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Case Report

Anterior transarticular screw fixation for atlantoaxial arthrodesis: A report of two cases

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Abstract

The sequelae of atlantoaxial instability (AAI) range from axial neck pain to life-threatening neurologic injury. Instrumentation and fusion of the C1-2 joint is often indicated in the setting of clinical or biomechanical instability. This is the first clinical report of anterior Smith-Robinson C1-2 transarticular screw (TAS) fixation for AAI. The first patient presented with ischemic brain tissue secondary to post-traumatic C1-2 segment instability from a MVC 7 years prior to presentation. The second patient presented with a 3 year history of persistent right-sided neck and upper scalp pain. Both were treated with transarticular C1-2 fusion through decortication of the atlantoaxial facet joints and TAS fixation via the anterior Smith-Robinson approach. At 16 months follow-up, the first patient maintained painless range of motion of the cervical spine and denied sensorimotor deficits. The second patient reported 90% improvement in her pre-operative symptoms of neck pain and paresthesia. Anterior Smith-Robinson C1-2 TAS fixation provides a useful alternative to the posterior Goel and Magerl techniques for C1-2 stabilization and fusion.

Key words: Anterior approach, atlantoaxial instability, C1-C2 fixation, transarticular screw fixation

INTRODUCTION

The clinical sequelae of atlantoaxial instability (AAI) range from axial neck pain to life-threatening neurologic injury.[1] AAI may be associated with an anterior atlantodental distance of greater than 3 mm in adults and 5 mm in children due to laxity or incompetence of the transverse atlantal ligament.[2] Common causes of AAI include trauma, tumor, rheumatoid arthritis, iatrogenic destabilization, infection and congenital anomalies.[3] In addition, in patients who fail conservative treatment for painful atlantoaxial osteoarthritis, surgical fixation has been reported with good clinical outcomes.[4] Instrumentation and fusion of the C1-2 joint is often indicated in the setting of clinical or biomechanical instability.

Early techniques for C1-2 fixation described by Gallie and Brooks and Jenkins utilized laminar wiring with concomitant on lay bone graft.[5,6] Transarticular screw (TAS) fixation later demonstrated superior biomechanical strength[7] and higher rates of fusion.[8] Despite reliable stability and high fusion rates, enthusiasm for TAS has decreased in some reports due to potential risk of vertebral artery injury.[9] Initially described by Goel *et al*. and Goel and Laheri[10,11] and later popularized by Harms and Melcher,[12] C1 lateral mass screw (C1 LMS) and C2 pedicle screw (C2PS) posterior fixation demonstrated biomechanical stability comparable to TAS techniques.[13] A consecutive series of 319 patients reported by Wang *et al*. have reported a low rate of screw misplacement and no clinical manifestation of vascular injury with the C1 LMS-C2PS technique.[14] Certain anatomic variations such as a "high-riding" vertebral artery may preclude safe C2PS placement.[15,16] C2 translaminar screws provides an alternative technique for

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posterior instrumentation,[17] however, limited biomechanical strength of the lamina, previous C2 laminectomy and certain morphologies of the lamina may preclude utilization of this technique as well.[18]

Approach to the anterior cervical spine by the familiar Smith-Robinson approach has a long track record of good clinical outcomes and low associated infection and complication rates.[19,20] An anterior approach to provide rigid fixation of C1-2 allows avoidance of occipital nerve exposure, manipulation and the potential for post-operative C2 neuralgia[12,21] and may also provide another safe technique to the spine surgeons' armamentarium for use in patients with anatomy unfavorable for posterior instrumentation.[9,15,16,22,23] We report the indications, surgical technique, clinical outcomes and radiographic findings of two patients who underwent anterior TAS fixation for AAI and painful atlantoaxial osteoarthritis.

