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Surgical Treatment of Traumatic Type II Odontoid Fracture Using Polyaxial C1 Lateral Mass and C2 Pedicle Screws Fixation

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ABSTRACT

Background Data: Posterior atlantoaxial fixation is indicated for C1-C2 instability or painful osteoarthritis. Different techniques were designed for atlantoaxial fixation as sublaminar wiring, transarticular screw fixation, and, recently, C1 lateral mass and C2 pedicle polyaxial screws and rod system.

Purpose: To investigate the safety, advantages, and complications of posterior atlantoaxial fixation with polyaxial C1 lateral mass and C2 pedicle screws in C1-C2 instability.

Study Design: A retrospective clinical case series.

Patients and Methods: Fourteen consecutive patients, ten males and four females, with a mean age of 40.8±9.6 years were reported. All had traumatic C1-2 instability due to type II odontoid fractures and underwent posterior fixation with polyaxial C1 lateral mass and C2 pedicle screws. Nine patients suffered from motor vehicle accident (MVA) and 5 suffered from falls. All patients were neurologically intact except four patients who had neurological deficits. We used Japanese Orthopedic Association Score (JOA) for their functional evaluation. The average follow-up was 17±1.96 (range, 12–20 months). Operative time, operative blood loss, screw trajectory, screw length, and injury of neurovascular structures were reported. Fusion and construct stability were evaluated by plain radiography and/or CT. Visual Analogue Scale (VAS) of neck pain and JOA were used to evaluate the functional outcome.

Results: The mean duration of surgery was 175.3±12.3 min. The mean blood loss was 553.6±106.5 ml and two patients required transfusion of one unit of blood. The mean length of C1 lateral mass and C2 pedicle screws were 30±1.6 mm and 16.4±1.8 mm, respectively. Correct screw placement and good stability were reported in all patients (100%) at the last follow-up. Mean neck pain on VAS was 2.8±0.8 and 2.3±0.5 at 6 and 12 months, respectively. The complications included moderate pain at iliac graft site for 3 months in 2 patients, pain and dysesthesia in C2 dermatome for 4 months in 3 patients, and superficial wound infection in 2 patients.

Conclusion: Posterior atlantoaxial fixation with polyaxial C1 lateral mass and C2 pedicle screws is a safe and effective method in the treatment of traumatic atlantoaxial subluxation due to type II odontoid fractures. (2019ESJ176)

Keywords: Atlantoaxial, spinal trauma, spinal fusion, instability, dens fracture.

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INTRODUCTION

The atlantoaxial joint is a complex articulation between the C1 and C2 vertebrae. The anatomical features of this joint allow for high levels of movement under normal physiological conditions, especially in rotation which makes this joint very unstable. So, external or nonrigid surgical immobilization is complicated by a failure rate more than that in subaxial cervical spine.[7,24,22,25]

Different pathological conditions can cause atlantoaxial instability and are classified into either traumatic or nontraumatic causes. The traumatic causes include odontoid fracture and ligamentous injury. The nontraumatic causes include rheumatoid arthritis, congenital anomalies, infection, and malignancy.[6,13,22,30]

Clinical manifestations of atlantoaxial instability include pain, progressive myelopathy, neurological motor or sensory deficit, and even death. Many traumatic injuries of C1-2 that are relatively stable can be treated with a rigid cervical neck collar or a halo-vest; however, the transverse ligament, which is the main support to C1–2 articulation, does not heal once injured. Furthermore, type II odontoid fractures that are common have a high nonfusion rate and can be complicated by atlantoaxial instability. These types of injury require surgical stabilization.[3]

The development of surgical techniques by using rigid screw fixation systems improves the fusion rates without using rigid external immobilization in the treatment of atlantoaxial instability. The surgical approaches for atlantoaxial stabilization can be classified into posterior and anterior procedures.[10,13] The posterior transarticular screw technique for C1-C2 fixation and fusion, described by Magerl in 1986, achieved high fusion rates and became popular. In this technique, the straight screw trajectory in the sagittal plane increases the risk of vertebral artery injury and up to 20% of patients cannot have safe insertion of bilateral transarticular screws in the event of medially located vertebral artery.[1,27,28] Harms and Melcher[13] introduced a modification of Goel and Laheri's technique[9,10] for atlantoaxial fusion using C1 lateral mass screws and C2 pedicle screws and rods system. This method was to decrease the risk of vertebral artery injury and may be performed in the situation of a medially located vertebral artery.[14]

We reported that our results in surgical management of 14 consecutive patients had traumatic atlantoaxial instability due to type II odontoid fractures with atlantoaxial subluxation using polyaxial C1 lateral mass screws and C2 pedicle screws to do posterior atlantoaxial fixation.

