Research Article

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A study of indications and assessment of fusion rates for atlantoaxial subluxation

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ABSTRACT

Background: Stabilization of the atlantoaxial articulation presents special problems due to the unique anatomical and functional characteristics of the upper cervical vertebra. The majority of rational movements occur at C1-C2; the cervical stabilization limits rational movement of the neck. The objective of the study was to assess the fusion rates using different techniques of atlantoaxial arthrodesis.

Methods: All the patients who were operated for atlantoaxial stabilization in the department of neurosurgery, between December 2012 and March 2015 formed the study group. Demographic data, detailed history of symptoms and other morbidities were recorded. Routine hematological and biochemical parameters were assessed. Imaging features like X-ray c spine {neutral, flexion & extension view}, CT scans C-spine, and MRI C-spine was used. The anatomic characteristics of cervicovertebral junction, presence of ventral or dorsal compression and atlantoaxial stability were noted. Operative details like types of approach, whether dorsal wiring or screw fixation or both were noted.

Results: Twelve patients had anterior displacement of the atlas on the axis averaging 9.6 mm. Five had posterior displacement averaging 9.2 mm. More than 2/3 of patients had preserved motor function, grade D according to Frankel Classification. More than 60% patients had difficulty in walking and required support to walk. Most of the patients presented with long tract signs and objective weakness. Most common procedure done was C1 lateral mass and C2 pedicle screw fixation. The next common procedure performed was C1-C2 fusion with Sub laminar wiring using titanium wires. There was no mortality.

Conclusions: There is no best method for OCF, and the method of surgery should be bases on the type of instability, the integrity of posterior cervical elements, the extension of decompression, co morbidities, individual anatomic variation, and the surgeon's familiarity with the techniques.

Keywords: Indications, Assessment, Fusion rates, Atlantoaxial subluxation

INTRODUCTION

Cervical spine C1-C2 motion segment is the most technically challenging atlantoaxial instability is treated surgically by different techniques.¹

Posterior fusion at C1-C2 segment is indicated in fractures, degenerative osteoarthritis, metastasis, ligamentous injuries, congenital anomalies, infection and

tumors. Atlantoaxial instability can cause severe neurological injury or death.

Posterior atlantoaxial arthrodesis is indicated in cases of instability to reduce deformity, to provide pain relief, and to minimize the risk of potential neural damage. The benefits of internal fixation include rigid stabilization, maintenance of alignment, minimal postoperative immobilization, and enhanced fusion rated.²

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Stabilization of the atlantoaxial articulation presents special problems due to the unique anatomical and functional characteristics of the upper cervical vertebra. The majority of rational movements occur at C1-C2; the cervical stabilization limits rational movement of the neck.

Hence present study was undertaken to study indications and assessment of fusion rates for atlantoaxial subluxation.

METHODS

All the patients who were operated for atlantoaxial stabilization in the department of neurosurgery, between December 2012 and March 2015 formed the study group.

Demographic data, detailed history of symptoms and other morbidities were recorded. All patients underwent a detailed systemic and neurological assessment data was entered in the questionnaire.

Routine hematological and biochemical parameters were assessed.

Imaging features like X-ray c spine (neutral, flexion & extension view), CT scans C-spine, and MRI C-spine was used.

The anatomic characteristics of cervivovertebral junction, presence of ventral or dorsal compression and atlantoaxial stability were noted.

Operative details: Types of approach, whether Dorsal wiring or screw fixation or both was noted

Anesthetic monitoring consisted of ECG, digital oximetry, capnography and intra –arterial BP monitoring.

Intra operative Fluoroscopy was used.

All post-operative events like fresh neurological deficits, infections or metabolic dysfunctions were recorded.

Each patient at the time of admission and discharge was assessed by

- 1. Nurick's Classification for myelopathy on the basis of gait abnormalities
- 2. Frankel Classification grading system

The evaluation was done as per the proforma included. The follow-up was done at 3 months, 6 months and 1 year. At each follow-up, each patient was evaluated as per the Grob et al classification.

Grob et al. Classification of results

Objective rating

- Good (no pain, sold fusion)
- Fair (Moderate pain, solid fusion)
- Bad (non union, sever pain)

Subject rating

- Good (no serious pain, no restriction of activity)
- Fair (Periods of pain, working capacity reduced)
- Bad (permanent sever pain, disability)

Inclusion criteria

- 1. Patients with post traumatic atlantoaxial instability
- Patients with atlantoaxial instability secondary to rheumatoid arthritis
- 3. Radiological evidence of Atlanto Dental Interval of >3mm was considered mandatory for inclusion in the study

All the included patients underwent atlantoaxial fixation at Osmania General Hospital, Hyderabad, India.

