

ANTERIOR TRANS-
ODONTOID SCREW FIXATION
IN ODONTOID FRACTURES

Anterior Trans-odontoid Screw Fixation in Odontoid Fractures

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Abstract

Background Data: Traumatic injury of the axis odontoid process is not uncommon disorder. The options for management include either conservative treatment in the form external stabilization or surgical treatment. Surgical intervention include posterior C1-2 fixation which although of its high fusion rate, it is not a risk free procedure. Anterior trans-odontoid screw fixation gave a comparable fusion rate and at the same time preserves the segment motion.

Purpose: to evaluate the safety and efficacy of the anterior trans-odontoid screw fixation in odontoid fractures.

Study Design: a retrospective clinical case study.

Patients and Methods: The medical records of ten patients who underwent anterior-trans-odontoid screw fixation for type II and shallow type III odontoid fracture were reviewed. The study was conducted in Cairo University Hospitals from January 2012 to May 2015. The Anderson and D'Alonzo classification system for odontoid fractures was used for patient enrollment. All patients were of less than six months duration. Frankel grading system was used for clinical assessment.

Results: Ten patients (8 males and 2 females) with a mean age of 37.2 years old were included. Their age ranged from 21 to 55 years. Four cases suffered shallow Type III and six were Type II fractures according to the Anderson and D'Alonzo system. Good outcome results either radiological or clinical were achieved in all patients and all inserted screws were in proper placement. After a mean follow-up of 6 months radiographic fusion was documented in 8 of 9 patients (89%).

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Conclusion: anterior trans-odontoid screw can be considered a good choice of surgical treatment dens fractures. Excellent fusion rate could be achieved without significant morbidity and early mobilization. (2017ESJ125)

Keywords: odontoid fractures, anterior fixation, cervical spine, trauma

Introduction

Instability of C1 C2 vertebrae is complex and had different varieties of both clinical and radiological presentation. This different range of presentation is due to its specific complex anatomy^{1,11,16}

According to the classification system of Anderson and D'Alonzo¹ the traumatic fractures of the dens could be one of three types. Type I and most of Type III could be managed with conservative treatment and achieve good results. Type II and shallow type III fractures are mechanically unstable. External immobilization using halo vest might not maintain adequate position to allow fusion and may be difficult to tolerate. These problems may increase the rate of failure.^{2,3,4,5,6,7} The complications related to the pins such as infections may be additional concern.¹ Most surgeons recommend the posterior C1-C2 fixation poly-axial screw-rod system fixation and consider it safe and effective in managing for upper cervical instability regardless of the etiology of this cervical instability^{8,9,10,11,12,13} but with consideration of the previously mentioned complications, other known intra operative risks and the post-operative limited range of segment motion^{14,15,16,17,18,22,23} Anterior approach has become popular as it is easier, less risky, preserve the normal range motion of C1-C2 segment and result in successful rate comparable to the posterior approach.^{3,7,19,20,21,25}

This study is one of the ongoing efforts to validate and evaluate the anterior trans-odontoid screw fixation in traumatic odontoid fractures.

Patients and Methods

The records of ten patients who underwent anterior trans-odontoid screw fixation for type II and shallow type III odontoid fracture from January 2012 to May 2015 in Cairo University Hospitals were reviewed. The Anderson and D'Alonzo classification system for odontoid fractures was used for patient selection. All patients were of less than six months duration. Radiographic investigations included plain X-ray A-P, open mouth, and lateral films were performed to visualize the odontoid fracture and its type. All patients were submitted for MS CT-scan and MRI of the cervical spine was done as well as the regular routine lab work for preparing patients for surgery. A minimum 6 months follow up period was applied to all patients. X-ray films were performed to monitor the fusion status in this study. The data of ten patients were reviewed including 8 male and 2 females, six patients were Type II and 4 shallow type III with age ranged from 21 to 55 years.

Operative Technique:

At the beginning of the procedure we restored the normal alignment C1-2 segment. This is achieved Gardner-Wells tong skull traction and monitored with A-P, open mouth and lateral projection. The approach of Louis, Robinson and Smith was used. A longitudinal skin incision is made at the C2-C3 disc and small part of the disc is removed not to exceed 1 cm. The exposure was maintained using regular retractors. just 2 mm below the centre of C2 body the guide wire is introduced toward the tip of the dens when it is achieved manual drill system was used to drill a hole in the dens tip. The length of the

screw is determined and screw caliber of 3.5 mm is used. After fixing the screw in position the wound is closed with drain^{8,9,22,23,24,25}

Results

In this study eight males and two female patients with mean age at presentation 37.2 years. Four patients had shallow Type-III and six had type-II fractures according to Anderson and D’Alonzo classification system. The causes of odontoid fractures were motor car accidents (6 cases), falls from a height (2 cases), and motorcycle accidents (2 cases). Neck pain was the main presenting symptom in all the cases. Frankel grading system for clinical assessment has been used in the pre-operative, post-operative and follow-up assessment. Two patients were Frankel grade C, 3 were grade D, and 5 patients were grade E. All the patients showed variable sensory affection due to

posterior column affection. Two patients suffered from associated head injury. In nine patients the screws were successfully introduced crossing the fracture site with good purchase. In one patient we could not introduce the anterior screw and procedure was abandoned. Patient managed later was posterior approach C1-C2 fixation. Out of the nine patients operated by trans-odontoid screw fixation, 8 (89%) had good fusion. One case had non-union and the patient preferred to continue conservative management with cervical collar. We did not record neurological deterioration in any of our patients. No recorded infection, CSF fistula, esophageal tear, or hypoglossal nerve palsies. Transient dysphagia was reported in 4 patients who improved within 6 weeks with medical treatment. Patients with preoperative Frankel grade C improved one to grade D and the other to grade E.

