Predicting The Occurrence of Complications Following Corrective Cervical Deformity Surgery: Analysis of A Prospective Multicenter Database Using Predictive Analytics

Disclosures

No financial disclosures to report.
INTRODUCTION

- As the field of cervical deformity (CD) surgery has progressed, it has become more common for surgeons to operate on more challenging cases and for more high-risk patients
  - Increases risk of developing complications
- Predictive analytics in spine surgery is an emerging but new field
  - Important for determining patient-specific predictors of adverse outcomes

**Purpose:** To develop a predictive model to describe factors that can predict medical and surgical complications for cervical deformity corrective surgery.
MATERIALS & METHODS

- Radiographically defined cervical deformity (CD) meeting at least one of the following criteria:
  - Cervical kyphosis - C2-7 sagittal Cobb angle $\geq 10^\circ$
  - Cervical scoliosis - C2-7 coronal Cobb angle $\geq 10^\circ$
  - C2-7 sagittal vertical axis - C2-7 SVA $\geq 4^\circ$
  - Chin-brow vertical angle $\geq 25^\circ$

- Patients with spinal neoplasm, spinal infection, or patients who were pregnant were excluded

- Final Prediction Model: Series of prediction models were built by sequentially adding predictors from ranked list $\rightarrow$ final model chosen based on the model with lowest Akaike information criterion (AIC).
  - Internal validation of the prediction model was performed by calculating area under the curve (AUC) of the corresponding final prediction model

MEDICAL COMPLICATIONS
- Respiratory
- Nervous System
- Cardiac
- GI/GU
- Organ Failure
- Vascular
- Dysphagia

SURGICAL COMPLICATIONS
- Infection
- Instrumentation
- Operative
- Radiographic
- Wound
RESULTS

Demographics of Cervical Deformity Patients:
- Average age: 61 years
- 61% female

Surgical Details of Cervical Deformity Patients:
- Average of 7.5 levels fused with only 18% with anterior-only approach
- 22% of patients had a three-column osteotomy

Baseline Radiographic Parameters:
- High cervical lordosis: $6.42 \pm 22.11^\circ$
- High cSVA: $47.35 \pm 28.53$mm
- High TS-CL: $37.29^\circ \pm 20.52^\circ$

Complications
- 27% of patients had a major complication:
  - Respiratory failure, severe dysphagia, C5 motor deficit, nerve root motor deficit, and DJK commonly
- 40% of patients had a minor complication:
  - Dysphagia, mental status change, superficial surgical site infection, radiculopathy commonly
RESULTS

Complication Occurrences

**Any Complication**
1. Neurologic (24.4%)
2. Dysphagia (15.4%)
3. Cardiopulmonary (11.4%)
4. Infection (9.7%)

**Medical Complication**
1. Neurologic (24%)
   - Mental status change (5.7%)
   - Nerve sensory deficit (4.9%)
   - Radiculopathy (4.9%)
   - CS motor deficit (4.1%)
2. Dysphagia (13%)
3. Cardiopulmonary (11%)
   - Respiratory failure (4.9%)
   - Cardiac event (3.3%)
   - Pneumonia (2.4%)
   - Arrhythmia/Tachycardia (1.6%)

**Surgical Complication**
1. Radiographic (7.3%)
   - DJK (7%)
2. Infection (6.5%)
   - Deep surgical site infection (5.7%)
3. Operative (6.5%)
   - Dural Tear (4.1%)
### Predictors of Overall Complications

<table>
<thead>
<tr>
<th>Predictor</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher baseline EQ5D pain score</td>
<td>2.75 (0.88-8.62)</td>
</tr>
<tr>
<td>Lower baseline EQ5D anxiety/depression score</td>
<td>0.14 (0.05-0.43)</td>
</tr>
<tr>
<td>Higher cVSA</td>
<td>1.04 (1.01-1.06)</td>
</tr>
<tr>
<td>Higher global SVA</td>
<td>1.01 (0.99-1.02)</td>
</tr>
<tr>
<td>AUC</td>
<td>79%</td>
</tr>
</tbody>
</table>

### Predictors of Medical Complication

<table>
<thead>
<tr>
<th>Predictor</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Corpectomies</td>
<td>0.49 (0.22-1.04)</td>
</tr>
<tr>
<td>Ames Cervical Deformity Descriptor</td>
<td>2.34 (0.83-6.59)</td>
</tr>
<tr>
<td>AUC</td>
<td>70.1%</td>
</tr>
</tbody>
</table>

### Predictors of Surgical Complication

<table>
<thead>
<tr>
<th>Predictor</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Blood Loss (per 500cc)</td>
<td>2.32 (0.69-7.85)</td>
</tr>
<tr>
<td>Baseline EQ5D VAS</td>
<td>1.04 (0.99-1.09)</td>
</tr>
<tr>
<td>Baseline ambulatory status</td>
<td>0.25 (0.07-0.87)</td>
</tr>
<tr>
<td>Baseline Pelvic Incidence</td>
<td>1.14 (0.97-1.35)</td>
</tr>
<tr>
<td>Lack of bowel issues at baseline</td>
<td>0.01 (0.0-0.43)</td>
</tr>
<tr>
<td>AUC</td>
<td>94.2%</td>
</tr>
</tbody>
</table>
Discussion

- Overall, **64.2%** of surgical CD patients sustained a *complication*.

- While the most reliable predictor of the occurrence of a complication involved a cluster of risk factors, a radiographic baseline sagittal parameter of *cervical SVA* was the strongest isolated predictor for complications across categories.

- Although these findings are specific to a cervical deformity population with moderate to severe deformities, collectively they can be utilized for pre-operative risk assessment and patient education.
Summary Points

- Over 60% of cervical deformity patients sustained at least one complication following CD-corrective surgery.

- The radiographic baseline sagittal parameter of cervical SVA was the strongest isolated predictor for complications across categories.

- These findings can be utilized for pre-operative risk assessment and patient education.