MATERIAL AND METHODS

This study included fourteen consecutive patients, ten males and four females. Patients' data were retrospectively collected from patients' files, while patients with missing data were excluded from the study. Patients' data, diagnosis, and treatment outcomes are confidentially kept private and patients are presented by specific codes. Patients' ages ranged between 25 and 55 years with a mean age of 40.8±9.6 years. All patients had traumatic atlantoaxial subluxation due to type II odontoid fracture. Nine patients suffered from high speed motor vehicle accident (MVA) and 5 patients suffered from falls. All patients were admitted to and operated upon at the Department of Neurosurgery, Tanta University Hospitals, from October 2014 to October 2017. (Table 1)

All patients were evaluated and subjected to clinical history, general and neurological examination, and routine laboratory investigations. Severe mechanical upper cervical neck pain was the presenting symptom in all patients, where Visual Analogue Score (VAS) was used to quantify degree of pain in every patient preoperatively. We used Japanese Orthopedic Association Score (JOA) for their functional evaluation. All patients were neurologically intact except four patients who had neurological deficits.

All patients were preoperatively radiologically evaluated with plain X-ray cervical spine in lateral, anteroposterior, open mouth view and lateral views in flexion and extension, multislice cervical spine computed tomography (CT) with sagittal and coronal reconstruction, and Magnetic Resonance Imaging (MRI). Written consent was obtained from all patients before surgery.

We evaluated intraoperative bleeding. Intraoperatively we monitored injury of the neural tissue and the vertebral artery. Operative time was recorded (retrieved from operative records). Purchase and length of screws were evaluated by postoperative CT done in the third day after surgery. Monitoring of postoperative complications was focused on delayed healing of the wound, breaking or loosening of screws, and development of malunion. Clinical outcome of neck pain and functional recovery was evaluated by VAS and JOA score at 3, 6, and 12 months postoperatively. Fusion of C1–C2 segment was evaluated by means of radiographs taken at 3, 6, and 12 months and CT taken at 6 months. Patients were followed up to a period ranging from 12 to 20 months with a mean of 17±1.96 months.

Operative Technique:

A wake fiberoptic intubation was used in all patients to avoid hyperextension-related spinal cord injury. Mean arterial blood pressure was maintained adequately high (i.e., > 85 mmHg) during the whole procedure. Patients were operated upon in prone position with head secured in Mayfield 3-pin head-holder. The head is placed in the military tuck position. Longitudinal skin incision (10 cm) extended from below the inion to the spinous process of C3.

The posterior elements of C1 and C2 between C2/3 articular line and caudal rim of the foramen magnum were exposed with subperiosteal dissection. Harms [13] technique was used for C1-2 fusion with a screw/rod system, by using C1 lateral mass screws and C2 pedicle screws. When inserting the C1 lateral mass screw, blunt dissection is performed along the inferior aspect of the posterior arch of C1 down to the lateral mass. While doing so, the C2 nerve root retracted caudally, while taking caution not to injure the venous plexus around the nerve, which can lead to profuse bleeding that can be controlled by Gelfoam and packing. The medial and lateral borders of C1 lateral mass were identified by Penfield dissector. A 2 mm burr was used to create a starting point for the screw at the middle of the lateral mass aiming directly to the anterior arch of C1 on the lateral fluoroscopic view. In the medial-lateral direction, the drill should be oriented directly straight anterior or angulated slightly medial. The drill hole is then tapped and a suitable screw size is inserted.

Penfield dissector was used to feel the rounded, medial border of the C2 isthmus. The starting point for C2 pedicle screw is 3 mm superior and lateral to the medial aspect of C2/C3 facet joint. The medial border of the C2 isthmus should be used as a guide during drilling and screw placement. The drill should be directed cephalad 35–45 degrees and medially 10–15 degrees. After drilling, the hole is tapped and a 3.5 mm fully threaded polyaxial screw of appropriate length is placed (Figure 1). Appropriate rod contoured in a slight degree of lordosis was used in order to achieve good reduction. The caudal rim of the posterior arch of C1, the cranial edge of the C2 lamina, and spinous process were decorticated. A monocortical bone graft from the posterior iliac crest is notched to fit in the decorticated bones.

The wound is closed in a standard fashion over a suction drain. Postoperatively, the patients are immobilized in a rigid neck collar, for a period of 6–8 weeks. Early ambulation was encouraged to prevent deep venous thrombosis and facilitate rehabilitation.