Table 1. Epidemiological Data Summary of Study Patients.

Case	Age	sex	Fracture type	Pre-Op Frankel	Post-Op Frankel	Post-Op fusion
1	21	M	II	D	D	Good fusion
2	40	M	II	E	E	Good fusion
3	33	F	III	C	E	Good fusion
4	27	M	II	E	E	Good fusion
5	47	F	II	E	E	Good fusion
6	30	M	III	C	D	Procedure was aborted converted to posterior fixation
7	37	M	II	E	E	Good fusion
8	28	M	III	D	E	Good fusion
9	52	M	II	E	E	Good fusion
10	55	M	III	D	D	Non fusion



Figure 1. (A) Sagittal reformat CT-scan showing pre-operative Type III odontoid fracture,(B) X Ray lateral showing post-operative follow up after anterior fixation with trans-odontoid single lag screw.



Figure 2. (A) Pre-operative CT-scan sagittal reformates showing fracture odontoid type II. (B) Post-operative X-ray showing adequate screw purchase

Discussion

Type-II and shallow type-III Odontoid fractures are mechanically unstable fractures. Surgical treatment of these patients has been advocated as a first choice. It has been resulted in higher successful rate in comparison to external immobilization by halo vest as a conservative treatment regime.¹³ The complex and unique anatomy and strong stability related to the ligamentous status of this region result in some

peculiarities that distinguish this region from the subaxial cervical spine.¹ The most determining factor in surgical option is the integrity of transverse ligament. Traumatic atlantoaxial dislocation is due to forced displacement of the neck resulting in disruption of the transverse ligament with uncommon simultaneous involvement of the alar and apical ligaments. A literature review by Ni et al,¹⁵ and Salunke et al,²¹ reported that traumatic atlantoaxial instability ranged from 45-78% of cervical spine trauma.

Surgical treatment of the fractured dens has usually been carried out by way of a posterior fusion of C1 and C2, with excellent rates of bony union between them.¹⁰ It is, however, associated with considerable mortality and morbidity and results in a decrease in the range of movement of the neck. The use of a Grob and Magerl¹⁰ fusion of C1 to C2 has given rates of union above 80% and a mean complication rate of 19%. These posterior fusions compromise axial rotation by 47° and flexion/extension by 10°. Grob and Magerl¹⁰ claim a rate of fusion of 100% but at the expense of a rigid C1 to C2 junction. Other studies using a fusion of C1 to C2 have also shown limitation in the range of movement after successful union. Complications of posterior approach may include blood loss, vertebral artery injury, infection, dural tears.⁹ In the study conducted by AlQazaz and Abou-Madawi¹ they found that radiological outcome has shown that all patients but one (98%) had very good screws purchase, and all patients (100%) had stable upper cervical vertebrae and sound fusion at follow-up period. This success rate is still at the expense of a rigid C1-C2 junction and loss of segment motion. Other studies conducted by Smith et al,²⁴ and also Clark et al,⁵ using posterior fusion of C1-C2 segment have reported good fusion rate that is associated with limitation in the range of movement which is the major drawbacks of this approach.

Despite excellent rates of fusion reported by posterior arthrodesis of C1-C2, anterior odontoid screw fixation is ideal for fixation of unstable odontoid fractures and is superior to posterior C1-C2 arthrodesis as it preserves C1-C2 rotational movement and obviates the need for autograft bone harvest.^{2,6,12} The technique of anterior screw fixation was first described by Bohler J in 1982.⁵ The reported fusion rate

in our study was 89.% which showed a success rate that even better than fusion rate reported by the posterior approach for C1 and C2.⁶ The failure rate recorded in the literature for the conservative treatment ranges from 0% to 64% and the successful rate for posterior fusion in most studies has reached 80% with complication rate up to 19%. The anterior screw fixation is the only operative treatment that enables direct osteosynthesis of the odontoid fracture. Immediate stability is achieved to the odontoid, thus decreasing the need for postoperative rigid external immobilization. And it is less surgically traumatic than posterior procedures.^{19,27} In this study a single screw has been used to repair the odontoid fracture and achieving good fusion rate. Some surgeons advocate using two lag screws for better fixation. In a study made by Sasso et al,²² they reported is no bio mechanical difference between one screw and two screws fixation.

