Cervical pedicle screws fixation treatment the atlantoaxial instability of axis burst fractures

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Research

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Abstract

Background

Although the cervical pedicle screws and rods were used for atlantoaxial instable, the axis fractures still a challenge for spine surgeon.

Objective

This study was to evaluated the clinical outcomes of axis burst fractures had C1C3 pedicles screws fixation treatment.

Methods

From June 2014 to July 2018, 45 patients with axis fractures were enrolled in this study; 23 patients was odontoid underwent C1C2 pedicles screws fixation, and 21 patients was odontoid combine body fractures had C1C3 pedicles screws fixation. The clinical outcomes of pain relief (visual analog scale, VAS), functional disability (neck disability index, NDI) were recorded at baseline and at the final follow-up.

Results

The pain index and NDI were all significantly improved when compared to pretreatment ($P < 0.01$). The VAS and ND were no significant difference between two groups ($P > 0.05$). All patients, suffered from severe mechanical upper cervical neck pain at pre-operative, were pain free post-operation. Pre-operative neurological examination was normal in all patients, and remained the same after surgery. All cases showed normal neurological function at the final follow-up. No vascular or neurological complication was noted. The fracture healing and the bony union of the fixed segments were revealed in all cases on CT views. Implant failure and instability were not seen on lateral flexion/extension radiographs of the cervical spine.

Conclusions

Cervical pedicle screws fixation was effective and safe procedures in the treatment of traumatic spondylolisthesis of axial fractures. The atlantoaxial instable of axis burst fractures can be managed with C1-C3 pedicles screws fixation.

Background

The atlantoaxial complex bears approximately 50% of rotary motion and 12% of flexion and extension movement of the cervical spine.[1–4] The atlantoaxial joint was superior articular processes of C2 articulate with the inferior articular process of C1, which allow for rotation around the dens. Axis (C2) is a unique vertebra in that it serves as the transition from the upper cervical spine to the lower cervical spine. [5, 6] However, the stability of atlantoaxial complex relies solely on the atlantoaxial joint and the

transverse ligament. Then, any injury of structure above may cause atlantoaxial instability, which was common in the odontoid fractures and pedicles fractures of axis, as well as axial body fractures.[7–10]

As an process of axis, odontoid fractures are very common, accounting for 18 to 20% of cervical injuries, of which 65 to 74% are type II fractures of Anderson and D'Alonzo classification. Type II fractures involve the base of the odontoid and do not extend into the C2 body and unstable associated with a nonunion rate of at least 32% with nonoperative treatment.[11–13] Odontoid fractures can causes the atlantoaxial instability, which may cause neck pain and stiffness, activity limitation, and progressive compression of the spinal cord.[14, 4, 15] As another special fractures of axis, Hangman's fractures was the pedicles fractures of C2 which may led to traumatic spondylolisthesis of the axis.[16, 17] Levin and Edwards classified the C2 pedicles fractures into four types, and unstable fractures indicated for surgery.[18–20] Therefore, recovering normal anatomical position within a short period of time and maintaining its stability are needed for the treatment of atlantoaxial instability to prevent further spinal cord injury.

Unlike odontoid fractures and hangman's fractures, axial body fractures are uncommon and have a variety of presentations. Although some axial fractures can be healed with nonoperative management, sequelae of varying degrees of nuchal pain because of malalignment and osteoarthritis of the atlantoaxial joint were common.[10, 19] Then, the current trend is surgical treatment in patients to align and stabilize the upper cervical spine protecting the neural elements. Due to axis specificity in structure and position, the axial body fractures still present a challenge for spinal surgeon. However, there are little paper about it in literature. The purpose of this study was to evaluate the clinical outcomes and efficacy of cervical pedicle screws fixation in the treatment of atlantoaxial instability of axis burst fractures.

Materials And Methods

From June 2014 to July 2018, 56 axis fractures patients with neurologically intact were enrolled in this study. All patients were diagnosed on the basis of clinical symptoms, X-rays of the cervical spine, computer tomography (CT), and magnetic resonance imaging (MRI). All patients were categorized into two groups, 35 patients was odontoid fractures or pedicle fractures were underwent C1C2 pedicles screws fixation (C1C2 group, included 13 men and 8 women with an average age of 38.74 ± 9.65 years), and 21 patients was axis body fractures had C1C3 pedicles screws fixation (C1C3 group, included 9 men and 6 women with an average age of 39.28 ± 7.36 years). The inclusion criteria were odontoid type II and type III fractures, C2 pedicle fractures, odontoid combine hangman fractures or body fractures; the . Exclusion criteria included pathologic conditions of the cervical spine (trauma, tumor, or infection). The injury times were 3.56 ± 1.73 day in C1C2 patients, and 3.14 ± 1.62 days in C1C3 patients. There were no significant difference among three group in age and sex distribution, older and the pain history ($P > 0.05$).