RESULTS

The estimated blood loss was 553.6±106.5ml (range, 450–800), and two patients required one unit of blood transfusion. The duration of surgery was 175.3±12.3 min (range, 150–195). The mean length of C1 lateral mass and C2 pedicle screws was 30±1.6 mm (range, 28–32) and 16.4±1.8 mm (range, 14–18), respectively. The length of stay from admission to hospital discharge was 9.4±3.2 days (range, 5–17) and means postoperative length of hospital stay was 6.1±2.4 days (range, 4–12). Neck pain was the main presenting symptom in all patients and was 8.1±0.8 (range, 7–9). Postoperatively, the mean neck pain on the VAS was 5.6±0.7, 2.8±0.8, and 2.3±0.5 at 3, 6, and 12 months, respectively. Four of 14 patients required irregular courses of analgesics. Quadriparesis was reported in 4 patients; two patients were grade 1, one patient was grade 2, and one patient was grade 3 according to JOA score. The remaining 10 patients were neurologically intact and remained the same after surgery. The four patients with quadriparesis showed neurological improvement according to JOA score. One patient became normal, and three patients became grade 1 at the 12-month follow-up (Tables 1 and 2).

There were no vascular or neurological injuries. Two patients had pain at the site of bone graft (posterior iliac crest) for about 3 months, which was classified as moderate according to Numerical Rating Pain Scale that is a segmented numeric version of the visual analogue scale; its pain scale is like VAS but more rapid and easy for our patients. Two patients had superficial wound infection. Three patients had postoperative occipital pain and dysesthesias from caudal retraction on C2 ganglion, but all patients showed marked improvement with medical treatment after 4 months (Table 1).

On the postoperative CT scan, correct screws position of the C1 lateral mass was reported in all 28 screws. 25 screws were bicortical and 3 screws were monocortical, and no screw perforated the anterior cortex more than 3 mm. Adequate C2 pedicle screws insertion was observed in all 28 screws, but two screws perforated the vertebral artery canal (< 1mm) without any complication.

Plain X-rays done after 12 months of follow-up showed good stability and alignment without any change in screw position or loss of reduction in all patients. Generally, no system failures were reported in any patient. As fusion evaluation is difficult due to the metallic artifacts of titanium implants, construct stability was defined by absence of hardware breakage or displacement. According to these criteria, construct stability was achieved in all 14 patients (100%) at the 6-month follow-up and maintained at subsequent follow-ups.

Table 1. Summary of patient demography and outcome.

Patient	Age	Sex	Neck pain (VAS)			JOA score		Morbidity
			3 mos	6 mos	12 mos	PreOp	PostOp	
1	38	M	6	4	3			C2 pain, dysesthesia
2	45	F	5	3	2	13 (Gr 1)	16 (normal)	
3	39	M	5	2	2			
4	50	M	6	3	2	9 (Gr 2)	13 (Gr 1)	Superficial infection, graft site pain
5	48	M	5	3	2			
6	32	M	5	3	3			
7	44	F	7	4	3			C2 pain, dysesthesia
8	52	F	6	4	3	13 (Gr 1)	15 (Gr 1)	Graft site pain
9	29	M	6	3	2			
10	27	M	7	2	2			
11	40	M	6	2	2			
12	55	F	5	2	2			Superficial infection
13	47	M	5	2	2			C2 pain, dysesthesia
14	25	M	5	2	2	7 (Gr 3)	12 (Gr 1)	

M: male, F: female, mos: months, PreOp: preoperative, PostOp: postoperative, JOA: Japanese Orthopedic Association, and Gr: grade.

Table 2. Summary of perioperative data of study patients (N=14).

Parameters	Mean±SD (range)
Duration of surgery (min)	175.3±12.3 (150–195)
Blood loss (ml)	553.6±106.5 (150–800)
C1 screw length (mm)	30±1.6 (28–32)
C2 screw length (mm)	16.4±1.8 (14–18)
Hospital stay (day)	9.4±3.2 (5–17)
Postoperative stay (day)	6.1±2.4 (4–12)