Exclusion Criteria

- 1. Concomitant thoracic kyphosis
- 2. Barrel chest deformity
- 3. Congenital anomalies like absence of posterior element of C1 with atlantoaxial instability

Indications for inclusion of occiput for arthrodesis

- 1. Widespread bony destruction
- 2. Deficient posterior arch, congenital or acquired
- 3. Congenital anomalies of the occipito-cervical joints
- 4. Herniation of odontoid into foramen magnum
- 5. Marked irreducible anterior shift of C-l on C-ll
- 6. Widespread infection
- 7. Postlaminectomy
- 8. Selected associated fractures

RESULTS

17 patients underwent atlantoaxial arthrodesis for atlantoaxial instability over the period of 2 years in department of Osmania General Hospital. Age ranged from 9 to 60 years mean being 36.2 yrs.

Maximum numbers of patients were seen in age group of 31-40 and 41-50 year. About 58.8% of patients were males.

Weakness of both upper and lower limbs was most common symptom followed by neck pain and posterior occipital headache. The duration of symptoms before fusion was average 15 months. Os odontoideum leading to atlantoaxial instability was the most common indication for surgery.

Twelve patients had anterior displacement of the atlas on the axis averaging 9.6 mm. Five had posterior displacement averaging 9.2 mm.

More than 2/3 of our patients had preserved motor function, grade D according to Frankel classification. More than 60% patients had difficulty in walking and required support to walk. Most of the patients presented with long tract signs and objective weakness.

Most common procedure done was C1 lateral mass and C2 pedicle screw fixation. The next common procedure performed was C1-C2 fusion with Sub laminar wiring using titanium wires.

Post operatively two patients had injuries to the spinal cord and roots. Two patients developed lower cranial palsies which were transient. There were no injuries to the vertebral artery. There was no dural leak. One patient reported with DVT and was appropriately treated. One patient developed wound infection, which subsided with

appropriate antibiotics and regular dressings.

We observed improvement in myelopathic symptoms in 68.8% (11/16) of the subjects using the Nurick score.

Minimum follow up period was 12 months and max was 20 months

Patients operated for C1 lateral mass and C 2 pedicle screw fixation, Occipito cervical fusion with contour rods and sub laminar wiring, Occipito cervical fusion with polyaxial screw and occipital plate instrumentation had 100 percent fusion rate. Long term follow up (mean, 12 months) demonstrated two non unions- one in patient in which C1-C2 fusion with Sub laminar wiring using atlas cable system and iliac bone graft was performed and the other in which C1-C2 fusion with Sub laminar wiring using titanium wires was done.

There was no mortality.

Table 1: Types of procedure performed.

Procedure	Indication	No. of patients	Total
	Os odontoideum	5	
C1 lateral mass and C2 pedicle screw fixation	Traumatic Atlantoaxial Instability	2	7
C1-C2 fusion with Sub laminar wiring using atlas cable system and iliac bone graft	Os odontoideum	2	2
C1-C2 fusion with Sub laminar wiring using titanium wires	Traumatic atlantoaxial	2	
C1-C2 fusion with Sub familiar wiring using trainful wires	instability Os odontoideum	2	4
C 1 Posterior arch excision+ Foramen magnum decompression+ Occipito cervical fusion with contour rods and sub laminar wiring	Basilar invagination	2	2
Trans oral odontoidectomy + C1 posterior arch excision + Occipito cervical fusion with contour rods and sub laminar wiring	Basilar invagination	1	1
C1 posterior arch excision + Occipito cervical fusion with polyaxial screw and occipital plate instrumentation	Os odontoideum	1	1

Table 2: Comparison of fusion rates.

Procedure	Total no. of Patients	Fusion rate
C1 Lateral mass and C2 pedicle Screw fixation	7	100%
C1-C2 fusion with Sub laminar wiring using atlas cable system and iliac bone graft.	2	50%
C1-C2 fusion with Sub laminar, wiring using titanium wires	4	75%
C1 Posterior arch excision + Foramen magnum decompression+ occipito cervical fusion with contour rods and sub laminar wiring	2	100%
Trans oral odontoidectomy + C1 posterior arch excision+ Occipito cervical fusion with contour rods and sub laminar wiring	1	100%
C1 posterior arch excision+ Occipito cervical fusion with polyaxial screw and occipital plate instrumentation	1	100%

Range of motion

Loss of rotation was not a significant problem. Inclusion of the occiput in the fusion mass had no noticeable effect on rotation. In the patients who underwent fusion at 20 years of age or less, rotation was diminished an average of 15%, at 20 to 40 years of age, 25%, and at more than 40 years of age, 28%.

