



Atlantoaxial Dislocation: Surgical Outcome following Anterior Retropharyngeal Approach to Odontoid with or without Fixation

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Abstract

Introduction Atlantoaxial dislocation (AAD) refers to a loss of stability between the atlas and axis vertebra. The conventional transoral approach and the anterior retropharyngeal approach (ARPA) are adequate for the upper cervical vertebral segments. This study was undertaken to evaluate the usefulness of the ARPA to the odontoid in patients of AAD.

Materials and Methods The study was undertaken on 20 patients admitted in Nil Ratan Sircar Medical College and Hospital, Kolkata, India, with functional disability secondary to AAD. These patients underwent surgery through ARPA to odontoid with or without fixation. Patients were analyzed between October 2014 and September 2016.

Results Maximum number of patients belonged to third decade of life. The male to female ratio was 1.5. The mean duration of symptoms was 10.86 months. Weakness of the upper and lower limbs predominated. About 65% patients had axial neck pain. Nine patients (45%) in total had difficulty in either bowel or bladder. Five patients presented with fracture odontoid and pannus formation of the odontoid process, while six had basilar invagination. One patient underwent anterior odontoid screw fixation and the other 19 patients underwent anterior retropharyngeal odontoidectomy with posterior fixation. Two patients expired in the present study. Most of the patients had improvement in Nurick grade during follow-up. Five patients had transient throat pain and dysphagia. Three patients had superficial surgical site infection. One patient had postoperative cerebrospinal fluid leak.

Conclusion The ARPA to odontoid is a feasible approach for decompression and fixation of the odontoid in AAD cases.

Keywords

- ▶ atlantoaxial dislocation
- ▶ anterior retropharyngeal
- ▶ Nurick grade

Introduction

The craniovertebral junction, comprising of the basiocciput, atlas, axis, and their supporting ligaments, constitutes the most complex and dynamic region of the cervical spine. The wide range of movements possible at this region makes it

vulnerable to injury and instability.¹ Atlantoaxial dislocation (AAD) refers to a loss of stability between the atlas and axis (C1–2), resulting in loss of normal articulation.

The atlantoaxial joints can lose stable articulation from traumatic, inflammatory, idiopathic, or congenital abnormalities.² The presentation of AAD ranges from minor axial neck

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pain to death.³ These include neck pain and/or neck movement restriction, weakness, and/or numbness and pyramidal signs. Sphincter disturbances, lower cranial nerve dysfunction, and respiratory distress may also be seen.

AAD can be defined with radiographic measurements of atlantoaxial joint articulation using the atlantodental interval (ADI). The ADI generally does not exceed 3 mm for adults and 5 mm for children.⁴ The main procedures reported in the literature are posterior occipitocervical/C1–2 fusion after anterior decompression of the odontoid if the dislocation is irreducible. However, currently it has been propagated by Goel et al⁵ that even in irreducible AAD, posterior approach alone with distraction and stabilization will achieve the desired results. Knowing this, both the procedures are well accepted among neurosurgeons for irreducible variety of AAD.

The conventional transoral approach traversing the midline pharyngeal raphe and the anterior retropharyngeal approach through the avascular plane between the carotid sheath and trachea and esophagus are adequate to approach the upper (C1–2) cervical vertebral segments. The study was undertaken to evaluate the surgical outcome of anterior retropharyngeal approach to the odontoid in patients of AAD and the associated complications using Nurick grade.⁶

Aims and Objectives

Following are the two aims and objectives of this article:

1. To seek data with respect to the outcome of the disease, severity of symptoms, preoperative and postoperative Nurick grade and improvement following anterior retropharyngeal approach to the odontoid.
2. To find out the intra and postoperative complications.

Materials and Methods

The study was undertaken on 20 patients with functional disability secondary to AAD, who underwent surgery through anterior retropharyngeal approach to odontoid with or without fixation. Patients were analyzed between October 2014 and September 2016.

Inclusion Criteria

All patients with clinical and radiological diagnosis of AAD admitted in neurosurgery ward of Nil Ratan Sircar Medical College and Hospital, Kolkata, India.