Surgical technique

The patient is positioned supine with the neck in slight extension and the shoulders securely taped to the patient's sides with all appropriate pressure points padded. The open-mouth odontoid view can be enhanced with the aid of a towel or cork in between the patient's teeth and is checked prior to prepping and draping the patient to ensure adequate visualization of the C1-2 articulation. Use of a radiolucent endotracheal tube by the anesthesia team facilitates high-quality intra-operative fluoroscopic visualization of the upper cervical spine. Dental implants may also prohibit optimal intra-operative radiographic visualization and can be assessed pre-operatively.

Routine left-sided Smith-Robinson anterior cervical approach is performed to expose the high anterior cervical spine and blunt peanut dissection is performed cranially along the anterior aspect of the cervical spine to the vertebral body of the axis. A radiolucent retractor is placed on the anterior arch of the atlas [Figure 1a]. A small angled curette can be placed into the C1-2 articulation to decorticate the atlantoaxial joint articular surface and prepare an adequate fusion bed. Iliac crest can be harvested and packed into the articulation with a penfield instrument. A 3.5-mm self-cutting cannulated partially threaded cortical screw is advanced from medial-to-lateral and anterior-to-posterior along threaded Kirschner wires under image intensification [Figure 1b and c].

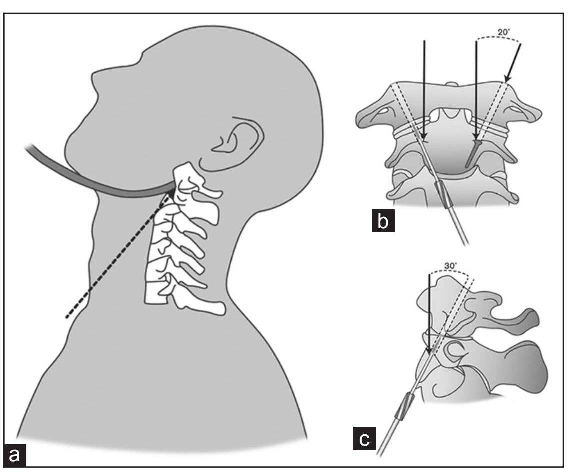

Figure 1: (a) Placement of a radiolucent retractor on the anterior arch of the atlas. (b) Coronal view of threaded Kirschner wire placement. (c) Sagittal view of threaded Kirschner wire placement

CASE REPORTS

Case 1

This is a first case of a 34-year-old male patient presented to the orthopedic out-patient clinic with a diagnosis of chronic AAI secondary to an os odontoideum. On presentation, he complained of neck stiffness and denied numbness or weakness. On examination, the patient was neurologically intact and had full range of motion of the cervical spine in flexion, extension, lateral bending and axial rotation. CT and plain radiographs demonstrated significant displacement in flexion and extension, os odontoideum and instability at C1-2 [Figure 2]. MRI of the brain showed cerebellar infarct, with confirmation on CT angiogram of bilateral vertebral artery occlusions between C2 and C3, collateral reconstitution from the right occipital artery and bridging anastomoses on the left. Significant instability at C1-2 warranted surgical fusion and an anterior approach was selected due to anomalous vascular anatomy, which precluded a safe posterior exposure and fixation by C1 LMS-C2PS.

The patient was treated with anterior transarticular C1-2 instrumentation and fusion as described by Sen *et al.*[24] Post-operative CT scans confirmed acceptable screw placement in the axial [Figure 3a and b], sagittal [Figure 4] and coronal [Figure 5a and b] planes. At 16 months follow-up, the patient maintained painless range of motion of the cervical spine with stable fixation and fusion without sensorimotor deficit.

