Systematic Review of Neurological Complications Following Surgical Treatment of Lumbar Spondylolisthesis

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Disclosures

All Authors

- None
Introduction

- Surgical reduction and stabilization is increasingly being utilized for treatment of spondylolisthesis - particularly in the elderly population.
- Surgical treatment traditionally involves decompression with either reduction or in-situ fusion; more recently posterior fixation has been shown to be superior in several studies compared to decompression alone.
- While there are several studies examining overall complication rates following surgical treatment of lumbar spondylolisthesis, there is scant data focusing on neurological complications specifically.
- The present study seeks to delineate risk factors that contribute to post-operative neurological complications following surgery for spondylolisthesis.
Methods

- A MEDLINE database search was performed for prospective and retrospective studies from 2007 to 2017 inclusive using keywords “spondylolisthesis,” “neurological complications OR postoperative complications.”
- Inclusion and exclusion criteria were well established; see flow diagram.
- Four independent reviewers compiled data on neurological complication rate, age, surgical approach, transient vs. permanent neurologic deficit, mean blood loss, and mean operative time and grade and percentage of spondylolisthesis reduction.
- Data analysis was performed using SPSS, Version 24.0 for Mac (Armonk, NY: IBM Corp). Kolomogorov-Smirnov test was used to evaluate for normality of distribution of the data.
Results

- A total of 176 studies were initially included. Based on review, 153 were excluded. Of the 23 remaining, 14 met inclusion criteria.

- 78,598 patients were included in the study, of which 767 (0.98%) experienced neurological deficits.
<table>
<thead>
<tr>
<th>Publication</th>
<th>Sample Size</th>
<th>No. of Neurological Complications</th>
<th>Rate (%)</th>
<th>Transient or Permanent</th>
<th>Age Range (mean)</th>
<th>Spondylolisthesis Reduction</th>
<th>Spondylolisthesis Grade</th>
<th>Technique</th>
<th>Mean Operative Time (min)</th>
<th>Mean Blood loss (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Okuyama et al. (2007)</td>
<td>28</td>
<td>1</td>
<td>3.6%</td>
<td>1 / 0</td>
<td>52-75 (60)</td>
<td>17% slip pre-op, 5% slip post-op</td>
<td>Grade 1</td>
<td>PLIF</td>
<td>200 +/- 34</td>
<td>318 +/- 151</td>
</tr>
<tr>
<td>Hosono et al. (2008)</td>
<td>240</td>
<td>59</td>
<td>24%</td>
<td>41 / 18</td>
<td>40-84 (67.5)</td>
<td>-</td>
<td>Grades 1-2</td>
<td>PLIF</td>
<td>175 +/- 49</td>
<td>746 +/- 489</td>
</tr>
<tr>
<td>Kalanathi et al. (2009)</td>
<td>66,601</td>
<td>527</td>
<td>0.79%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>PLIF</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sansur et al. (2010)</td>
<td>10,242</td>
<td>91</td>
<td>0.89%</td>
<td>86 acute / 32 delayed</td>
<td>59</td>
<td>-</td>
<td>-</td>
<td>Multiple</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Takahashi et al. (2011)</td>
<td>43</td>
<td>1</td>
<td>2.3%</td>
<td>-</td>
<td>65.9 +/- 6.5</td>
<td>-</td>
<td>-</td>
<td>Multiple</td>
<td>233 +/- 65</td>
<td>187 +/- 99</td>
</tr>
<tr>
<td>Desai et al. (2013)</td>
<td>389</td>
<td>1</td>
<td>0.26%</td>
<td>-</td>
<td>65.5</td>
<td>-</td>
<td>-</td>
<td>TLIF</td>
<td>208.5</td>
<td>620.05</td>
</tr>
<tr>
<td>Lian et al. (2013)</td>
<td>73</td>
<td>4</td>
<td>5.5%</td>
<td>4 / 0</td>
<td>70-84 (74)</td>
<td>15.2% / 5.3%</td>
<td>Grade 1-2</td>
<td>PLIF</td>
<td>127 / 119</td>
<td>443.3 +/- 142.3</td>
</tr>
<tr>
<td>Sakaura et al. (2013)</td>
<td>112</td>
<td>6</td>
<td>5.3%</td>
<td>6 / 0</td>
<td>42-86 (67)</td>
<td>-</td>
<td>-</td>
<td>PLIF</td>
<td>158</td>
<td>279</td>
</tr>
<tr>
<td>Kelly et al. (2014)</td>
<td>92</td>
<td>7</td>
<td>7.6%</td>
<td>-</td>
<td>60-80</td>
<td>-</td>
<td>-</td>
<td>PLIF</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Okuda et al. (2014)</td>
<td>109</td>
<td>7</td>
<td>6.4%</td>
<td>6 / 1</td>
<td>22-79 (57)</td>
<td>24% slip pre-op / 10% slip post-op</td>
<td>Grade 1-3</td>
<td>PLIF</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Brodano et al. (2015)</td>
<td>64</td>
<td>3</td>
<td>4.7%</td>
<td>-</td>
<td>28-56 (46) / 32-58 (51)</td>
<td>-</td>
<td>Grade 1</td>
<td>TLIF</td>
<td>121.7</td>
<td>437.2</td>
</tr>
<tr>
<td>Macki et al. (2015)</td>
<td>103</td>
<td>54</td>
<td>52%</td>
<td>-</td>
<td>55-59 (57.6)</td>
<td>-</td>
<td>Grade 1-2</td>
<td>Multiple</td>
<td>-</td>
<td>700</td>
</tr>
<tr>
<td>Ghogawala et al. (2016)</td>
<td>66</td>
<td>4</td>
<td>6.0%</td>
<td>-</td>
<td>50-80 (66.6)</td>
<td>-</td>
<td>Grade 1</td>
<td>Multiple</td>
<td>289 +/- 66</td>
<td>514 +/- 334</td>
</tr>
<tr>
<td>Sembrano et al. (2016)</td>
<td>26</td>
<td>2</td>
<td>7.7%</td>
<td>-</td>
<td>63-64 (64)</td>
<td>-</td>
<td>-</td>
<td>MIS TLIF</td>
<td>172</td>
<td>-</td>
</tr>
</tbody>
</table>
Results