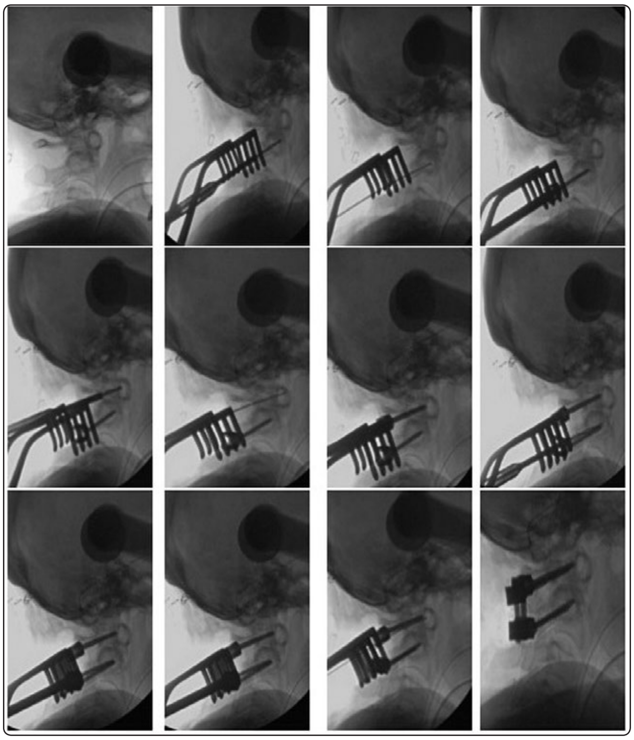

Figure 1. Intraoperative fluoroscopy showing operative steps of screw insertion.

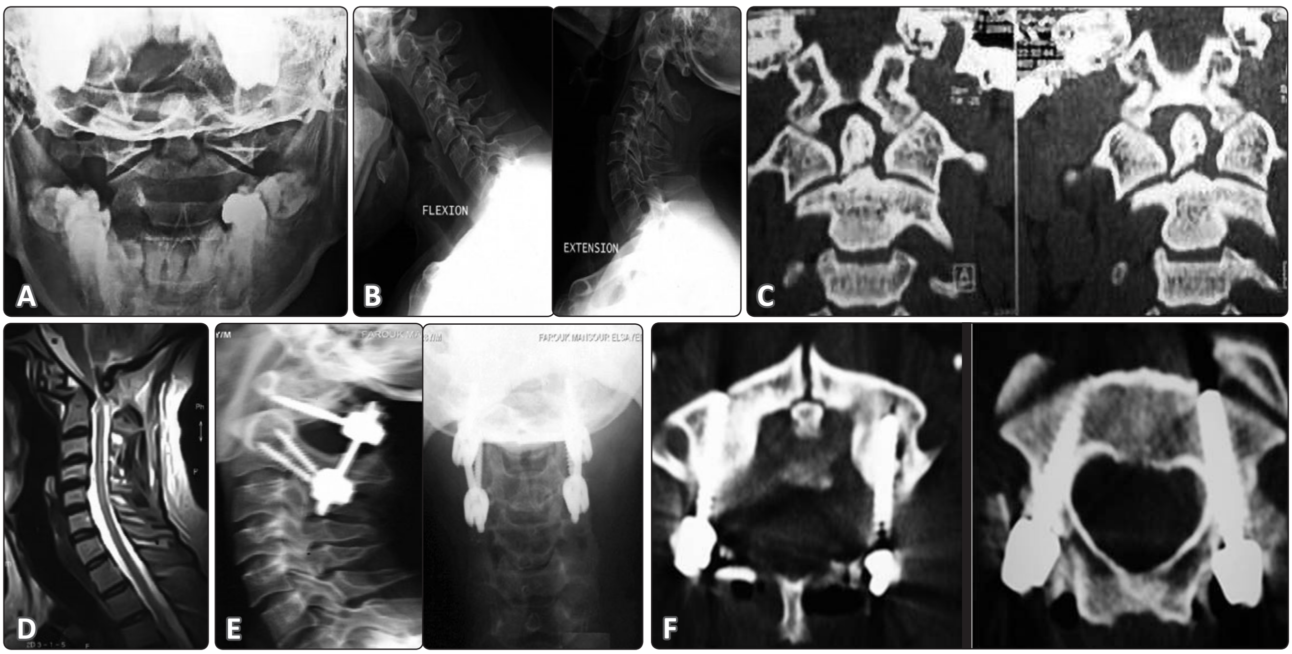

Figure 2. (A) Preoperative X-ray cervical spine open mouth view showing odontoid fracture type II and (B) X-ray flexion and extension films showing atlantoaxial instability. (C) Coronal preoperative CT showing type II odontoid fracture. (D) Preoperative MRI cervical spine sagittal T_2 showing odontoid fracture and atlantoaxial dislocation. (E) Postoperative X-ray cervical spine lateral and A-P views showing reduction and fixation by C1 lateral mass screws and C2 pedicle screw. (F) Postoperative CT scan axial views showing good screws position.

Figure 3. (A) Sagittal and coronal preoperative CT showed type II odontoid fracture. (B) Early postoperative plain X-ray lateral views and A-P showed C1-C2 fixation by screws and rod system. (C) Postoperative MS-CT scan axial, sagittal, and coronal views showing C1-C2 fixation.

