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

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...
motor evoked potential [MEP] monitoring), a posterior fixation alone maintained reduction. Those with irreducible AAD, where the dislocation could not 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 with 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.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.⁵ 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

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**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 ADD in flexion, (b) preoperative X-ray showing irreducible ADD 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 canal narrowing at C1 with obliteration of anterior CSF spaces, (f) intraoperative X-ray after position under general anesthesia before thumb maneuver showing AAD, (g) intraoperative X-ray after position 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 quadriparesis | 12 months | Irreducible AAD | Irreducible AAD     | Reduced                           | Posterior C1-C2 fusions | Fused   |
| 3       | 12          | M   | Progressive quadriparesis | 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   |

Figures and text:

- 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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