Exclusion Criteria

Following are the exclusion criteria:

1. Patients with concomitant subaxial cervical spine problems.
2. Age less than 1 year.

Surgical Technique

All patients were applied skull traction to attempt reduction using Gardner Wells traction starting with 7 to 8% of body

weight with graded increase to a maximum of 7 kg over 2 weeks. Serial lateral cervical radiographs were obtained to monitor the reduction. Irreducible AAD was subjected to decompression of the odontoid through the anterior retropharyngeal approach.

The surgical technique followed at our institute is as follows.

Preoperative Preparation

The patient is kept nil per oral on the morning of the operation. A dose of preoperative antibiotic is given during induction of anesthesia. General anesthesia is administered, and an endotracheal tube is placed.

Patient Position and Incision

The patient is placed supine on the operating table under Gardner Wells cervical traction that was placed preoperatively. A pillow is placed under the shoulder, and the head extended on a head ring. A transverse submandibular incision is placed 2 cm inferior to the mandible, starting from the angle of the mandible to just below the chin. A vertical limb is dropped along the anterior border of sternocleidomastoid muscle.

Cervical Dissection

The superficial cervical fascia including the platysma is incised in line with the skin incision and retracted, thus exposing the investing lamina of the deep cervical fascia. The investing lamina of the deep cervical fascia is opened. The intermediate tendon of posterior belly of digastric muscle is divided after taking stay sutures for repair after surgery.

Wide dissection of the fascial plane between the sternocleidomastoid and the carotid sheath laterally and the trachea and esophagus medially permits exposure of the retropharyngeal space and the prevertebral fascia covering the longus-colli muscles. The retropharyngeal areolar tissue and the prevertebral fascia are opened exposing the anterior surface of the anterior arch of atlas and the C2 and C3 vertebrae.

Bony Drilling

An orientation to the midline is gained by noting the attachment of the longus-colli muscle on both sides as they converge toward the anterior tubercle of atlas as well as the anterior longitudinal ligament in the midline. The medial segment of the odontoid is removed using a cutting burr till the inner cortical shell remains and this is further removed using diamond burr and Kerrison's punch. The posterior longitudinal ligament is excised exposing a bulging dura mater.

Results and Analysis

Nineteen patients underwent anterior retropharyngeal odontoidectomy with posterior fixation and one patient underwent odontoid screw fixation through anterior retropharyngeal approach with the incision as described earlier where the vertical limb was dropped up to C5 level.

Age Distribution of the Patients

The mean age of the patient population was 39.6 years with youngest being 10 years and the oldest 66 years. Maximum number of patients belonged to third decade of life (►Table 1).

Sex Distribution of the Patients

Total number of males and females were 12 (60%) and 8 (40%), respectively. The male to female ratio was 1.5:1 (►Table 1).

Duration of Symptoms

The mean duration of symptoms in the present study was 10.86 months that varied from 1 week to 5 years. Twelve patients had symptoms for less than 6 months and 2 patients had symptoms for more than 2 years.

Symptoms at Presentation

In the present study, weakness of the upper limbs predominated (100% patients) predominantly affecting fine motor functions, followed by weakness of the lower limbs that was present in 90% patients. About 65% patients had axial neck pain that was not responding to conservative management. Nine patients (45%) in total had difficulty in either bowel or bladder. Six patients had both bowel and bladder complaints and the remaining three had involvement of bladder alone (►Table 2).

Radiology of the Patients at Presentation

Nine patients presented with a history of trauma. Among these, five patients had fracture of the odontoid with anterior AAD. The other four patients had anterior AAD with

half of them also having rotational component along with anterior dislocation. Six patients had basilar invagination with anterior AAD (►Fig. 1) Among these, one patient had assimilation of the posterior arch of atlas. Five patients had pannus formation of the odontoid process with anterior AAD (►Table 3).

Surgery Performed

Depending on the radiology, the patients underwent the following procedures:

1. Odontoid screw fixation through anterior retropharyngeal approach in one patient.
2. Anterior retropharyngeal odontoidectomy with posterior C1, C2 wiring in two patients.
3. Anterior retropharyngeal odontoidectomy with posterior cervical screw rod fixation in four patients (►Fig. 2).
4. Anterior retropharyngeal odontoidectomy with posterior occipitocervical fixation in 13 patients (►Fig. 3).