Table 3: Frankel Classification grading system at admission.

Grading at the time of admission	No. of Patients	Percentage
Gr. A	0	0%
Gr. B	1	6%
Gr. C	3	18%
Gr. D	13	76%
Gr. E	0	0

Table 4: Frankel Classification grading system at discharge.

Grading at the time of admission	No. of Patients	Percentage
Gr. A	0	0%
Gr. B	1	6%
Gr. C	1	6%
Gr. D	7	41%
Gr. E	8	47%

DISCUSSION

Age distribution

The mean age of the patients included in the study was 36.2 years (34+10.704), ranging from 9 to 60 years.

Bohlman reported that the average age was forty seven years. More than half (161 patients) were twenty one to fifty years old.¹

Sex distribution

11 (59%) of the patients included in the study were males, while 6 (41%) were females.

In 2001, Haid RW et al reported that their study group was composed of 43 men and 32 women, with a mean age of 44 years ranging 8 to 76 year.²

Cause of atlantoaxial instability

The cause of the atlantoaxial instability among the patients included in the study was one of the following:

• Os odontoideum: 10 (59%)

- Traumatic atlantoaxial instability: 4 (24%)
- Basilar invagination: 3 (17%)

RW McGraw in 1973 included congenital abnormality of dens, atlantoaxial rotator Subluxation, fracture of dens and rheumatoid arthritis. ^{2,3}

Clinical features

Weakness of both upper and lower limbs was most common symptom present in all the patients followed by neck pain and posterior occipital headache present in 88% of patients. In 53% some sensory abnormality was present. 18% of patients had complains of nystagmus, hearing loss and tinnitus. 12% of patients had vertigo and skeletal dysplasia.

NA Rana et al found pain in 76% patients of rheumatoid arthritis with atlantoaxial subluxation in the upper cervical or the sub occipital areas with variable radiation to the mastoid, occipital, temporal or frontal regions had paraesthesias or pain in the hands or fingers, and one complained of bouts of "uselessness" of the upper limbs. One also suffered vertigo on extension of the neck.⁴

Fielding et al found that neurological complaints were present in twenty-four patients, cord compression in 6 patients, while 4 had nerve-root irritation. Pain and limitation of motion of the neck were present in 29 patients. 14 patients were asymptomatic.⁵

Clark C reported that in 9 patients, the chief complaint was pain in the neck and in 9 it was occipital aches. 9 patients had no appreciable pain and instability was diagnosed on screening radiographs.

Additional symptoms included subjective cervical crepitus in 13, weakness of upper extremities in 5, Clumsiness in 1, Progressive muscular weakness in 2, feeling of impending doom in 2, radicular pain in 8, stiff neck and limited range of in 3, severe spasms in neck in 1, paraesthesias of upper extremity in 8, transient quadric paresis in 1, weakness of lower extremity in 1, and dysphasia in 1.

RA Swinkels and RA Oostendrop in 1996 concluded that conventional X-rays fail to give adequate information about atlantoaxial instability however CT scan and MRI scan can visualize much more information but neither is an absolute standard. They also concluded that there is no correlation between the measure of hyper mobility and the presence of clinical symptoms.⁷

In our study twelve patients had anterior displacement of the atlas on the axis averaging 9.6mm; five had posterior displacement averaging 9.2 mm. In a study by Fielding WJ at the department of orthopedic surgery, St. Luke's hospital and medical center New York, out of the fifty seven patients that operated forty-two patients had anterior displacement of the atlas on the axis averaging 9.6 mm, ten had posterior displacement averaging 9.2 mm, and five had no displacement.

Ostensen H et al in 1998 studied 20 patients of rheumatoid arthritis for instability of the occipito-atlanto-axial joints and cranial migration of the odontoid process. While conventional on CT examination and the degree of cranial migration of odontoid process quantified.⁷

Significantly though, as recently as 2005, Karhu et al evaluated patients with rheumatoid arthritis and concluded that conventional radiographs with flexion and extension views should be the first imaging modality.⁸

Sub laminar wiring

Long term follow up demonstrated two non-unions – one in patient in which C1-C2 fusion with sub laminar wiring using atlas cable system and iliac bone graft was performed and the other in which C1-C2 fusion with Sub laminar wiring using titanium wires was done.

