Cervical Pedicle Subtraction Osteotomy for Rigid Deformity Treatment - Surgical Nuances

Osteotomia de Subtração Pedicular Cervical para Tratamento de Deformidades Rígidas – Técnica Cirúrgica

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ABSTRACT

Pedicle subtraction osteotomy (PSO) of the cervical spine is a complex and challenging procedure used to treat severe and rigid deformities, especially those secondary to ankylosing spondylitis. In this paper, we discuss the indications of the cervical PSO in a patient with ankylosing spondylitis, as well as the surgical nuances of this technique, in a step-by-step fashion.

Key words: Deformity; Cervical; Pedicle Subtraction; Osteotomy; Rigid Deformity, Ankylosing Spondylitis

INTRODUCTION

Cervical osteotomies are extremely challenging surgical procedures with high risk for postoperative neurological complications, such as nerve root injury or even catastrophic tetraplegia and death. These surgeries are generally performed in patients with severe and rigid cervical deformities, compromised by important cervical axial pain, difficulty to swallow, and in the majority of the cases, inability to maintain an horizontal gaze.

Pedicle subtraction osteotomy (PSO) is a powerful procedure used for sagittal imbalance correction, usually performed for the lumbar spine, and based on shortening of the posterior and middle spinal columns with no lengthening of the anterior column. A modified PSO has been described for the cervico-thoracic region, generally at C7 or T1 level, for the correction of severe cervical deformity, such as chin-on-chest deformity, as an alternative to combined anteroposterior or posterior approaches. The power of correction is tremendous, even though the complications rate may be quite high.

In order to reinforce the potential benefits of cervical PSO in the patients' quality of life, in the present manuscript we present a case of a patient with a rigidly fixed cervical kyphosis who underwent a C7 PSO. The surgical nuances of this procedure are described in a step-by-step fashion and the indications and potential tips to avoid complications are discussed.

CASE REPORT

A 42-year old woman presented at our outpatient clinic with a history of progressive cervical axial pain, refractory to analgesics and opioids, difficulty in swallowing, and inability to walk with a horizontal gaze. She had been diagnosed with ankylosing spondylitis (AS) in another hospital. She also had diabetes and was a heavy smoker, with no previous history of approaches. In this case, a C7 PSO was performed to correct the severe cervical kyphosis and improve the patient's quality of life.
spine surgery or another known rheumatologic disease.

Physical examination evidenced the inability to move her neck, with limitation of all movements (flexion, extension and lateral bendings). She had no neurological deficits or reflex abnormalities. Plain radiographs of the cervical spine showed a fixed cervical kyphosis, with evident bone fusion in the anterior and posterior elements of her spine. A cervical MRI was performed and no spinal cord compression was visualized (Figure 1A and 1B). She also had an ankylosed lumbar and thoracic spine on plain radiographies.

Due to the patient's poor quality of life, inability to maintain a horizontal gaze while walking and substantial cervical pain led us to decide to perform a cervical pedicle subtraction osteotomy. The C7 level was chosen after we made sure through a CT angiogram that the vertebral artery (VA) was passing anterior to the vertebral foramen, in order to avoid vascular injury.

Due to the inability to extend her neck, bronchial intubation using a fibroscope was performed. Total intravenous anesthesia was used and the patient was prone positioned with a head holder, under neurophysiological monitoring of somatosensory and motor evoked potentials (Figure 2).

After a posterior midline incision and C2-T3 subperiostal exposure, we performed a C2-T3 fusion, with wide C6-7-T1 laminectomies. We used bilateral C2 pars screws, bilateral C3-4-5 lateral mass screws and T1-2-3 pedicle screws. After laminectomies, both lateral masses of C7 were removed with a high speed drill. Then, the nerve roots above (C7 Roots) and below (C8 Roots) C7 pedicles were totally released from their medial to their lateral aspect. The next step was the resection of C7 pedicles bilaterally, using a Leksell rongeur. After total C7 pedicle resection, the posterior part of the vertebral body of C7 was removed using a high-speed drill. The medial aspect of the pedicle was used as a barrier to avoid entering the spinal cord with the drill. The removal of the PLL should be before the posterior corpectomy, which was already mentioned above, using Leksell rongeurs, curettes and Kerrinson punchers in order to achieve total circumferential spinal cord release.

