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Clinical Study

# Self-designed posterior atlas polyaxial lateral mass screw-plate fixation for unstable atlas fracture

Baorong He, MD, Liang Yan, MD, Qinpeng Zhao, MD, Zhen Chang, MD, Dingjun Hao, MD*

*Department of Spine Surgery, Hong Hui Hospital, Xi'an Jiaotong University College of Medicine, Friendship Road 555, Xi'an 710054, China*

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**Abstract**

**BACKGROUND CONTEXT:** Most atlas fractures can be effectively treated nonoperatively with external immobilization unless there is an injury to the transverse atlantal ligament. Surgical stabilization is most commonly achieved using a posterior approach with fixation of C1–C2 or C0–C2, but these treatments usually result in loss of the normal motion of the C1–C2 and C0–C1 joints.

**PURPOSE:** To clinically validate feasibility, safety, and value of open reduction and fixation using an atlas polyaxial lateral mass screw-plate construct in unstable atlas fractures.

**STUDY DESIGN:** Retrospective review of patients who sustained unstable atlas fractures treated with polyaxial lateral mass screw-plate construct.

**PATIENT SAMPLE:** Twenty-two patients with unstable atlas fractures who underwent posterior atlas polyaxial lateral mass screw-plate fixation were analyzed.

**OUTCOME MEASURES:** Visual analog scale, neurologic status, and radiographs for fusion.

**METHODS:** From January 2011 to September 2012, 22 patients with unstable atlas fractures were treated with this technique. Patients' charts and radiographs were reviewed. Bone fusion, internal fixation placement, and integrity of spinal cord and vertebral arteries were assessed via intraoperative and follow-up imaging. Neurologic function, range of motion, and pain levels were assessed clinically on follow-up.

**RESULTS:** All patients were followed up from 12 to 32 months, with an average of 22.5±18.0 months. A total of 22 plates were placed, and all 44 screws were inserted into the atlas lateral masses. The mean duration of the procedure was 86 minutes, and the average estimated blood loss was 120 mL. Computed tomography scans 9 months after surgery confirmed that fusion was achieved in all cases. There was no screw or plate loosening or breakage in any patient. All patients had well-preserved range of motion. No vascular or neurologic complication was noted, and all patients had a good clinical outcome.

**CONCLUSIONS:** An open reduction and posterior internal fixation with atlas polyaxial lateral mass screw-plate is a safe and effective surgical option in the treatment of unstable atlas fractures. This technique can provide immediate reduction and preserve C1–C2 motion. 

*Keywords:* Posterior approach; Atlas fractures; Open reduction; Internal fixation; Unstable fracture; Transverse atlantal ligament

## Introduction

Acute fractures of the atlas represent 1% to 2% of spinal column fractures and account for 2% to 13% of all acute cervical spine fractures [1–3]. First reported by Cooper in 1822 [2], the subsequent historical publication of Jefferson et al. [4] in 1920, and later reports by Segal et al. [5] and Sherk and Nicholson [3] have resulted in the use of the term ''Jefferson fracture'' to indicate a burst fracture injury of the atlas ring. Atlas fractures have historically been categorized as stable or unstable injuries, based primarily on the structural integrity of the transverse atlantal ligament (TAL). The unstable atlas fracture is an atlas burst fracture with concomitant injury of TAL [6,7]. Whether an unstable atlas fracture should be treated

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* Corresponding author. Department of Spine Surgery, Hong Hui Hospital, Xi'an Jiaotong University College of Medicine, Friendship Road 555, Xi'an 710054, China. Tel.: (86) 29-87806269; fax: (86) 29-87800002.

*E-mail address*: haodingjunspine@sina.com (D. Hao)

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surgically or nonsurgically is controversial. Nonsurgical treatment of displaced atlas burst fractures confers high rates of nonunion, and neurologic sequelae can arise because of cranial settling at C0–C2. Hence, C1–C2 or occiput-to-C2 fusion has been increasingly popular for treatment of unstable atlas fractures, but normal motion, such as C1–C2 rotation and C0–C1 flexion/extension, is sacrificed [8–10].

