Cervical Pedicle Subtraction Osteotomy for Fixed Cervical Sagittal Imbalance

Vedat Deviren, MD; Associate Professor in Clinical Orthopaedics
UCSF Spine Center

Background

Cervical Deformity

Etiology
- Advanced degenerative disease
- Drop head Syndrome
- Trauma
- Neoplastic disease
- Systemic arthritis
  - Ankylosing spondylitis
  - Rheumatoid arthritis
- Most common cause is iatrogenic (i.e., postsurgical)
- Others (syndromic, congenital….)

Cervical Deformity

Clinical Presentation
- Mechanical neck pain
  - Worst with activity
- Unable to maintain horizontal gaze
- Neurologic
  - Radiculopathy
  - Myelopathy
    - Ventral compression
- Swallowing difficulties

Background

Rigid vs. Flexible

Cord Compression (none/focal/global)
**Background**

- Cervical Kyphosis
  - Semi-rigid kyphosis w/ or w/o neurologic symptoms
  - Rigid subaxial kyphosis w/ neurologic symptoms
  - Rigid subaxial or cervicothoracic kyphosis w/o neurologic symptoms

**Semi-rigid deformity with or without neurologic symptoms**

- Multilevel SPO with Posterior Stabilization C2-T3 with CoCr rod
  - Able to be mobilized with posterior facet osteotomies
  - Less complication than multi level anterior surgery
  - May apply corrective force with:
    - Mayfield
    - Cantilever (CoCr)
    - In-situ bending (CoCr)

**3.5 CoCr SPO**

- Images of spinal procedures and implants.

---

6/4/2011
Rigid subaxial deformity with neurologic symptoms

540 Osteotomy - Subaxial Fixed Kyphosis

540 Osteotomy
Circumferential Osteotomy for fixed cervical kyphosis: Novel Surgical Technique.

Vedat Deviren, M.D, Bobby K Tay, Mauricio Andrés Campos, Christopher P Ames, Vedat Deviren, M.D. (submitted to Spine)

PURPOSE: Demonstrate feasibility of circumferential osteotomy by back/front/back cervical approach

METHODS: 14 consecutive patients with fixed cervical kyphotic deformity (average age 55 (23-68))

RESULTS:

Osteotomy 3.9 (3-6) levels anteriorly
6.6 (3-18) levels posteriorly.
Correction 28 degrees (10-37).
Average EBL was 3484 cc (400-4600 cc)
LOS: 19(3-35)
ICU stay: 6.5 (0-15)
Intubated days: 3.8 (0-15)

CONCLUSIONS:
Safe, reproducible, and powerful method to correct fixed cervical deformity while improving pain and neurologic function. A protracted postoperative course is predictable. Initial findings are encouraging.

- Rigid subaxial or cervicothoracic kyphosis without neurologic symptoms

- The surgical techniques and outcomes of 131 patients

- Chin-brow to vertical angle to 0°-10° of flexion

- Wide decompression
  - Increased lateral resection area greatly reduces the possibility of nerve root impingement
Surgical Technique: OWO (Open wedge osteotomy)

- Complete removal of superior, inferior articular process and transverse process followed by neck extension.

Background

PSO vs. SPO

Biomechanics

PSO vs. SPO

Osteotomy Type

PSO was significantly stiffer than the SPO.
Purpose
This study details our cervicothoracic pedicle subtraction osteotomy technique and report our experience in 10 cases.

Materials and Methods
- 2008 to 2010,
- 10 pts modified PSO;
- 8 patients at C7, 1 patient at C6 and C7, and 1 patient at T1
- Age of the 10 patients was 72.1 years (range, 56-94).
- Indications
  - sagittal imbalance of the cervical spine affecting horizontal gaze
  - persistent pain
  - inability to maintain an erect posture

Table 1: Patient demographic, diagnosis, procedure, and complication information. PSO = pedicle subtraction osteotomy

<table>
<thead>
<tr>
<th>Number</th>
<th>Sex</th>
<th>Age</th>
<th>Diagnosis</th>
<th>Procedure</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>70</td>
<td>Chin-on-chest deformity</td>
<td>C7 PSO</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>56</td>
<td>Cervical kyphosis and cervical myelopathy</td>
<td>C7 PSO</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>82</td>
<td>Chin-on-chest deformity</td>
<td>C7 PSO</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>80</td>
<td>Chin-on-chest deformity</td>
<td>C7 PSO</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>73</td>
<td>Fixed coronal + sagittal plane cervical deformity</td>
<td>C6 and C7 PSO</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>69</td>
<td>Cervical kyphosis</td>
<td>C7 PSO</td>
<td>dysphagia/peg</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>59</td>
<td>Chin-on-chest deformity</td>
<td>C7 PSO</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>75</td>
<td>Cervical kyphosis</td>
<td>C7 PSO</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>F</td>
<td>94</td>
<td>Chin-on-chest deformity</td>
<td>T1 PSO</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>63</td>
<td>Chin-on-chest deformity</td>
<td>C7 PSO</td>
<td></td>
</tr>
</tbody>
</table>

Fixed long standing CT and midsubaxial kyphosis
C7 Pedicle Resection

- Preop CT angio
- Complete Facetectomy
- Skull Base Rongeur (Lempert) for medial portion
- Drill for decancellation
- Curette for scoring anterior cortex prn
- Precontoured rod/hinged
- Mayfield/Halo Manipulation

C7 PSO Technique 1

C7 PSO Technique 2

C7 PSO Technique 3
RESULTS

Table 2: Radiographic measurements for the pre and postoperative periods. All values are presented in degrees unless otherwise noted.