After completion of the osteotomy, an unscrubbed surgeon released the head holder while the scrubbed surgeon extended and distracted the head to the final desired position under continuous assessment of neurophysiological potentials monitoring. The final position was checked using intraoperative fluoroscopy. The rods were then inserted without tension, and the screws were properly tightened after checking that the dura mater was not compressed and the nerve roots were fully freed. The harvesting bone from the laminectomy was used as a graft for posterolateral arthrodesis. Adequate wound closure, with two drains, was performed. Figure 3 shows all the described steps in detail. Figure 4 shows the intraoperative pre and post correction fluoroscopy images and Figure 5 shows the postoperative CT scan and plain radiographs.

The postoperative CT scan showed an important correction of up to 45 degrees, and the patient regained an almost normal horizontal gaze. The patient presented severe cervical pain for five days and left sided radiculopathy, but no other complications. A soft cervical collar was prescribed, as well as narcotics for a short period. Two months after surgery, she complained of a mild pain, reporting as lighter than before surgery, and used analgesics sporadically. The horizontal gaze was reestablished, improving deambulation. In Figure 6, a lateral picture of the patient in standing position before and after surgery documents significant changes in neck position, showing also a decreasing in the chin-brown vertical angle (from 30° to 0).
The patient was positioned prone. Severe cervico-thoracic kyphosis can be clearly noticed.

Figure 2

Figure 3 A. C2 T3 instrumentation. B. After C6-7-T1 laminectomies, removal of C7 both lateral masses and releasing C7 and C8 nerve roots. C. The osteotomy was closed with the extend head after changing the head holder position. D. Final construction with the two rods attached.

Figure 3

Figure 4. A. Intraoperative fluoroscopy before instrumentation (40°). B. Intraoperative radiography after the instrumentation and closure of the osteotomy with the same position of the fluoroscopy (85°). About 45° of correction was obtained.

Figure 4

Figure 5. A,B. Postoperative CT scan with deformity correction and instrumentation. C. Cervico-thoracic lateral radiography. D. Full spine lateral radiography in standing position.

Figure 5

Figure 6. A. Preoperative picture of the patient in standing position showing her inability to have horizontal gaze. The chin-brow vertical angle was about 30° preoperative and B. Postoperative picture in standing position showing a significant correction of her horizontal gaze and neck position and a zero degree chin-brow vertical angle.

Figure 6
**DISCUSSION**

The most common indication for a cervical PSO is a rigid deformity caused by ankylosing spondylitis. Other causes may include degenerative cervical deformity, post-traumatic or post-infections deformity, among others.

Cervical PSO is a powerful surgery for improving cervical lordosis. Deviren et al. reported their results in 11 cases of cervicothoracic pedicle subtraction for cases of rigid cervical kyphosis. The mean PSO improvement was 19 degrees, with significant improvement of visual analog scale score for neck pain (8.1 to 3.9; \( p=0.0021 \)). In our case, a 30° correction of the chin-brow vertical angle was achieved, an objective index for evaluating horizontal gaze in kyphotic deformity secondary to ankylosis of the cervical spine, which can be associated with patient outcome.

Prior to surgery it is of paramount importance to evaluate and minimize risk factors for complications, such as to stop smoking, diabetes control and other medical comorbidities. Patients with rigid cervical deformities have an inability to extend the neck, usually requiring fibroscopy for intubation, which must be planned preoperatively. Neurological complications are high, up to 23%, as reported by Etame et al. The most common neurological complication is nerve root injury when completing the osteotomy, which is transient in the majority of the cases.

Patients with osteoporosis and osteopenia may course with pseudoarthrosis and material failure, requiring revision surgeries. In cases where a large anterior gap is created by the posterior osteotomy, some authors recommend the use of anterior cervical plate in the same procedure in order to avoid instrumentation failure.

Vascular complications may include VA injury, and once some patients may have a VA entering the C7 transverse foramen, it is advisable the assement of VA anatomy of C7. Performing the osteotomy in the upper thoracic level, such as T1, is an alternative of C7 PSO. Even though thoracic osteotomies may have fewer complications, they have a lower power of correction compared to the cervical osteotomies.

Finally, it is important to mention that cervical deformity is affected by global spinal alignment, which is strongly correlated with health-related quality-of-life measures. Spine surgeons must consider all global spinal alignment in the treatment plan of cervical deformity to improve patient’s final outcome.

**CONCLUSION**

Cervical pedicle subtraction osteotomy is an efficient procedure to treat severe rigid cervical kyphosis, especially those secondary to ankylosing spondylitis. Assessment of potential risk factors of surgical failure can minimize complications and improve patient’s outcome. Spine surgeons must consider this procedure in the armamentarium of cervical deformity surgery.

**REFERENCES**


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