DISCUSSION

Type II odontoid fractures are known by their high nonfusion rate. Management of these fracture types is still questionable. Nondisplaced type II odontoid fractures may be treated by halo-vest immobilization. However, it is important that the patient knows the risk of nonfusion, which is up to 50%, and up to half of the patients may need surgical fixation.[16] Also, halo-vest immobilization in elderly patients has been reported to increase morbidity and mortality and is poorly tolerated and provide low outcomes when compared to C1-2 fusion.[16,18] Acute trauma which leads to transverse ligament injury, with an atlantodens distance more than 5 mm, in an adult patient is considered to be unstable and should be surgically fused.

Although anterior fixation with the odontoid screw technique is considered a simple procedure and advantageous because it does not affect atlantoaxial movement, however, its indications are limited and it is contraindicated in multiple situations.[11,26] The posterior approach is the most common approach for C1-C2 fixation and dorsal wiring techniques have increasingly been replaced by screw fixation techniques.[4,11,13,14,23] Posterior wiring for atlantoaxial fixation was first described by Gallie in 1939.[8] Multiple modifications of the technique were subsequently introduced. However, these systems do not control rotation and need postoperative halo-vest immobilization. Also, these techniques need intact posterior elements of atlas and axis.[7,22]

Because of the limitations observed with all dorsal wiring techniques, newer techniques of dorsal atlantoaxial fixation have used rigid screw fixation of the atlas and axis. These rigid screw techniques provide significantly higher rates of fusion, do not require postoperative halo immobilization, and can be done in absence of intact posterior elements, but are technically more demanding, requiring intraoperative fluoroscopy and/or surgical navigation tools.[5,22,24,30]

Magerl and Seeman[20] published the technique of direct transarticular C1-C2 screw fixation in 1986, usually associated with one of the dorsal wiring techniques for bony fusion. This technique provides strong biomechanical stabilization for flexion/extension and rotation.[12,28] The success rate of bony fusion of the Magerl technique ranges within around 86.9–100%.[4,12,15] Because the trajectory of the transarticular screw is straight in the sagittal plane, up to 20% of cases cannot have safe insertion of bilateral screws.[1,19] In a large survey of about 2,500 transarticular screws, injury to the vertebral artery has been reported in 2.2%, causing neurological deficit in 3.7% of injured vertebral arteries.[32] Transarticular screw fixation is often combined with sublaminar wiring to improve the fusion and increase the stability, which also increases the risk of complications.[20] A cadaveric study by Abou-Madawi et al.[1] and Madawi et al.[19] demonstrated that bilateral screws could not be placed in up to 20% of specimens because of anatomic variations in the location of the foramen transversarium that placed the vertebral artery at risk during screw placement.

Goel and Laheri in 1994[10] described a new technique for atlantoaxial fixation by using C1 lateral mass screws and C2 pedicle screws connected with plates. Harms and Melcher, in 2001[13], described a technique for posterior atlantoaxial fixation with polyaxial C1 lateral mass and C2 pars screws, connected with rods. The trajectory of C2 pedicle screw is directed 20–25° medially and thus passes medial to an enlarged or medially located vertebral artery.[6,10,13,22,29,30] Moreover, direct visual control during drilling and insertion of C2 pedicle screw increases the safety over transarticular screw insertion.[10,13]

Many authors[6,9,10,13,29,30] concluded that no clinically significant vertebral artery injury from C2 pars screw placement has been observed. In Stulik et al.[30] three out of 56 C2 pedicle screws (5.4%) perforated the vertebral artery canal without any clinical significance. In the current series, we had two out of 28 (7.1%) C2 pedicle screws which had perforated the vertebral artery canal (<1mm), without any clinical consequence. The main drawback of C2 pedicle screw insertion over C1-2 transarticular screw insertion is the caudal retraction or cutting of the C2 ganglion for C1 screw placement. In three out of 14 patients, we reported pain and/or annoying temporary paresthesia along with the distribution of C2 dermatome that improved after 6 months with medical treatment. We did caudal retraction in all patients to spare the greater occipital nerve. Payer M. et al.[24] and Harms and Melcher[13] also recommended leaving the nerve intact and retracting it caudally. Stulik et al.[30] reported the same results in 28 patients and they saved the greater occipital nerve in all patients.

In 2002, Goel et al.[9] published the results of 160 patients with atlantoaxial instability treated by C1 and C2 screw fixation; in order to gain wide exposure of C1 lateral mass, they sectioned the C2 ganglion sharply and reported no significant clinical symptoms. They stated that patients can tolerate dissection of the nerve quite well and explained this by the fact that patients were so satisfied with total pain relief and functional improvement and they simply ignored the C2 anesthesia.