Analysis of Nurick Grade

Two patients expired in the present study. One patient had deterioration in Nurick grade after surgery and there was no change in the Nurick grade in one patient after 12 months of follow-up. At the time of discharge, two patients showed improvement in Nurick grade. Ten patients were able to resume employment at the end of 1 year and six patients were independently able to perform their daily activities (►Table 4).

Table 1 Distribution of the patients by age

Age group (y)	No. (male: female)	%
10–20	2 (1:1)	10
21–30	7 (5:2)	35
31–40	2 (2:0)	10
41–50	2 (1:1)	10
51–60	5 (2:3)	25
>60	2 (1:1)	10

Table 2 Symptoms at presentation

Symptoms		Present	%
Neck pain		13	65
Gait disturbances		17	85
Weakness	Upper limb	20	100
	Lower limb	18	90
	Hands	20	100
Sphincter	Bowel	6	30
	Bladder	9	45
Sensory		10	50
Autonomic		12	60

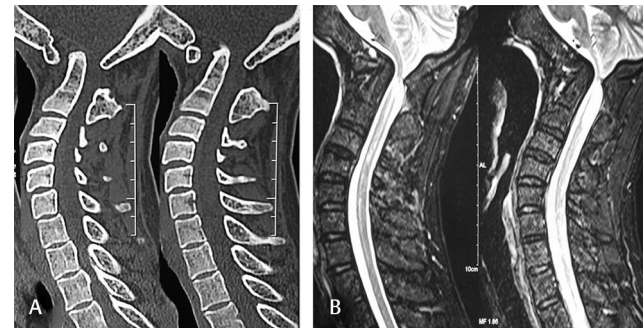


Fig. 1 (A) Computed tomography of a patient showing basilar invagination with anterior atlantoaxial dislocation. (B) Magnetic resonance imaging of the same patient showing compression on brain stem.

Table 3 Radiology at presentation

Radiology	No.	%
Type 2 odontoid fracture with AAD	4	20
Comminuted C2 fracture with AAD	1	5
Anterior AAD	2	10
Rotational with anterior AAD	2	10
Basilar invagination with AAD	6	30
Pannus formation of odontoid with AAD	5	25

Abbreviation: AAD, atlantoaxial dislocation.

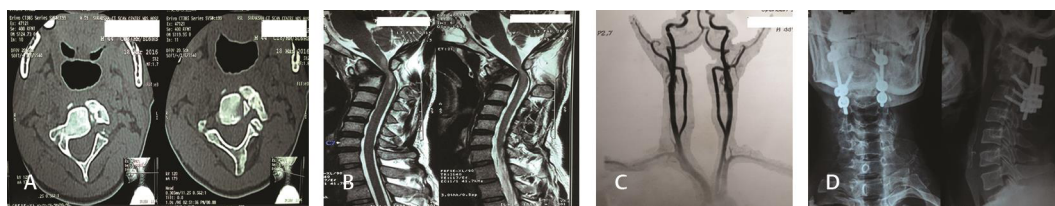


Fig. 2 (A) Axial computed tomography of a patient with C2 comminuted fracture. (B) Magnetic resonance imaging of the same patient showing severe compression over craniocervical junction. (C) Computed tomography angiogram of the same patient done to delineate the course of vertebral artery. (D) Postoperative skiagram of the patient with occipitocervical fixation.



Fig. 3 (A) Computed tomography of a patient with rheumatoid arthritis showing pannus formation of the odontoid process. (B) Magnetic resonance imaging of the same patient showing severe compression over craniocervical junction. (C) Intraoperative image of the patient with occipitocervical fixation. (D) Postoperative skiagram of the patient with occipitocervical fixation.

Table 4 Analysis of Nurick grade

Nurick grade	1	2	3	4	5	Total
Pre-op	0	1	7	7	5	20
At discharge	0	0	5	10	3	18
3 months	0	2	8	7	1	18
6 months	2	6	8	1	1	18
12 months	2	8	6	2	0	18

Complications

Eight patients had no postoperative complications. Five patients had transient throat pain and dysphagia that resolved conservatively (25%). Three patients had superficial surgical site infection (15%). One patient had postoperative cerebrospinal fluid (CSF) leak that was managed conservatively (5%). One patient had traction pin site infection with temporoparietal epidural abscess leading to transient aphasia. Two patients expired in the postoperative period (10%). One expired due to bleeding diathesis, the cause of which remained unknown. The second patient expired due to autonomic dysfunction in the postoperative period.

