The MIS approach can potentially contribute to a lower risk of cranial ASD in patients undergoing PLIF.

None of the authors has any potential conflict of interest.