In our management we used Langenberg retractors used in cervical anterior discectomy with easier exposure and protection of vital structures like esophagus. Although Apfelbaum et al,⁴ proposed special retractors to prevent complication like esophageal tear but we did not found it necessary. This procedure requires less dissection and exposure of normal tissue during the surgical approach, which can result in decreased blood loss, less postoperative pain and a much quicker recovery. Operative time was 120 min. Early in the surgeon's learning curve, with experience, the operative times was reduced to 60 min;^{3,7,12} the common recorded complication of this approach is injury to the surrounding soft tissue, such as the esophagus, trachea, recurrent laryngeal nerve, and carotid artery, as well as postoperative dysphagia. which we encountered in 4 cases in this study for anterior screw fixation, Indications are

very selective include a favorable fracture line (a fracture line from anterosuperior to posterosuperior), as well as good fracture reduction and alignment.^{19,26}

Contraindications include fracture comminution, severe cervicothoracic kyphosis, severe osteoporosis, late fractures, and ligament transverse rupture. Long standing cases more than six months have a higher non-union rate additionally. Older patients may have a higher rate of pseudarthrosis using this technique, as well as postoperative dysphagia and pneumonia, gastrostomy tube placement due to swallowing problems. So posterior approach has a higher rate of fusion and is indicated in patients with severe atlantoaxial misalignment

and with poor bone quality. It is also used as a salvage procedure after failed anterior screw.

Through reviewing of literature we can summarize the differences between both approaches concerning patient selection, surgical technique, functional out come and complication which could be guild line for choosing the proper approach.³

In this study all patient require hospital stay for 10 days and drain removed in 2nd day of surgery. Neurologically affected patients were transferred to physiotherapy center for rehabilitation. Anterior approach enables direct osteosynthesis of the odontoid fracture and immediate stability, so neurologically intact patients were allowed to return to work 2 months postoperatively.

Table 2. Comparison between AOSF and PCIF.³

Characteristic	AOSF	PCIF
Motion preservation of the atlantoaxial joints	Yes	No
Soft-tissue injury	+	++/+++
Bone graft requirement	No	Yes
Risk of vertebral artery injury	+	++
Operative time	+	++/+++
Blood loss	+	++/+++
Limited by fracture morphology	Yes	No
Limited by body habitus	Yes	No
Limited by the status of the transverse ligament	Yes	No
Postop narcotic requirement	+	++/+++
Early injuries (≤6 mos)	Yes	Yes
Remote injuries (≥18 mos)	No	Yes
Risk of dysphagia after surgery (especially in older patients)	++/+++	+

+: mild; ++: moderate; +++: strong; AOSF: anterior odontoid screw fixation; PCIF: posterior cervical instrumented fusion³

Conclusion

Anterior trans-odontoid screw can be considered a good choice of surgical treatment dens fractures. Excellent fusion rate could be achieved without significant morbidity and early mobilization. But with limited patient selection or failed approach posterior fixation will be the solution on the expense of the range of movement and surgeons should be aware of both techniques.

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الملخص العربي

تثبيت كسور النتوء السني عن طريق المسمار السني الامامي

البيانات الخلفية: ان كسور النتوء السني شائعة الحدوث ويظل علاجها تحدي كبير وذلك لوجود مخاطر اثناء الجراحه وسبب ذلك للتركيب التشريحي المعقد لهذه المنطقه الفاصله بين الجمجمه والعمود الفقري العنقي. ان العلاج التحفظي لهذه الحالات والذي يشمل لبس الهالوفيست (جاكت) لا يتيح ثبات النتوء الثني ولذلك ينتج عنه عدم الالتحام بين العظام المكسوره. ان العلاج الجراحي كان يتمعن طريق تثبيت الفقره الاولي والثانيه العنقيه من الخلف وبالرغم من حدوث التحام عظمي جيد الا انه كان يحدث اصابه للشريان الفقاري مما يؤدي الي نسبه وفيات اوتدهور في القوي العضليه والحاله العصبيه وكذلك يحدث نقص في نطاق الحركياالأمامي للنتوء السني.

الغرض: مراجعه الحالات الجراحيه ذات التثبيت لمعرفه مدي الامان و فاعليتها.

تصميم الدراسة: دراسة بأثر رجعي.

المرضي و الطرق: تم مراجعة سجلات المرضى الذين كانوا يعانون من كسور للنتوء السني للدرجه الثانيه والثالثه والتثبيت عن طريق مسمار امامي لهم في الغتره من يناير ٢٠١٢ الي مايو ٢٠١٥

النتائج: تضمنت الدراسه ١٠ مرضي منهم ٦ يعانون من كسر درجه الثانيه و٤ يعانون من الدرجه الثالثه وكانت نتائج مرضيه في ٨ مرض بعد متابعه ٥ شهور اكلينيكي وبالاشعه لمعرفه مدي الالتئام

الاستنتاج: ان استخدام التثبيت من الامام عن طريق تركيب مسمار في النتوء السني يعتبر احسن من التثبيت الخلفي في النتائج و اقل في المخاطر كما انه لا يؤثر علي النطاق الحركي للفقرات العنقيه بعد الجراحه .