Fielding et al. recommend this type of fusion because it was more effective with a higher rate of fusion and relief of symptoms than other techniques.⁹

Sherk and Synder opinioned that odontoid anomalies carry the greatest risk of fusion failure and that immobilization in halo or tongs has a higher fusion rate. 10

Chen XS et al. concluded that Gallie's fusion technique is an effective method to manage atlantoaxial instability. However, for a successful outcome, careful wiring or cable traversing decortication of the posterior arch of C1 and maintaining the physiological height between the C1 and the C2 posterior arch are mandatory.¹¹

C1 lateral mass and C2 pedicle Screw fixation

Most common procedure dine was C1 lateral mass and C2 pedicle screw fixation. Patients operated for C1 lateral mass and C2 pedicle screw fixation, Occipito cervical fusion with contour rods and sub laminar wiring, Occipito cervical fusion with polyaxial screw and occipital plate instrumentation had 100 percent fusion rate.

In our study, seven cases were operated by C1 lateral mass and C2 pedicle screw fixation, one patient had root injuries but there was no vertebral artery injury.

Stokes in 2002 reported no vertebral artery injury, C2 nerve injuries or spinal cord injuries with this technique. However, C2 pars screw placement cannot be used in patients with a narrow C2 pars or a medially located foramen transversarium.¹²

Bin Ni and Zhuangchen Zhu reported 13 cases for which bilateral C1 laminar hooks combined with C2 pedicle screws fixation for treatment of C1-C2 instability not suitable for placement of transarticular screws. Bony fusion and construction stability were observed in all 13 patients (100%) on their follow-up radiographs, and no instrument failure was observed.

CONCLUSION

There is no best method for OCF, and the method of surgery should be bases on the type of instability, the integrity of posterior cervical elements, the extension of decompression, comorbidities, individual anatomic variation, and the surgeon's familiarity with the techniques.

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institutional ethics committee

REFERENCES

- Haid RW, Subach BR, McLaughlin MR, Rodts GE, Wahlig JB. C1-C2 transarticular screw fixation for atlantoaxial instability: a 6 years' experience neurosurgery. 2001;49(1):69-70.
- Scott Ew, Haid Rw, Peace D. Type 1 fractures oof odontoid process: Implications for atlanto-occipital instability. Case report. J Neurosurg. 1990;72:488-92.
- 3. Rana NA, Hancock DO, Taylor AR. Hill AGS. Atalnto-Axial Subluxation in Rhenumatoid Arthritis. J Bone joint Surg Br. 1973;55(3):458-70.
- 4. Fielding JW, Hawkins RJ, Ratzan SA. J Bone Joint Surg AM. 1976;58:400-7.
- 5. Clark CR, G oetz DD, Menezes AH. Arthrodesis of the cervical spine in rheumatoid arthritis. J Bone joint Surg AM. 1989;71:381-92.
- 6. Swinkles RA, Oostendop RA. Upper cervical instability: fact or fiction? J Manipulative Physio Ther. 1996;19(3):185-94.
- 7. Karhu JO, Parkkola RK, Koskinen SK. Evaluation of flexion/extension of the upper cervical spine in patients with rheumatoid arthritis. MRI study with a dedicated positioning device compared to conventional radiographs. Acta Radilog 2005;46(1):55-66.
- 8. Fielding, JW, Cochran GVB, Lawsing JF, Mason H. Tears of the Transverse Ligament of the Atlas. A Clinical and Biomechanical Study. J Bone Joint Surg AM. 1974;56:1683-91.
- 9. Sherk HH, Nicholson JT. Rotatory Atlanto Axial Dislocation Associated with Ossiculum Terminate and Mongolism. A case report. J Bone Joint Surg Am. 1959;51:957-64.
- 10. Chen XS, Jia LS, Yuan W, Ye XJ, Chen DY, Zhou XH. Key points about Atlanto-axial internal fixation

- and fusion using Gallie's technique. Zhonghua Wai Ke Za Zhi. 2004;42(21):1312-5.
- 11. Harms J, Melcher RP. Posterior C1-C2 fusion with polyaxial screw and rod fixation. Spine. 2001;26:2467-71.
- 12. Magerl F, Seeman PS. Stable posterior fusion of the atlas and axis by transarticular screw fixation. Ion Kehr P, Werdner. Cervical spine 1.

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