

Original Article

Use of intraoperative X-ray to differentiate between reducible versus irreducible atlantoaxial dislocation

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Abstract

Background: The treatment and classification of atlantoaxial dislocations (AADs) remain controversial. Here, we utilized intraoperative X-ray to differentiate between reducible and irreducible AADs.

Methods: Five patients were diagnosed as having irreducible AAD on dynamic and post-traction X-rays. Under general anesthesia, they were placed prone in a neutral position utilizing skeletal traction. The X-rays and motor evoked potential (MEP), were then monitored before, during, and after placing a thumb on the C2 spinous process and pushing it anteriorly to attain reduction.

Results: The intraoperative X-ray confirmed reducibility of AAD in four patients; they subsequently underwent a C1–C2 posterior fusion, which maintained that reduction. For the one patient with an irreducible AAD (despite thumb maneuver), an anterior release was required first to attain reduction, followed by posterior C1–C2 fusion.

Conclusion: Here, we divided irreducible AAD into two categories: a) reducible—utilizing a thumb maneuver to compress/push the C2 spinous process forward with the patient positioned prone and b) irreducible—those who cannot be reduced with this technique. A posterior only approach was sufficient for those with “reducible” AAD, whereas those who could not be reduced required an anterior release followed by posterior fusion.

Key Words: Anterior release, dynamic X-ray, irreducible atlantoaxial dislocation (AAD), posterior cervical surgery, push-prone maneuver, thumb maneuver, traction

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INTRODUCTION

The treatment and classification of atlantoaxial dislocations (AADs) remain controversial. It is generally accepted that the treatment of symptomatic AAD should include surgical reduction and fusion/fixation.^[1,2] Reducibility is traditionally attained using dynamic X-ray imaging with skeletal traction. For patients with reducible AAD utilizing the thumb pressure technique posteriorly compressing the C2 spinous process anteriorly (e.g., under X-ray control, with traction and

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motor evoked potential [MEP] monitoring), a posterior fixation alone maintained reduction. Those with irreducible AAD, where the dislocation could not be reduced by traction or in this study by such compression of the C2 spinous process anteriorly, first require trans-oral release followed by posterior fusion/fixation.

MATERIALS AND METHODS

Five patients were diagnosed as having irreducible AAD based on preoperative dynamic and post-traction X-rays [Table 1]. There were three males and two females averaging 14 years of age (range ages 4–32).

After general anesthesia, patients were placed in a prone neutral position utilizing skeletal traction, X-ray, and MEP monitoring. They then underwent a reduction by applying posterior thumb pressure, compressing the C2 spinous process anteriorly [Figure 1].

RESULTS

Full reduction of AAD with or without associated odontoid fractures, was successfully achieved and maintained in four patients; all four successfully underwent posterior

C1–C2 fusions [Figures 2 and 3]. The one patient who failed to achieve reduction required an initial trans-oral release followed by posterior C1–C2 fusions.

All patients achieved/maintained correction in spine alignment and bony fusion over a mean follow-up period of 14.4 months (4–23 months).

DISCUSSION

Differentiating between “reducible” and “irreducible” AADs is complicated. It is typically defined utilizing radiological investigations: dynamic and post-traction X-rays. Utilizing X-ray, traction, and MEP monitoring, we proposed utilizing a novel posterior C2 thumb compressive maneuver to differentiate between “reducible” and “irreducible” AADs [Figure 1].

Sharp and Purser described a procedure of manual reduction of atlantoaxial subluxation in patients with atlanto-axial instability in patients with ankylosing spondylitis and/or rheumatoid arthritis. The anterior subluxation in the flexed position was reduced by extension and, consequently, increased the space available for the cord.^[4]

“Reducible” AAD requires posterior fusion alone whereas an “irreducible” AAD requires an anterior transoral decompression/release followed by a posterior fusion.^[3,5] In 2006, Wang *et al.*^[5] described that most “irreducible” AADs could be reduced following anterior release of contracted soft tissues. Srivastava *et al.*^[3] similarly showed that anterior release followed by an instrumented posterior fusion was safe and effective for “irreducible” AAD associated with basilar invagination.

CONCLUSION

Here, we defined irreducible AAD into two categories: a) reducible—those for whom posterior-anterior C2 thumb

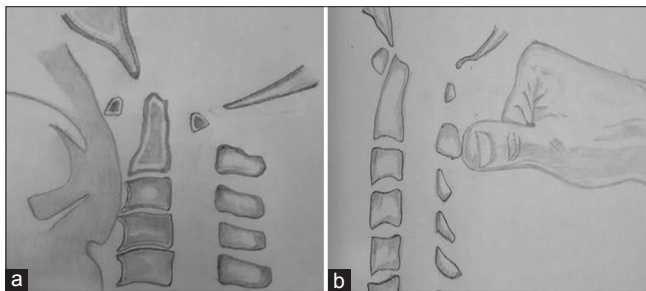


Figure 1: (a) AAD with canal narrowing at C1. (b) Intraoperative thumb maneuver (pushing of C2 spinous process anteriorly) after positioning under general anesthesia showing reduction of AAD