The internal carotid artery and the hypoglossal nerve pass a few millimeters along the anterior aspect of C1 lateral mass and may be injured from excessive anterior perforation during bicortical C1 lateral mass screw insertion. You can avoid this injury by directing the drill toward the anterior tubercle of C1 on the lateral fluoroscopic image and advancing the drill under fluoroscopic guidance. Caution should be taken in order to not advance the drill beyond the anterior border of the odontoid and not go all the length to the anterior border of C1 on the fluoroscopic images as the vertebral body is curved anteriorly.[24] Correct C1 screw insertion is reported in the series by Harms and Melcher.[13] Stulik et al.[30] and Goel et al.[9] adequate C1 screw insertion within the lateral masses was reported in all screws in the current study, with 25 screws being bicortical and three being monocortical.

Fusion has been reported in the majority of patients managed by posterior atlantoaxial fixation using polyaxial C1 lateral mass screws and C2 pedicle screws.[6,13,29,30,33] We reported the same results in our study as we achieved a good fusion and constructed stability in all 14 patients 6 months after surgery. The same results were encountered by AlQzaz and AbouMadawi who reported fusion in all their patients.[2]

Many studies[17,21,19] have compared the biomechanical characteristics of both transarticular technique and C1 lateral mass C2 pedicle screw technique and concluded that biomechanical stability of both techniques was the same. Both methods have high clinical fusion rates.

The most important issue in all types of C1–C2 fixation with screws is the possible injury of the vertebral artery and the nerve structures. Some authors reported damage of the vertebral artery when using the Magerl technique in 3.7–8.2% of patients.[4,19,31,32] Madawi et al.[19] reported misdirected screws in 14%, vertebral artery injuries in 8%, hardware failure in 4%, temporary hypoglossal nerve paresis in 2%, and iliac crest donor site infection in 2%. The risk of vertebral artery injury with this technique has been well documented in the literature. With the insertion of screws after Harms[13] or Goel[9,10] neither of the two authors has reported any case of vertebral artery or spinal cord injuries. They explained this fact to a better direct visual control of screws insertion as compared to the Magerl technique.[30] It is the same in our study as there were no vertebral artery or spinal cord injuries.

The study limitations are the small number of patients and the short follow-up period. But the clinical and radiological improvements are significant. On the other hand, we used one atlantoaxial fixation technique with all patients. Increasing the patient numbers will improve the accuracy of the results especially in regard to the safety of the described procedure, particularly regarding vertebral artery injuries.

CONCLUSION

Posterior atlantoaxial fixation with individual polyaxial C1 lateral mass screws and C2 pedicle screws is a safe and effective method in the treatment of traumatic C1-2 instability due to type II odontoid fractures.

REFERENCES

1. Abou-Madawi A, Solanki G, Casey AT, Crockard HA: Variation of the groove in the axis vertebra for the vertebral artery. Implications for instrumentation. J Bone Joint Surg Br 79:820-823, 1997
2. AlQzaz M, AbouMadawi A: Safety and Efficacy of Polyaxial Screw-rod System Fixation in Managing Upper Cervical Instability. Egy Spine J 20:5-17, 2016
3. Aryan HE, Newman CB, Nottmeier EW, Acosta FL, Jr., Wang VY, Ames CP: Stabilization of the atlantoaxial complex via C-1 lateral mass and C-2 pedicle screw fixation in a multicenter clinical experience in 102 patients: modification of the Harms and Goel techniques. J Neurosurg Spine 8:222-229, 2008
4. Dickman CA, Sonntag VK: Posterior C1-C2 transarticular screw fixation for atlantoaxial arthrodesis. Neurosurgery 43:275-280; discussion 280-271, 1998
5. Ebraheim N, Rollins JR, Jr., Xu R, Jackson WT: Anatomic consideration of C2 pedicle screw placement. Spine 21:691-695, 1996
6. Fiore AJ, Haid RW, Rodts GE, Subach BR, Mummaneni PV, Riedel CJ, Birch BD: Atlantal lateral mass screws for posterior spinal reconstruction: technical note and case series. Neurosurg Focus 12:E5, 2002
7. Fried LC: Atlanto-axial fracture-dislocations. Failure of posterior C.1 to C.2 fusion. J Bone Joint Surg Br 55:490-496, 1973
8. Gallie W: Fractures and dislocations of the cervical spine. The American J of Surg 46:495-499, 1939
9. Goel A, Desai KI, Muzumdar DP: Atlantoaxial fixation using plate and screw method: a report of 160 treated patients. Neurosurgery 51:1351-1356; discussion 1356-1357, 2002