- Mean age was 62; Mean operative time was 185 minutes; Mean blood loss was 480 mL.
- The most prevalent surgical technique involved a PLIF either with or without an attempt for reduction.
- Majority of deficits (75.4%) were transient and involved a new sensory deficit.
- The average reduction of the slip was 14%.
- Statistical analysis demonstrated a significant positive correlation between complication rate and
  - mean blood loss (correlation coefficient CC 0.676, $p < 0.001$)
  - age (CC 0.434, $p < 0.001$)
  - operative time (CC 0.221, $p < 0.001$) and
  - degree of slip reduction (CC 0.793, $p < 0.001$).
Results

- Due to the wide range of complication rates (0.13% to 52.4%), additional analysis revealed that two studies demonstrated an aberrantly high complication rates (52.4% in Macki et al. and 24.6% in Hosono et al.)

- Similarly, study by Desai et al. reported an aberrantly low complication rate (0.26%)

- As a result, sensitivity analysis was performed, and exclusion of the three above studies strengthened the correlation between complications and risk factors
Discussion

- While a number of studies have examined general complications, neurological complications following spondylolisthesis reduction has not been well examined in literature.
- Important potential complications of surgical repair include cauda equina syndrome as well as L5 motor nerve root deficits are a potential concern from slip angle and extent reduction.
- It has been suggested that neuro-monitoring may be beneficial for prevention of lumbar and sacral nerve deficits as a guide to allowable reduction.
- Our study found a weak but statistically significant correlation between age, operative time, blood loss, and slip reduction with the development of neurologic complications. Performing sensitivity analysis resulted in strengthening of those associations.
Conclusions

- There is a paucity of data specifically examining neurological deficits following surgical treatment for lumbar spondylolisthesis.
- In this systematic review, we demonstrate statistically significant association between operative risk factors - in particular the degree of spondylolisthesis reduction and the development of neurological deficit.
- Our results suggest great attention must be paid to the extent of operative repair and neuro-monitoring should be considered.
- Decompression and stabilization are more important than radiographic correction alone.