Discussion

Our study group comprised of 20 patients in whom the mean age of the patient population was 39.60 years. Wang et al⁷ quoted the mean age of 32 years in their study of 33 patients with irreducible AAD. Youngest patient in our study was 10 years old and the oldest was 66 years old that is in concordance with the study done by Shetty et al⁸ and Wang et al.⁷ In an earlier study done by Goel et al⁵ on 160 patients, the mean age of presentation was 23 years and the age ranged between 18 months and 79 years.

Total number of males and females in our study were 12 and 8 (male to female ratio 1.5:1), respectively. However,

the study done by Goel et al⁵ comprised of 91 males and 69 females (male to female ratio 1.3:1). In a similar study by Shetty et al,⁸ out of the 63 patients there were 49 males and 14 females (male to female ratio 3.5:1).

In the present study, quadriplegia was observed in 18 (90%) of the patients. Goel et al⁵ in their study on 160 patients with atlantoaxial instability observed quadriplegia in 154 (97.5%) patients. In the study conducted by Menezes et al,⁹ 148 (65.6%) patients presented with quadriplegia. The most common symptom that was present in 181 patients (82.65%) in the study by Menezes et al⁹ was neck pain. In our study, 13 patients (65%) had axial neck pain that was not responding to conservative management.

Nine patients (45%) in total had either bowel or bladder dysfunction in our study. Six patients had both bowel and bladder complaints and the remaining three had involvement of bladder alone. A high incidence of bladder dysfunction that is, 137 out of 219 patients (62.5%) paralleled the motor sensory deficits in the study done by Menezes et al.⁹

In the present study, the sensory abnormality usually was related to posterior column dysfunction that was observed in nine patients (45%). Spinothalamic tract dysfunction was unusual, a finding noted only in 1 patient (5%). The unusual presentation of spinothalamic tract dysfunction quoted by Menezes et al⁹ corroborates with the present study. Goel et al⁵ in their study observed that 48 patients (30%)

presented with posterior column dysfunction and 46 cases (28.7%) presented with spinothalamic tract dysfunction.

In our study, reduction was achieved in one patient with type 2 odontoid fracture in which odontoid screw was placed through anterior retropharyngeal approach (—Fig. 1). In other 19 patients, reduction could not be achieved and therefore we performed decompression of the odontoid through anterior retropharyngeal approach followed by posterior fixation to achieve stability. On literature search, there was no study mentioning the anterior retropharyngeal approach to decompress the odontoid in cases with AAD.

There was a significant improvement in majority of patients in the postoperative and follow-up period. In our study, 95% of the patients had moderate-to-severe functional disability with significant gait difficulties, clumsiness, and bladder problems when graded using the Nurick grade (Grade 3–5). The average preoperative Nurick grade was 3.8 (range: 0–5). All except two patients showed improvement over their preoperative neurology and functional disability to a variable extent. The follow-up average Nurick grade at discharge, 3 months, 6 months, and 1 year was 3.89, 3.39, 2.61, and 2.44, respectively, reflecting that the residual neurological and functional disability improved significantly.

There was only one patient with Nurick grade 2 preoperatively. At 1-year follow-up, there were eight patients who had a Nurick grade of 2. This points out to the significant improvement in patients in our study. There were seven patients with Nurick grade of 4 preoperatively, while at 1-year follow-up the number of patients with Nurick grade of 4 was only 2. Similarly, five patients presented with preoperative Nurick grade of 5 and at 1-year follow-up there was no patient with Nurick grade of 5. This points out to the minimal disability left after treatment in our study.

Out of the 18 patients followed up at 1 year, 16 patients (88.88%) were able to resume employment or their daily activities. Axial neck pain improved first followed by improvement in gait difficulties and paraesthesia; bladder function and hand function were the last to improve.

Preoperatively, 35% of the patients either used to walk with someone's help or with the help of a frame and 25% patients were bed or chair bound. At 3 months follow-up, only one patient (5.55%) remained bed or chair bound, at 6 months follow-up only one patient (5.55%) required someone else's help or the aid of frame to walk, and at 1-year follow-up there was no patient who was bed or chair bound, and 88.88% patients were able to resume employment or their daily activities.