Table 1 General data of patients (Means $\pm$ SD)

Group	Gender		Age (Years)	Herniation levels		Injury times (days)
	Male	Female		TA	Fall	
C1C2 (35)	19	16	38.74 $\pm$ 9.65	14	21	3.56 $\pm$ 1.73
C1C3 (21)	12	9	39.28 $\pm$ 7.36	8	13	3.14 $\pm$ 1.62

Note: TA = Traffic accidents

Surgical procedures

After general anesthesia, patient in the prone position. Based on the nature of the C2 fracture, skull traction was performed and preliminary fracture reduction was achieved by maximal cervical flexion or extension in accordance with the direction of fracture displacement. C1, C2, and C3 pedicle screw insertion was performed through the posterior approach as previously described.[21,22,4] To make sure that the screw and bone were appropriately fixed, X-ray and CT scans were performed. Finally, the wound was rinsed and the incisions closed. Patients were allowed to walk with a soft cervical collar at least four weeks post- operatively.

Critical of clinical outcomes

Before surgery and at the one year follow-up, operation times, blood loss, hospital stays, pain relief (visual analog scale, VAS), functional disability (neck disability index, NDI) were used to evaluate patient function. Furthermore, postoperative radiographs, CT, and MRI scans of the cervical spine were obtained for all patients and bone fusion was used as a means of radiological assessment.

Statistical analysis

All measurements were performed by a single observer and are expressed as means $\pm$ SD. Using the SPSS 17.0 statistics software, classic t-test and chi-square test were performed.

Results

Results

There was no intraoperative death in this series. In ends 47 cases had follow-up at least one year and 9 cases lost, and the follow-up rate was 82.9% (29/35) in C1C2 pedicle screw fixation groups and 85.7% (18/21) in C1C3 pedicle screw fixation groups ($P > 0.05$). The followed time was from 13 to 16 months (average 14 months), and average 13.95 $\pm$ 1.16 months in C1C2 pedicle screw fixation groups and 13.84 $\pm$ 1.13 months in C1C3 pedicle screw fixation groups ($P > 0.05$).

Table 2 Follow up time and operation date of patients (Means $\pm$ SD)

Group	Follow up		Operation time*	Blood loss*	Hospital days*
	Rate	Time (Month)	(Minutes)	(mL)	(Days)
C1C2	82.9% (29/35)	13.95 $\pm$ 1.16	64.37 $\pm$ 19.45	148.75 $\pm$ 32.46	8.24 $\pm$ 2.58
C1C3	85.7% (18/21)	13.84 $\pm$ 1.13	75.28 $\pm$ 25.34	165.23 $\pm$ 36.81	8.57 $\pm$ 2.49

Note: * No Significant difference ($P > 0.05$)

The average operational time, blood loose, and hospital days were showed in table 2. The operation time, blood loose and hospital days were similar between two groups and there were no significant difference ($P > 0.05$). The average operation time, blood loose and hospital days was 64.37 $\pm$ 19.45 minutes, 148.75 $\pm$ 32.46 mL and 8.24 $\pm$ 2.58 days in C1C2 groups; 75.28 $\pm$ 25.34 minutes, 165.23 $\pm$ 36.81 mL and 8.57 $\pm$ 2.49 days in C1C3 pedicle screw fixation groups.

Table 3 Clinical results date of patients (Means $\pm$ SD)

Group	C1C2*		C1C3*	
	Preoperative	Postoperative	Preoperative	Postoperative
VAS	8.72 $\pm$ 1.13	1.29 $\pm$ 0.52	8.69 $\pm$ 1.24	1.27 $\pm$ 0.43
NDI	36.57 $\pm$ 7.83	2.56 $\pm$ 0.27	37.42 $\pm$ 8.61	2.48 $\pm$ 0.34

Note: * No Significant difference ($P > 0.05$)

The pain index and ODI were better all patients (Table 3). The VAS and ODI were significant better than preoperative ($P < 0.01$), and were no significant difference between two groups on the average change of VAS and ODI scores ($P > 0.05$). The VAS and ODI improved from 8.72 $\pm$ 1.13 to 1.29 $\pm$ 0.52 and 36.57 $\pm$ 7.83 to 2.56 $\pm$ 0.27 in C1C2 pedicle screw fixation groups, and from 8.69 $\pm$ 1.24 to 1.27 $\pm$ 0.43 and 37.42 $\pm$ 8.61 to 2.48 $\pm$ 0.34 in C1C3 groups.

