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Technical Report

Posterior realignment of irreducible atlantoaxial dislocation with C1–C2 screw and rod system: a technique of direct reduction and fixation

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Abstract

BACKGROUND CONTEXT: Treatment of chronic and irreducible atlantoaxial dislocation (AAD) with ventral compression is challenging for surgeons. The main procedures are occipitocervical/C1–C2 fusion after transoral odontoidectomy or release of the periodontoid tissues. These surgical procedures, which are performed simultaneously or intermittently, have many disadvantages that may discount their effectiveness. Therefore, a more effective way to achieve surgical reduction and to keep solid stability with only a single procedure is needed.

PURPOSE: We describe a technique to reduce chronic and irreducible AAD with C1 lateral mass and C2 pedicle screw and rod system.

STUDY DESIGN: This was a retrospective case series.

PATIENT SAMPLE: Our sample comprised 26 patients (9 men and 17 women) with irreducible AAD who ranged in age from 15 to 54 years (mean, 35 years).

OUTCOME MEASURES: Patients' neurologic status was evaluated with the Japanese Orthopedic Association (JOA) scale.

METHODS: Twenty-six symptomatic patients underwent posterior realignment and reduction through the C1 lateral mass and C2 pedicle screw and rod system. The proposed mechanism of reduction is that the implanted screws and rods between C1 and C2 acting as a lever system drew C1 backward and pushed C2 downward and forward after removing circumambient obstruction and scars and thoroughly releasing the facet joints. The preoperative and postoperative JOA score, the extent of reduction, and the conditions of C1–C2 bony fusion were examined.

RESULTS: No neurovascular injury occurred during surgery. Follow-up ranged from 6 to 40 months (mean 20.7 months). Radiographic evaluation showed that solid bony fusion was achieved in all patients, and that complete reduction was attained in 18 patients and partial reduction (>60% reduction) in 8 patients. The mean postoperative JOA score at last follow-up was 15.7, compared with the preoperative score of 12.1 ($p<.01$).

CONCLUSIONS: This C1–C2 screw and rod system provides reliable stability and sufficient reduction of the anatomic malalignment at the craniovertebral junction and meanwhile retains the mobility of atlanto-occipital joints in the treatment of chronic and irreducible AAD. Sophisticated skills, thorough release of the facet joints, and intraoperative protection of the vertebral artery are key points to accomplish this technique.

Keywords: Atlantoaxial dislocation; Craniovertebral junction; Irreducible; Realignment; Reduction

FDA device/drug status: Not applicable.

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IRB approval/Research Ethics Committee: All aspects of this study were approved by our institutional review board and the informed consent was obtained from study participants.

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Introduction

Numerous pathologies involving the craniovertebral junction (CVJ) often lead to atlantoaxial dislocation (AAD). In some special conditions such as congenital or developmental CVJ anomalies, rheumatoid arthritis, old traumatic dens fracture, Down's syndrome, or metabolic diseases, the dislocation at C1–C2 was a dynamic process and usually irreducible and cannot be reduced by cervical traction [1–5]. Treatment of this kind of chronic and irreducible AAD is challenging for surgeons, although improvements in the surgical techniques have brought some encouraging results over the years [2–8]. The main procedures reported in the literature are posterior occipitocervical/C1–C2 fusion after transoral odontoidectomy [9–11] or periodontoid tissue release [5,12–14]. These procedures, which are performed simultaneously or intermittently, have many disadvantages, such as increasing hospitalization costs and length of stay, and may discount their effectiveness.

Recently a few studies involving direct reduction with occiput and C2 fixation were reported [2,4]; nevertheless, occipitocervical fusion sacrifices the motion of both atlanto-occipital and atlantoaxial joints, leading to the rigidity and limitation of cervical spine movement. Therefore, a more effective way to achieve surgical reduction involving fusion of merely one motion segment is needed. In recent years, we used the modified Harms et al. [15] and Goel et al.'s [16,17] technique of atlantoaxial fixation to achieve the direct anatomic reduction in patients of irreducible AAD as a preferred method at our institution. The aim of the present article is to report the early results of application of this method.

Materials and methods

Patient population

From January 2009 to February 2012 at our institution, the symptoms of 26 patients with irreducible AAD had been reduced successfully with insertion of the C1 lateral mass and C2 pedicle screw and rod system. The patients included 17 women and 9 men, ranging in age from 15 years to 54 years (mean 35 years). The most common presenting symptoms were restricted neck movement, muscle weakness of the extremities, and paresthesia (Table 1). The condition was caused by old traumatic dens fracture in two patients, os odontoideum in five patients, neoplasms of the CVJ in two patients, ankylosing spondylitis in one patient, and congenital/developmental anomaly of basilar invagination or occipitalization of the atlas in 16 patients (Table 2). All aspects of this study were approved by our institutional review board, and the informed consent was obtained from study participants.

A thorough preoperative assessment including the radiographic film, thin-slice (0.625~1.0mm) computed tomographic (CT)/CT angiography, and magnetic resonance imaging (MRI) was performed in all patients. Dynamic evaluation (hyperextension and flexion position of the radiographic film/CT/MRI scan) also was performed to check the cervical spine stability and reducibility of AAD unless severe oblongata or spine cord compression existed.

Table 1
Principal presenting clinical features of 26 patients

Symptoms and signs	No. of patients (%)
Short neck	9 (34.6)
Restricted neck movement	18 (69.2)
Occiput/neck pain	14 (53.8)
Quadriparesis	19 (73.1)
Hemiparesis	5 (19.2)
Paresthesia	22 (84.6)
Ataxia	18 (69.2)
Lower cranial nerve dysfunction	12 (46.2)
Dyspnea or sleep apnea	4 (15.4)

Operative technique

Under general anesthesia, the patient was placed in the prone and neutral position with a Mayfield head holder. Through a midline incision, the posterior edge of the foramen magnum, posterior arch of C1/occipitalized C1, and the lamina of C2 were exposed. The C2 isthmus and superior-interior edge of the C2 pedicle were exposed along the subperiosteal plane. Usually, after the local release of atlantoaxial facet joint capsule and removal of scars and osteophytes, the mobility between C1 and C2 could be felt intraoperatively. If not, C2 nerve roots were cut and the facet joints were opened. The cartilage end-plate was curetted and drilled to further increase the mobility. Then bilateral C1 lateral mass and C2 pedicle screws (diameter, 3.5 mm; length, 18–24 mm; Vertex, Medtronic Sofamor Danek, Minneapolis, MN, USA) were implanted as described by Harms et al. [15] and Goel et al. [16,17] To drill part of the infraoccipital margin will help expose the operative field clearly and make the placement of C1 screws safer and less uncomfortable under the circumstance of basilar invagination or occipitalization of atlas. Bilateral titanium rods (diameter, 3.5 mm; Vertex) were then cut to size and contoured in a slight curved shape that drew C1 backward and pushed C2 downward and forward when the screws and rods system was gradually fastened and locked (Fig. 1). The surgical assistant pressed down firmly on the C2 spinous process, which made the reduction process easier and safer. Adjustment of the patient positioning to a slightly extense posture will help the process of reduction. Cancellous or decorticated massive bone from the posterior iliac bone was placed over the decorticated atlantoaxial complex, and the wound was closed in layers. Hard cervical collars were worn by the patients for 3 months.

Radiographic evaluation and follow-up

The postoperative radiographic film, three-dimensional CT, or MRI was performed first at discharge and then at