There are several studies showing the efficacy of anterior retropharyngeal approach to the upper cervical spine, but there is no study available on literature search to compare with our present study, as pre- and postoperative Nurick grade was not implied to denote the outcome in any other study. Thus, our study is unique in that it has reviewed the result of surgery specifically for AAD with respect to Nurick grade.

Although there are no studies specifically using Nurick grade for the assessment of the outcome after anterior retropharyngeal approach to odontoid for AAD, Behari et al¹⁰ in a

study conducted on five patients have stated the advantages and disadvantages of the anterior retropharyngeal approach for anteriorly situated lesions from the clivus to C3. Three of the five operated patients in their study had significant improvement in spasticity and power.

In our study, eight patients (40%) had no postoperative complications. Five patients (25%) had transient throat pain and dysphagia that resolved conservatively. Skaf et al¹¹ in their study on six patients performed anterior retropharyngeal approach to upper cervical spine with excision of the submandibular gland. They reported transient dysphagia in two patients that subsided conservatively. Similarly, Hodges et al¹² reported transient dysphagia in 3 out of 14 patients, and one of them required placement of a feeding tube. In our study, feeding tube for dysphagia was not required in any patient.

Three patients in our study had superficial surgical site infection (15%) that was managed conservatively with dressings, which prolonged the hospital stay. Hodges et al¹² reported infection at the graft site with no complications related to the approach in one patient. Keloid formation, which was scheduled to be addressed with revision surgery, was noted in one patient. We had no case with keloid formation of the surgical site.

In our study, two patients had intraoperative dural breach. One patient (5%) out of these had postoperative CSF leak that was managed conservatively. Though in the study of Behari et al¹⁰ two patients with ossification of the posterior longitudinal ligament had dural breach during the surgery, there was no postoperative CSF leak.

In our study, two patients expired in the postoperative period (10%). One expired due to bleeding diathesis the cause of which remained unknown. The second patient expired due to autonomic dysfunction in the postoperative period. Skaf et al¹¹ reported one death due to failure of extubation followed by severe respiratory failure due to pulmonary embolism.

There was no postoperative hypoglossal nerve injury in our study. We took care not to ligate any vessel in the field of surgery and to remain in the facial planes as far as possible. Similarly, there was no hypoglossal nerve paresis in the study of Behari et al¹⁰ and Skaf et al.¹¹ However, Sengupta et al¹³ reported a case of hypoglossal nerve injury in a 35-year-old female who underwent corpectomy and fusion from C2 to C5 using iliac crest bone graft through anterior retropharyngeal approach for tuberculosis of C2–3. For a high retropharyngeal approach to the upper cervical spine, the hypoglossal nerve may traverse the field and resemble a large blood vessel; great care should be taken in ligating and dividing any structure in this field.¹⁴

Harms et al¹⁵ used transoral technique to fix the anterior cervical spine in patients undergoing transoral approaches to the odontoid for AAD due to various pathologies. The advantage of this technique is that the patient undergoing transoral does not require subsequent posterior neck incision for C1–2 fixation. The technique is performed with the use of a “T-plate.” The horizontal portion of the plate is placed over the C1 lateral masses anteriorly and screws

are placed through the anterior C1 lateral mass to achieve a bicortical purchase. The vertical portion of the plate rests on the body of C2 inferior to the base of the dens. Two vertebral body screws are then placed into the C2 body.¹⁶

Conclusion

The anterior retropharyngeal approach is a feasible approach for decompression and fixation of the odontoid in AAD cases. Besides achieving a wide, bilateral exposure, the approach avoids the potential contamination of the oropharyngeal cavity and thus provides for a simultaneous arthrodesis and instrumentation during the primary surgical procedure. It also provides a safer environment for a simultaneous intradural procedure and management of a CSF fistula. The ability to extend the incision down the cervical spine makes it a versatile exposure that can facilitate multiple spinal procedures including decompression, grafting, and instrumentation.

Although the anterior retropharyngeal approach is not subject to the high infection rates of the transoral approach, the complex regional anatomy makes this a technically demanding procedure.

Though currently newer approaches like distraction and fixation in a single procedure have evolved, our approach still holds a good alternative with excellent results and minimal complications.

Funding

None.

Conflict of Interest

None declared.

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