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Original Article

New technique for C1-C2 fixation

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Abstract

Background: There are several techniques for treating atlantoaxial instability, including the Magerl transarticular screw fixation and the Harms/Goel C1-C2 screw rod techniques. Here, we present a novel technique utilizing a polyaxial screw rod system and a combination of C1 lateral mass and C1-C2 transarticular screws.

Methods: We retrospectively reviewed 14 patients (7 women, 7 men; mean age 62) who underwent surgery for type II odontoid fractures ($n = 7$), pseudarthrosis after anterior odontoid screw placement ($n = 3$), Os odontoideum ($n = 2$), atlantoaxial instability after C3-C5 fusion ($n = 1$), and craniovertebral rheumatoid arthritis ($n = 1$). Ten patients underwent posterior C1-C2 fixation, three patients with osteoporosis had C1-C4 fixation, and one patient had C1-Th1 fixation. The mean follow-up time was 22 months.

Results: Intraoperatively, there were no complications (e.g., vertebral artery, nerve root, or spinal cord injury). Postoperative imaging showed no screw malpositioning, and no screw loosening, fracture, or bone absorption around the screws. Furthermore, all patients exhibited postoperative improvement in neck pain.

Conclusions: C1 lateral mass and C1-C2 transarticular polyaxial screw rod fixation techniques were effective in achieving immediate rigid immobilization of the C1-C2 motion segment.

Key Words: Atlantoaxial instability, C1-C2 Fixation, craniocervical junction, odontoid fracture, os odontoideum

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INTRODUCTION

Several techniques treat atlantoaxial instability, ranging from external immobilization to surgery (e.g., Magerl transarticular screw fixation and the Harms/Goel C1-C2 rod technique).[2-4] Here, we present a novel technique for posterior atlantoaxial fixation that uses a polyaxial screw rod system and utilizes both C1 lateral mass and C1-C2 transarticular screws [Figures 1 and 2].

MATERIALS AND METHODS

Patients

We reviewed the records of 14 patients averaging 62 years of age who underwent atlantoaxial fixation using both C1 lateral mass screws and C1-C2 transarticular screws (2012–2017). All patients had preoperative thin-sliced computerized tomography (CT) scan and/or CT-angiography to confirm the course of the vertebral artery and to detect any anomalies.

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Surgical technique

After the routine midline approach, the inferior facet of C2 was docked, and drilling was performed through the C1-C2 facet joint to the level of the anterior arch of C1 under fluoroscopy, within the lateral mass of C1. A polyaxial screw, typically 40 mm in length, was placed. Next, the dorsal arch of C1 was exposed laterally. The C2 nerve root was identified and mobilized inferiorly. The lateral part of the C1 arch, which overlies the lateral mass below the sulcus arteriosus, was drilled until the lateral mass was exposed. After drilling at the decorticated C1 lateral mass and under fluoroscopy, a polyaxial screw was inserted. Then, the polyaxial screws were fixed with rods. Bone graft was placed in the interlaminar space or laterally in the facet joint.

RESULTS

The patient's clinical and treatment data are presented in Table 1. There were no major complications (e.g., vertebral artery or spinal cord injury). One patient had superficial wound infection and a persistent dural tear caused by spinal decompression. X-ray and/or CT performed postoperatively confirmed no instance of incorrect screw position [Figure 3a and b]. Patients were followed an average of 22 postoperative months (range 3–72 months). Postoperative studies documented no screw loosening, screw fractures, or bone absorption around the screws. Furthermore, all patients clinically improved cases.

Table 1: Characteristics of the patients

Characteristics	Number (*N*)
Sex	
Women	7
Men	7
Age (years)	62 (range, 20-86)
Indication for surgery	
Odontoid fracture	7
Screw loosening after odontoid screw placement	3
Os odontoideum	2
AAI rheumatoid arthritis	1
Other	1
Levels	
C1-C2	10
C1-C4	3
C1-C7	1
Surgical and postoperative complications	
Vertebral artery injury	0
Superficial infection	1
Screw malposition	0
Screw loosening	0
Follow-up time (months)	22 (range, 3-72)

DISCUSSION

We were able to demonstrate that the combination of C1 lateral mass screws with C1-C2 transarticular screws is a safe and solid technique for posterior atlantoaxial fixation