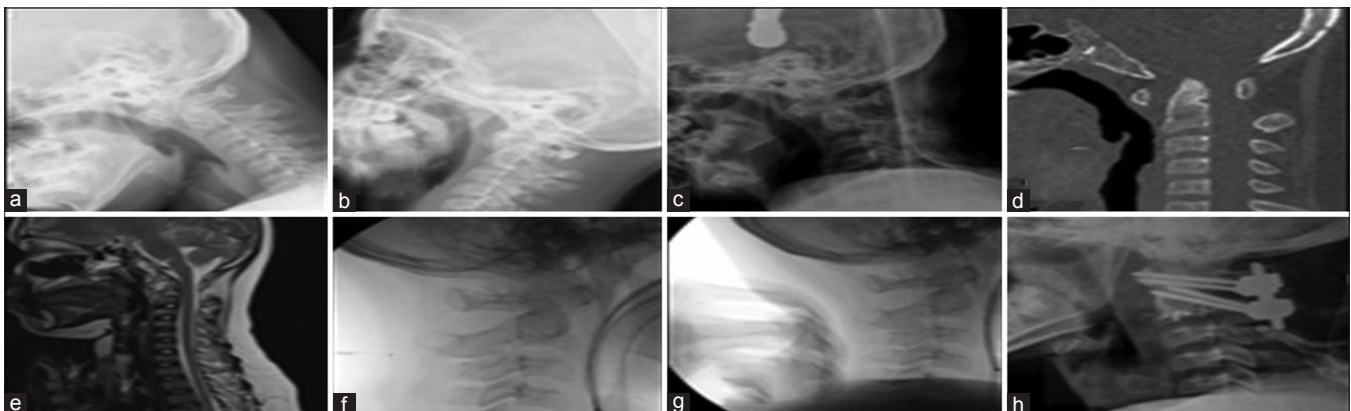


Figure 2: Case 1 atlantoaxial dislocation (AAD) without fracture: (a) preoperative X-ray showing irreducible AAD in flexion, (b) preoperative X-ray showing irreducible AAD in extension, (c) post-traction X-ray showing irreducible AAD, (d) midsagittal computed tomography spine showing AAD with canal narrowing, (e) Magnetic Resonance Imaging cervical spine showing AAD at C1 with obliteration of anterior CSF spaces, (f) intraoperative X-ray after positioning under general anesthesia before thumb maneuver showing AAD, (g) intraoperative X-ray after positioning under general anesthesia after thumb maneuver showing reduction of AAD, (h) postoperative implant *in situ* with reduction of AAD

Table 1: Summary of clinical data for all five patients

Patient	Age (years)	Sex	Clinical presentation	Duration	Dynamic X-ray	Post-traction X-ray	After intraoperative thumb maneuver	Surgery	Fusion at follow-up
1	14	M	Posttraumatic neck pain	7 days	Irreducible AAD	Irreducible AAD	Reduced	Posterior C1-C2 fusions	Fused
2	32	F	Progressive quadriplegia	12 months	Irreducible AAD	Irreducible AAD	Reduced	Posterior C1-C2 fusions	Fused
3	12	M	Progressive quadriplegia	15 months	Irreducible AAD	Irreducible AAD	Reduced	Posterior C1-C2 fusions	Fused
4	8	M	Neck pain and neck tilt	60 months	Irreducible AAD	Irreducible AAD	Reduced	Posterior C1-C2 fusions	Fused
5	4	F	Posttraumatic neck pain	1.5 months	Irreducible AAD	Irreducible AAD	Could not be reduced	Trans-oral release followed by Posterior C1-C2 fusions	fused

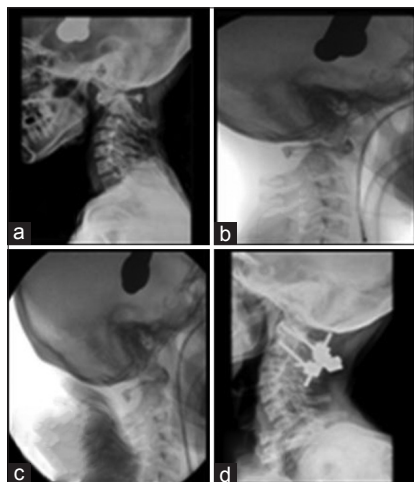


Figure 3: Case 2 AAD with odontoid fracture: (a) preoperative X-ray showing odontoid fracture with AAD, (b) intraoperative X-ray after positioning under general anesthesia before thumb maneuver showing AAD, (c) intraoperative X-ray after positioning under general anesthesia after thumb maneuver showing reduction of AAD, (d) postoperative X-ray showing implant *in situ* with reduction of AAD

maneuvers resulted in adequate reduction requiring posterior fusion alone and b) irreducible despite the thumb maneuver, warranting initial anterior release followed by posterior fusion.

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Conflicts of interest

There are no conflicts of interest.

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