Case 2

The second case report is about a 68-year-old female patient who presented to the orthopedic out-patient clinic with a 3 years history of persistent right-sided axial neck and occipital

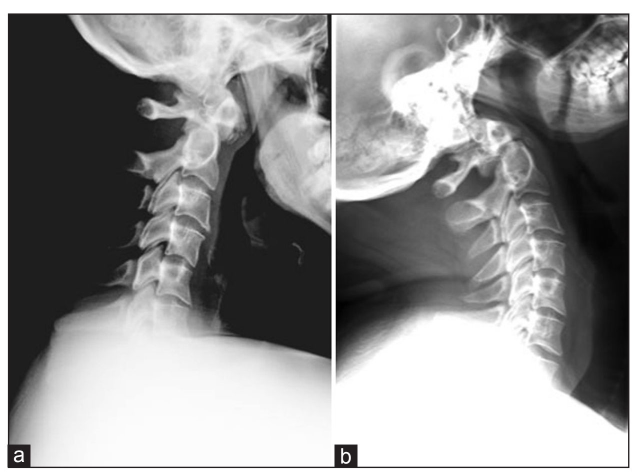

Figure 2: Atlantoaxial instability of os odontoid on flexion/extension and lateral plain radiography (Case 1)

pain. On presentation, she complained of severe pernicious neck pain that radiated to her occiput. On physical examination, she was hypesthetic in a C2 distribution. Objective motor strength was 4/5 in the right deltoid and 3/5 in the right shoulder internal/external rotators, consistent with her previous total shoulder replacement. CT [Figure 6] and plain radiographs of the cervical spine demonstrated coronal deformity, severe right sided facet arthropathy at C1-2 and congenital fusions at C2-3, C3-4 and C4-5. Attempted conservative management included C1-2 facet injections and occipital nerve block, which provided only transient relief. The association of Klippel-Feil syndrome with anomalous vertebral artery anatomy that frequently follows a less predictable course,[25-29] made an anterior approach for C1-2 fusion an appealing surgical option.

The patient was treated with anterior transarticular C1-2 fusion [Figure 7]. At 6 months follow-up, the patient reported 90% improvement in her pre-operative symptoms of neck pain and paresthesia [Figure 8].

DISCUSSION

Variation in osseous or vascular anatomy can impede proper fixation and enhance risk for vascular injury during posterior TAS placement.[9] Findings of narrow C2 isthmus[22] which is seen in 10% of patients, or high-riding transverse foramen seen in up to 20% of patients[23] can each preclude safe C2PS placement. An anomalous course of the vertebral artery has been shown to be a relatively common occurrence,[30] generating additional risk for vascular injury with C1 LMS-C2PS posterior fixation. In Case 1, the presence of bilateral vertebral artery occlusions with collateral reconstitution through an occipital vessel makes the posterior approach a less desirable surgical option. Case 2 demonstrates that the anterior Smith-Robinson approach may be an attractive alternative in patients suffering from painful atlantoaxial osteoarthritis. Additional benefits of this technique include a lower risk of post-operative infection by avoiding posterior approaches to the cervical spine[20]

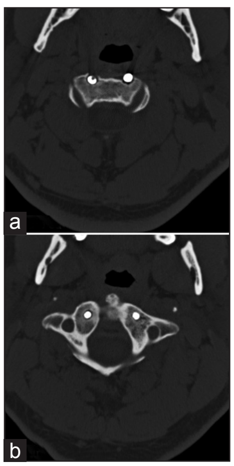

Figure 3: (a) Post-operative axial computed tomography (CT) demonstrating anterior atlantoaxial screw position in the axis. (b) Post-operative axial CT showing tip of screw in atlas

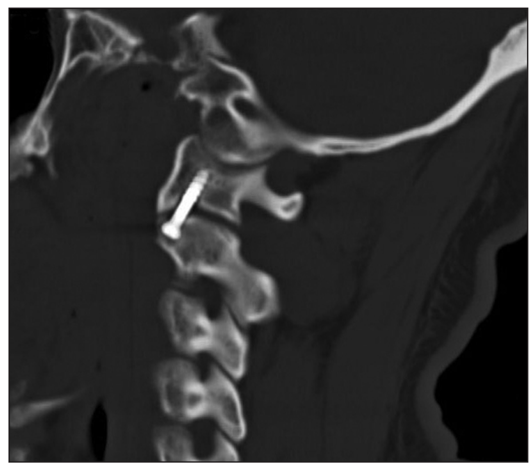

Figure 4: Post-operative sagittal computed tomography showing anterior atlantoaxial screw position across the C1-C2 articulation