<table>
<thead>
<tr>
<th></th>
<th>Patient</th>
<th>Preop Sva</th>
<th>Postop Sva</th>
<th>Preop Correction</th>
<th>Postop Correction</th>
<th>No.</th>
<th>Kyphosis</th>
<th>Sva (cm)</th>
<th>Correction</th>
<th>Sva (cm)</th>
<th>Correction</th>
<th>Sva (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.0</td>
<td>9.0</td>
<td>20.8</td>
<td>10.0</td>
<td>9.0</td>
<td>4.0</td>
<td>52.0</td>
<td>4.2</td>
<td>32.0</td>
<td>5.0</td>
<td>37.0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>11.4</td>
<td>9.0</td>
<td>20.8</td>
<td>10.0</td>
<td>9.0</td>
<td>4.0</td>
<td>52.0</td>
<td>4.2</td>
<td>32.0</td>
<td>5.0</td>
<td>37.0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>30.0</td>
<td>9.0</td>
<td>15.0</td>
<td>0.0</td>
<td>15.0</td>
<td>0.0</td>
<td>47.0</td>
<td>5.0</td>
<td>42.0</td>
<td>5.0</td>
<td>47.0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>30.0</td>
<td>6.6</td>
<td>20.0</td>
<td>12.0</td>
<td>12.0</td>
<td>0.0</td>
<td>52.0</td>
<td>5.0</td>
<td>47.0</td>
<td>5.0</td>
<td>47.0</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>30.0</td>
<td>7.5</td>
<td>15.0</td>
<td>0.0</td>
<td>15.0</td>
<td>0.0</td>
<td>52.0</td>
<td>5.0</td>
<td>47.0</td>
<td>5.0</td>
<td>47.0</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>22.6</td>
<td>7.5</td>
<td>15.0</td>
<td>0.0</td>
<td>15.0</td>
<td>0.0</td>
<td>44.7</td>
<td>4.6</td>
<td>45.3</td>
<td>3.5</td>
<td>43.8</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>16.0</td>
<td>7.5</td>
<td>15.0</td>
<td>0.0</td>
<td>15.0</td>
<td>0.0</td>
<td>43.0</td>
<td>4.0</td>
<td>61.0</td>
<td>5.0</td>
<td>63.0</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>20.6</td>
<td>7.5</td>
<td>15.0</td>
<td>0.0</td>
<td>15.0</td>
<td>0.0</td>
<td>47.0</td>
<td>5.0</td>
<td>47.0</td>
<td>5.0</td>
<td>47.0</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>20.6</td>
<td>8.3</td>
<td>17.0</td>
<td>0.0</td>
<td>17.0</td>
<td>0.0</td>
<td>47.0</td>
<td>5.0</td>
<td>47.0</td>
<td>5.0</td>
<td>47.0</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>32.2</td>
<td>9.1</td>
<td>15.0</td>
<td>0.0</td>
<td>15.0</td>
<td>0.0</td>
<td>47.0</td>
<td>5.0</td>
<td>47.0</td>
<td>5.0</td>
<td>47.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>27.6</td>
<td>9.0</td>
<td>15.0</td>
<td>0.0</td>
<td>4.0</td>
<td>52.0</td>
<td>4.2</td>
<td>32.0</td>
<td>5.0</td>
<td>37.0</td>
<td></td>
</tr>
</tbody>
</table>

- Cervical sagittal imbalance
  Pre: 8.0±1.4cm  Post: 3.5±1.8cm  Correction: 4.5±1.5cm (43.6%).
- PSO correction was 18.8°.
- Cervical correction of 51.2±6.2°.

Patient Outcomes

- NDI scores (24.6%, 51.1 to 38.6, p=0.03).
- VAS scores (55.7%, 7.6 to 3.4, p=0.0083).
- There was an 18.4% increase in PCS scores (30.2 to 35.8).
Intra-operative Results and Complications

- EBL: 1110±484cc
- Average surgical time was 4.3±0.6hrs
- There were no intra-operative complications
- One patient developed dysphagia postoperatively.
- There were no neurological complications in any of the ten patients.
  - There were no changes in the intraoperative neurophysiological monitoring during correction.

Conclusion

- Cervicothoracic junction PSO being a safe, reproducible and effective procedure for the management of cervicothoracic kyphotic deformities.
- It results in excellent correction of kyphosis and CBVA with a controlled closure
- Currently, the authors prefer the pedicle subtraction osteotomy at the cervicothoracic level for treatment of chin-on-chest deformity

Acknowledgements

- Christopher Ames  MD UCSF Neurosurgery
- Co-founder High Risk Spine Service

Orthopaedic surgery and Neurosurgery collaboration redefine complications for high risk patients

Where Do We Go From Here?

New cervical deformity classification is required to define indications and contraindications for complex cervical reconstruction