Introduction

- The Anterior Cervical Discectomy and Fusion (ACDF) procedure is a safe and effective method of treating several types of nerve impingements in the cervical region.
- The use of the ACDF procedure has become common in surgical treatment of numerous pathologies such as cervical radiculopathy, cervical myelopathy, and other diseases processes involving anterior elements of the spine.
- While originally performed as single level procedures, there has been an emergence of multilevel procedures, including three- and four-level procedures.
- To date, there is a paucity of information surrounding ACDF procedures’ success rates and time to fusion when three or more cervical levels are fused.
- We identified 119 patients who underwent a three- or four-level ACDF procedure at UVA with at least two years of follow-up and examined their electronic medical record to determine the rate and timing of fusion as well as complication and revision rates.

Methodology

- All patients who underwent a three- or four-level ACDF procedure at UVA between 2010 and July of 2017 were reviewed; four patients were excluded from this list due to loss of follow-up including one post operative death.
- Four surgeons generated 123 cases over this time.
- Basic demographics such as age, BMI, sex, smoking status, and osteoporosis status were collected from the EMR at time of procedure.
- The primary outcome was complete fusion at two years post operatively in the operated regions; this was determined via combination of neuroradiologic interpretation as well as objective measurement of cervical displacement (<1 mm on extension and flexion).
- If a patient had only some cervical fusion, it was not considered fused.
- The secondary outcome was time to fusion in the operated regions.
- From these data, a time to fusion Kaplan-Meier figure was generated using GraphPad Prism v8.

Patient Demographics

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Age (Years)</th>
<th>% Male</th>
<th>BMI (kg/m²)</th>
<th>Tobacco Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-level (n = 79)</td>
<td>58.6 (35 - 83)</td>
<td>45.6</td>
<td>30.4 (17.7 - 81.0)</td>
<td>7.59 (38.0) (54.4)</td>
</tr>
<tr>
<td>4-level (n = 40)</td>
<td>58.1 (36 - 79)</td>
<td>55.0</td>
<td>28.6 (16.8 - 46.2)</td>
<td>10.0 (50.0) (40.0)</td>
</tr>
</tbody>
</table>

The value for age is the mean of the cohort followed by the range at time of operation. The value for BMI is the mean of the cohort followed by the range at time of operation. Tobacco use is presented as the percentage value of current, (former), and (never) smokers.

Radiographic Analysis and Results

<table>
<thead>
<tr>
<th>Procedure</th>
<th>12 mo. 24 mo.</th>
<th>24 mo. Fusion</th>
<th>Mean Fusion Time</th>
<th>Revision Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-level (n = 79)</td>
<td>84.8%</td>
<td>57.0%</td>
<td>63.3%</td>
<td>89.9%</td>
</tr>
<tr>
<td>4-level (n = 40)</td>
<td>85.0%</td>
<td>57.5%</td>
<td>60.0%</td>
<td>87.5%</td>
</tr>
</tbody>
</table>

- The time to fusion, fusion rates at both 12 and 24 months, and revision rates were all non-significant when comparing patients who underwent three- and four-level procedures.
- The fusion rates at 24 months attained by patients undergoing three- and four-level ACDF procedures at UVA are markedly higher compared to published rates at other institutions (42-70%).
- Complication rates were quite low, and few patients required revision; coupled together, this demonstrates that three- and four-level ACDF procedures are both effective and safe.
- When performing single variate analyses, there was no statistically significant impact on fusion rates or outcomes when controlling for BMI, age, gender, smoking status, osteoporosis, length of procedure, nor length of hospital stay.

Future Directions

- There is a marked difference between previous published fusion rates for three- and four-level ACDF procedures and our data; an assessment of why this interhospital discrepancy is occur needs to be performed.
- Many of the patients on whom these procedures were performed still have regular clinical follow-up; as such, we can continue to monitor the success of these procedures to determine longer term outcomes.
- For patients who required revision, it would be interesting to perform multivariate analysis over time to determine if patient demographics, perioperative variables, or cervical load/degree of kyphosis plays a role in unsuccessful fusions/symptom relief.
- Last, the actual load on the individual vertebra may lead to differing rates of fusion; a deeper dive into what levels are more prone to fail may result in the discovery of significantly worse vertebra(e) as it relates to propensity to fuse.

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