All patients, suffered from severe mechanical upper cervical neck pain at pre-operative, were pain free post-operation. Pre-operative neurological examination was normal in all patients, and remained the same after surgery. All cases showed normal neurological function at the final follow-up. No vascular or neurological complication was noted. The fracture healing and the bony union of the fixed segments were revealed in all cases on CT views. Implant failure and instability were not seen on lateral flexion/extension radiographs of the cervical spine.

Discussion

Axis body fracture, as well as odontoid and pedicle fractures, may cause atlantoaxial instability which may cause neck pain and stiffness, activity limitation, and progressive compression of the spinal cord. [23,24] Atlantoaxial instability caused by C2 fractures need surgical reduction and stabilization to limit the anterior displacement of atlas effectively and enhance the atlantoaxial sagittal stability to prevent further spinal cord injury.[25,14] Because of the anatomical peculiarity of the axis and the complexity of injury pathology, clinical management of the axis fractures was hard work for spine surgeon.[15] Among

the treatment of axis fractures, the posterior pedicles screws fixation was preferred for its relative simple exposure with no major vascular and visceral structures. According to the data of this series, cervical pedicles screw fixation was safely performed in all patients, and there were no complications of nerve and vascular injury in this study cases.

The key to the surgical treatment of atlantoaxial instability caused by axis fractures is to reconstruct the axis structures.[20,26,5] The pedicle screw had the advantage not only at the solid fixation for bone fusion, but also at the active manipulation and reduction of atlantoaxial subluxation. C1 screws combined with separate instrumentation of C2 screws allow for the active manipulation and reduction in atlantoaxial luxation or subluxation.[27,16] In the situation of C2 body fractures and pedicle fractures, C3 pedicle screws was inserted in this series. C3 pedicle screws combined with C1 pedicle screws or lateral mass screw can work as a thoracolumbar spine pedicle screws fixation system and have shown obvious superiority in reduction the C2 body fractures.[28,29] The results of all patients had bone fusion which shown C1-C3 cervical pedicle screw fixation stable and serve to transmit the weight of the cranium to caudally.

Atlantoaxial instable caused by odontoid type II and III fractures, pedicle fractures, and body fractures of axis, are usually suitable for surgical treatment.[30,31,5] Literature has mainly focused on axis fractures because the stability of this region is vital importance. Pedicles screw fixation surgery involves atlantoaxial fixation with an indirect attempt to reduce and fuse the fracture.[32-34] However, it carries the risks of injury to the vertebral arteries, hemorrhage from the paravertebral venous plexus and the C2 root ganglion.[35,16] There were no intraoperative neurological and vascular injury in this series case, and no complication related to internal fixator was found. The data of this series suggest that preoperative imaging details, proper patient positioning, meticulous dissection, thorough anatomical knowledge and few added surgical nuances are the cornerstones in ideal pedicle screw placement.

Because conservative management of atlantoaxial instable caused by axis fractures has a high rate complication, for patients with atlantoaxial instable caused by odontoid type II and III fractures, pedicle fractures, and body fractures of axis, are usually suitable for surgical treatment, and the cervical pedicle screw fixation management is valuable for better clinical outcomes. Optimal treatment of axis fractures is controversial, further clinical series are needed to provide evidence for optimal management of axis fractures.

Conclusion

Cervical pedicle screws fixation was effective and safe procedures in the treatment of traumatic spondylolisthesis of axial fractures. The atlantoaxial instable of axis burst fractures can be managed with C1-C3 pedicles screws fixation.

Declarations

Ethical approval and consent to participate

This study was approved by the hospital ethics committee of the First People's Hospital of Zhaoqing, Zhaoqing City, Guangdong Province, and all patients signed had informed consent.

Consent for publication

Author Denglu Yan, Zaiheng Zhang, and Zhi Zhang all agree to publication.

Availability of data and materials

The datasets are available under reasonable request.

Competing interests

Author Denglu Yan, Zaiheng Zhang, and Zhi Zhang declare that they have no conflict of interest.

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Authors' contributions

DY participated in the design of the study and drafted the manuscript. ZZh participated in the design of the study and coordination and helped to draft the manuscript. ZZ participated in the design of the study and performed the statistical analysis. All authors read and approved the final manuscript.

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Abbreviations

VAS: visual analog scale

NDI: neck disability index

CT: computer tomography

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Figures

Figure 1

Male patient with 42 years old had odontoid type II fractures (A, B) were underwent C1-C2 pedicles screws fixation (C).

Figure 2

Male patient with 41 years old with axis body fractures (A, B) had C1-C3 pedicles screws fixation (C)