We present in this report a retrospective analysis of 22 cases of open reduction and fixation using an atlas polyaxial lateral mass screw-plate construct in unstable atlas fractures. To our knowledge, this present study is the first to report about the atlas polyaxial lateral mass screw-plate construct and represents the largest case series for the unstable atlas fractures.

EVIDENCE & METHODS

**Context**
Surgical intervention in the setting of an atlas fracture often involves substantial loss of cervical motion postoperatively. The authors present their results using a polyaxial screw plate, intended to preserve cervical range of motion.

**Contribution**
The authors report on a series of 22 patients treated for atlas fractures using the polyaxial screw plate technique. Average follow-up for patients approximated 2 years postoperatively. Satisfactory results are reported along with ''well-preserved'' cervical range of motion.

**Implications**
This is a small, retrospective series conducted by the inventors of the polyaxial screw plate. As a result, it is subject to confounding by selection, measurement and possibly information bias. The results of this level IV study can be viewed as a ''proof of concept'' only. More scientifically robust, independent, analyses are certainly required before surgeons could accept the advertised efficacy of the polyaxial screw plate technique.

*—The Editors*

## Materials and methods

Throughout January 2011 to September 2012, 30 patients with atlas fracture were admitted, accounting for 6.1% of all cervical fractures of the same period. Routine preoperative anteroposterior and lateral radiographs and computed tomography (CT) were collected in each case. Then, all patients underwent magnetic resonance imaging (MRI) before surgery to study the ligament elements of the craniovertebral junction, thus assessing the stability. Particular attention was paid to check for the integrity of TAL. Of the 30 cases of atlas fracture, 22 cases with rupture of TAL were classified as unstable atlas fractures. They included 16 male and 6 female patients ranging in age from 23 to 68 years with a mean of 43.5 years. The atlas posterior screw-plate fixation was performed in each case. The atlas lesions were because of a fall in 12 cases and motor vehicle accidents in 10. All patients were awake, alert, and cooperative and presented neck stiffness and pain without neurologic deficits. Thirteen cases had failed to unite with primary conservative treatment for 3 to 6 months because of nonunion in eight cases and instability in five (occiputocervicothoracic cast in seven cases and hard collar in six). This study was approved by the institutional review boards, and written informed consent was obtained from each patient.

Skull traction was performed in each case for 2 weeks, with a weight of 3 kg and appropriate angle according to the individual mechanism of injury. The patients were positioned prone in a Mayfield head holder. The head was placed in the military neck position. A standard posterior midline skin incision was made to expose the posterior structure of the upper cervical spine, including C1 posterior arch to the upper edge of the C3 lamina, and laterally to the external edge of the articular process. Bilateral polyaxial screws were placed into the lateral mass of atlas using the technique initially described by Goel and Laheri [11] and popularized by Harms and Melcher [12]. After placement of the screws, the polyaxial screw nuts were locked so as to allow lateral to medial compression of the whole atlas ring via the screw without toggling of the screw nuts. A titanium plate was molded into a bowed contour to assist with reduction and placed transversely between the two atlas screws. Lateral compression was achieved between the two atlas lateral mass screws before final tightening of the construct with the goal of achieving symmetrical compression of the fracture both anteriorly and posteriorly and of preventing future lateral displacement of the lateral mass (Figure). Osteosynthesis of atlas was performed with atlas polyaxial lateral mass screw-plate. This product was designed by our team and produced by Wego Company in Shandong province of China. The acceptable fracture reduction and the position of the plating were verified by open-mouth posteroanterior C-arm fluoroscopic views.

The patients were mobilized the first postoperative day. Postoperative external immobilization via hard collar was used for 6 weeks. Routine antibiotic therapy was instituted after surgery for 3 days. A postoperative CT scan was performed within 3 days to assess the position of the C1 screw-plate and the reduction of the fracture. Patients were followed up at 6 weeks and 3, 12, and 24 months after surgery, with assessment of neck pain on a visual analog scale (VAS), neurologic status, and with anteroposterior and lateral radiographs. Computed tomography scans with sagittal and coronal reconstructions were performed 6 months postsurgery to evaluate the fusion.