10. Goel A, Laheri V: Plate and screw fixation for atlanto-axial subluxation. Acta Neurochir 129:47-53, 1994
11. Grauer JN, Shafi B, Hilibrand AS, Harrop JS, Kwon BK, Beiner JM, et al: Proposal of a modified, treatment-oriented classification of odontoid fractures. Spine J 5:123-129, 2005
12. Grob D, Crisco JJ, Panjabi MM, Wang P, Dvorak J: Biomechanical evaluation of four different posterior atlantoaxial fixation techniques. Spine 17:480-490, 1992
13. Harms J, Melcher RP: Posterior C1-C2 fusion with polyaxial screw and rod fixation. Spine 26:2467-2471, 2001
14. Holness RO, Huestis WS, Howes WJ, Langille RA: Posterior stabilization with an interlaminar clamp in cervical injuries: technical note and review of the long term experience with the method. Neurosurgery 14:318-322, 1984
15. Jeanneret B, Magerl F: Primary posterior fusion C1/2 in odontoid fractures: indications, technique, and results of transarticular screw fixation. J Spinal Disord 5:464-475, 1992
16. Kuntz Ct, Mirza SK, Jarell AD, Chapman JR, Shaffrey CI, Newell DW: Type II odontoid fractures in the elderly: early failure of nonsurgical treatment. Neurosurg Focus 8:e7, 2000
17. Kuroki H, Rengachary SS, Goel VK, Holekamp SA, Pitkanen V, Ebraheim NA: Biomechanical comparison of two stabilization techniques of the atlantoaxial joints: transarticular screw fixation versus screw and rod fixation. Neurosurgery 56:151-159; discussion 151-159, 2005
18. Lennarson PJ, Mostafavi H, Traynelis VC, Walters BC: Management of type II dens fractures: a case-control study. Spine 25:1234-1237, 2000
19. Madawi AA, Casey AT, Solanki GA, Tuite G, Veres R, Crockard HA: Radiological and anatomical evaluation of the atlantoaxial transarticular screw fixation technique. J Neurosurg 86:961-968, 1997
20. Magerl F SP: Stable posterior fusion of the atlas and axis by transarticular screw fixation. text book of cervical spine, first ed. Springer, New York, 1986
21. Melcher RP, Puttlitz CM, Kleinstueck FS, Lotz JC, Harms J, Bradford DS: Biomechanical testing of posterior atlantoaxial fixation techniques. Spine 27:2435-2440, 2002
22. Menendez JA, Wright NM: Techniques of posterior C1-C2 stabilization. Neurosurgery 60:S103-111, 2007
23. Mummaneni PV, Haid RW: Atlantaxial fixation: overview of all techniques. Neurology India 53:408-415, 2005
24. Payer M, Luzi M, Tessitore E: Posterior atlanto-axial fixation with polyaxial C1 lateral mass screws and C2 pars screws. Acta Neurochir 151:223-229, 2009
25. Penning L, Wilmink JT: Rotation of the cervical spine. A CT study in normal subjects. Spine 12:732-738, 1987
26. Pisapia JM, Nayak NR, Salinas RD, Macyszyn L, Lee JY, Lucas TH, et al: Navigated odontoid screw placement using the O-arm: technical note and case series. J Neurosurg Spine 26:10-18, 2017
27. Puttlitz CM, Melcher RP, Kleinstueck FS, Harms J, Bradford DS, Lotz JC: Stability analysis of craniovertebral junction fixation techniques. J Bone Joint Surg Am 86-A:561-568, 2004
28. Richter M, Schmidt R, Claes L, Puhl W, Wilke HJ: Posterior atlantoaxial fixation: biomechanical in vitro comparison of six different techniques. Spine 27:1724-1732, 2002
29. Stokes JK, Villavicencio AT, Liu PC, Bray RS, Johnson JP: Posterior atlantoaxial stabilization: new alternative to C1-2 transarticular screws. Neurosurg Focus 12:E6, 2002
30. Stulik J, Vyskocil T, Sebesta P, Kryl J: Atlantoaxial fixation using the polyaxial screw-rod system. Eur Spine J 16:479-484, 2007

31. Tan M, Wang H, Wang Y, Zhang G, Yi P, Li Z, et al: Morphometric evaluation of screw fixation in atlas via posterior arch and lateral mass. Spine 28:888-895, 2003
32. Wright NM, Lauryssen C: Vertebral artery injury in C1-2 transarticular screw fixation: results of a survey of the AANS/CNS section on disorders of the spine and peripheral nerves. American Association of Neurological Surgeons/Congress of Neurological Surgeons. J Neurosurg 88:634-640, 1998
33. Yehya A: The Use of Lateral Mass C1 and Pedicle C2 Screw for Fixation of Post Traumatic Upper cervical Instability: Surgical Technique and Operative Outcome. Egy Spine J 3:11-18, 2012