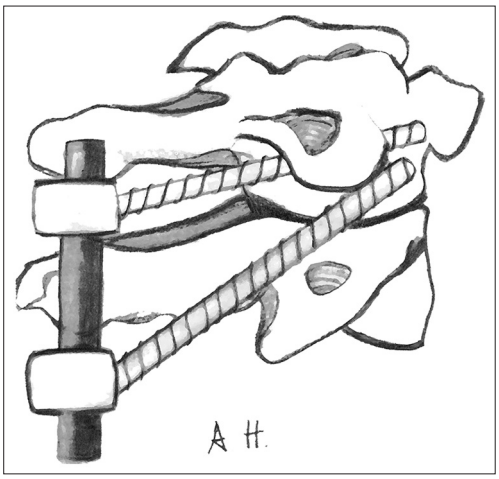

Figure 1: Schematic drawing showing posterior atlantoaxial fixation with combination of C1 lateral mass and C1-C2 transarticular screws using a polyaxial screw rod system

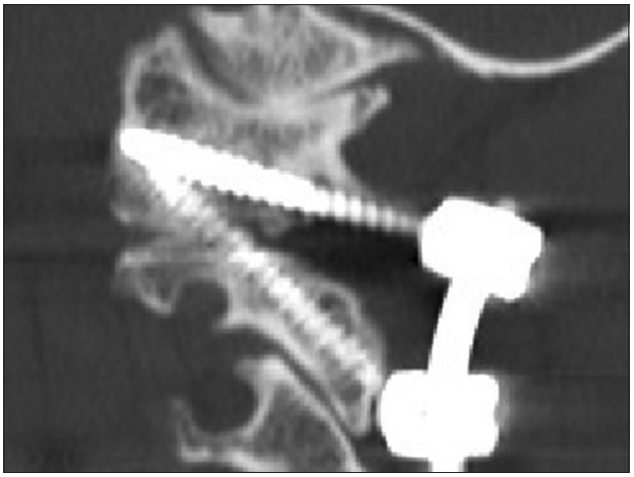

Figure 2: Postoperative sagittal CT-reconstructed view after atlantoaxial fixation with combination of C1 lateral mass and C1-C2 transarticular screws

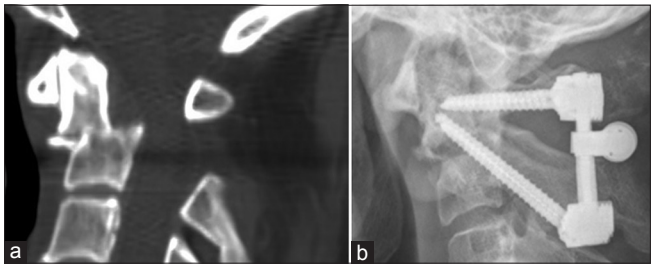

Figure 3: (a) Preoperative sagittal CT-reconstructed view of a patient with dislocated odontoid fracture (Patient 1). (b) Postoperative lateral X-ray after complete reposition and posterior atlantoaxial fixation with combination of C1 lateral mass screws and C1-C2 transarticular screws (Patient 1)

based on well-established posterior atlantoaxial fixation techniques.

The C1-C2 motion segment has the widest range of movement of any spinal motion segment. This range of motion even increases if components of the C1-C2 motion segment are damaged by trauma, inflammation, neoplasm, or congenital defects. Therefore, atlantoaxial immobilization by instrumentation is challenging.[5] Posterior wiring techniques and interlaminar clamps are nowadays completely replaced by rigid screw fixations of the atlas and axis (e.g., techniques of Magerl[4] and Harms[3]/Goel[2]).

The C1 lateral mass screw with C1-C2 transarticular screw is a novel posterior atlantoaxial fixation technique for atlantoaxial instability and is based on established posterior atlantoaxial fixation techniques.[2-4] Therefore, it has the advantages and strengths of both techniques.[1] This technique can be useful in cases when the C1 posterior arch is fractured or a C1 laminectomy is required. Additionally, it can be applied in a multilevel construct. The main limitation of the C1-C2 transarticular fixation technique relates to anatomic variations of the vertebral artery that occur in up to 20% of patients.[4,6] In cases where anatomic variations of the vertebral artery occur on one side, C1 lateral mass screws can be combined with either a pedicle or pars screw on the ipsilateral side and a transarticular screw on the contralateral side.

CONCLUSION

We conclude that C1 lateral mass and C1-C2 transarticular polyaxial screw rod fixation is a novel and effective surgical technique to achieve immediate rigid immobilization of the C1-C2 motion segment.

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Conflicts of interest
There are no conflicts of interest.

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