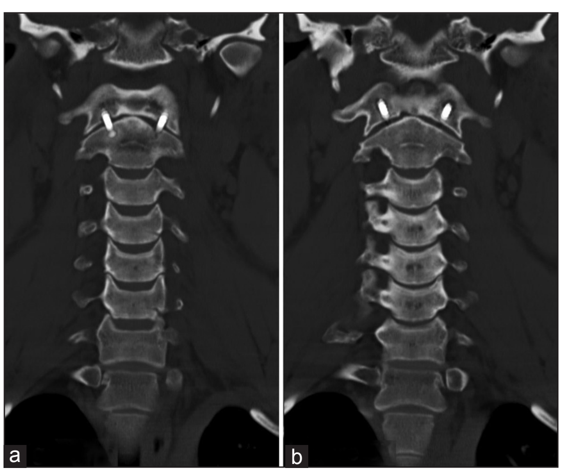

Figure 5: (a) Post-operative coronal computed tomography (CT) demonstrating screw placement through the axis. (b) Post-operative coronal CT showing screw placement into the atlas

Figure 6: Pre-operative computed tomography reveals Klippel-Feil anomalies-ankylosis at the C3-C4 level, degenerative changes at the C6-C7 level and degenerative arthrosis at the atlanto-dens interval with remodeling of the anterior arch of C1 and close apposition of the tip of the dens with the basion (Case 2)

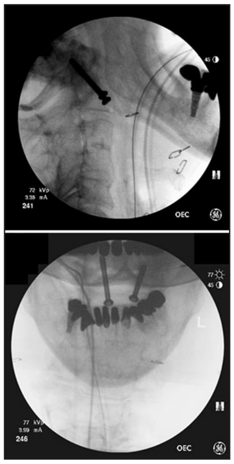

Figure 7: Intra-operative fluoroscopic images during anterior atlantoaxial transarticular screw placement (Case 2)

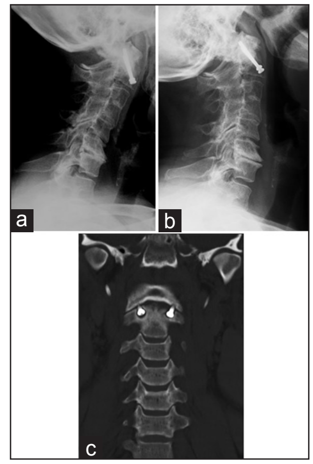

Figure 8: (a) Post-operative lateral flexion view of the cervical spine. (b) Post-operative lateral extension view of the cervical spine. (c) Post-operative coronal view of the cervical spine (Case 2)

and decreased risk of vertebral artery injury during screw insertion.[24] The avoidance of exposure of the C1-C2 joint from the posterior aspect may also decrease occipital neuralgia.[31]

Posterior approaches to C1-2 fusion have been reported well-described;[5,6,12,32] however, it may not be suitable in the setting of revision posterior surgery, anomalous vascular anatomy, hypoplastic bone morphology or deficit. The anterior approach is very familiar to spine surgeons and adds a viable treatment option to rigid atlantoaxial TAS.[33] The current English literature to date includes a technical note,[34] a biomechanical analysis.[24,33] To the best of our knowledge, this is the first clinical report of the anterior Smith-Robinson approach for TAS fixation for AAI or severe spondylotic arthropathy of C1-2. These preliminary reports suggest encouraging early post-operative clinical and radiographic outcomes.

Although limited, our clinical experience with the two patients presented in this report has been encouraging. Anterior TAS fixation is a useful adjunct to the spine surgeon's armamentarium for the treatment of biomechanical and clinical instability of the atlantoaxial complex.

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