الملخص العربي

المعالجة الجراحية لكسر النتوء السني من النوع الثاني الناتج عن الاصابات باستخدام مسامير متعددة المحور في الكتلة الجانبية للفقرة العنقية الأولى ومسامير البرزخ للفقرة العنقية الثانية

البيانات الخلفية: يستخدم التثبيت الداخلي الخلفي بين الفقرات العنقيه الاطلسيه و المحوريه لعلاج الانخلاع المفصلي و عدم استقرار بين ذات الفقرات أو التهاب العظام المؤلم. تم تصميم تقنيات مختلفه للتثبيت الداخلي الخلفي بين الفقرات العنقيه الاطلسيه و المحوريه مثل استخدم أسلاك تمر من تحت الرقائق العضميه, استخدام المسمار عبر المفصل بين الفقره العنقيه الأولي و الثانيه, و اخيرا باستخدام مسامير متعددة المحور في الكتله الجانبيه للفقره العنقيه الأولي و مسامير البرزخ للفقره العنقيه الثانيه مع استخدام القضيب.

تصميم الدراسة: سلسلة حالات سريريه اكلينيكيه بأثر رجعي.

الغرض: التحقق من سلامة و مزايا و كذلك الكشف عن المضاعفات الناتجه عن التثبيت الداخلي الخلفي بين الفقرات العنقيه الاطلسيه و المحوريه باستخدام مسامير متعددة المحور في الكتله الجانبيه للفقره العنقيه الأولي و مسامير البرزخ للفقره العنقيه الثانيه.

المرضى والطرق: 14 مريض علي التوالي منهم 10 رجال و 4 نساء و كان متوسط اعمارهم 40.8 سنه. جميع المرضي كانوا يعانوا من انخلاع الفقره الاطلسيه- المحوريه المفصلي الناتج عن الاصابات التي ادت الي كسر من النوع الثاني في عضمة السنيه. متوسط مدة المتابعه كانت 17 شهرا. تم تقييم مدة الجراحه و فقدان الدم اثناء الجراحه كما تم تقييم وضع و اتجاه و طول المسامير بعد الجراحه. كذلك تم تقييم الاتحام العظمي و استقرار الفقرات الناتج عن استقرار وضع المسامير و القضيب بواسطة تصوير الأشعه العاديه أو المقطعيه كل 3 شهور بعد الجراحه. تم استخدام مقياس التماثليه البصريه لتقييم الألم. أيضا تم تقييم اصابة الشريان الفقري و كذلك الأنسجه العصبيه أثناء الجراحه.

النتائج: متوسط مدة الجراحه كانت 175.3±12.3 دقيقه, متوسط فقدان الدم اثناء الجراحه كان 553.6±106.5 ملليتر واحتاج اثنان من المرضي لنقل الدم. متوسط طول مسامير الكتله الجانبيه للفقره العنقيه الاولي كان 30 ±1.6مم و 16.4±1.8 لمسامير البرزخ للفقره العنقيه الثانيه. وضع المسامير كان صحيحا في كل الحالات و تم الوصول لحاله جيده من الالتحام بين الفقرتين بعد الجراحه. متوسط الم الرقبه كان 2.8 ±0.8 بعد 3 شهور و 2.3±0.5 بعد 6 شهور من اجراء الجراحه و ذلك باستخدام مقياس التماثليه البصريه. المضاعفات كانت تتلخص في ألم في عظمة الحوض الحرقفيه و هو مكان أخذ الرقعه العظميه في اثنين من المرضي و استمر هذا الألم لمدة 3 شهور, ألم و خذلان حسي في 3 من المرضي في المنطقه التي تغذي عصبيا من العصب العنقي الثاني و تراوحت مدة الألم من 3 ل 6 شهور, و عدوي سطحيه في الجرح في اثنين من المرضي.

الاستنتاج: التثبيت الداخلي الخلفي بين الفقرات العنقيه الاطلسيه و المحوريه باستخدام مسامير متعددة المحور في الكتله الجانبيه للفقره العنقيه الأولي و مسامير البرزخ للفقره العنقيه الثانيه طريقه أمنه و فعاله في علاج انخلاع الفقره الاطلسيه- المحوريه المفصلي الناتج عن الاصابات التي ادت الي كسر من النوع الثاني في عضمة السنيه.