Atlantoaxial fusion technique

Technical considerations

Some cases require incorporation of the occiput in addition to C1–2. Surgical options include: Rigid instrumentation:

1. C1-C2 fusion using polyaxial screws connected by rods:

a) C1: screws placed in lateral masses. May be used in cases where the posterior arch of C1 is compromised

b) C2 screw options:

● screws may be placed in pedicles (pars)

● screws may be placed in lateral masses

● crossed C2 laminar screws

2. C1–2 posterior transarticular facet screws (TAS)

Posterior cervical wiring and fusion. With the development of rigid fixation, these techniques are used less frequently. While they are poor in limiting rotation, they are effective in limiting flexion. And since the Dickman & Sonntag technique is effective in limiting extension, it has recently been used to offload C1 lateral mass screws which have a tendency to break at the point of entry to the bone of C1

1. Interspinous fusion technique of Dickman and Sonntag

2.

a) Brooks fusion (the Smith-Robinson technique as modified by Griswold): C1 to C2 sublaminar wires with 2 wedge bone grafts

b) Gallie fusion and its modifications: midline wire under the arch of C1 with an “H” bone graft

-Halifax clamps with fusion. These clamps are effective in minimizing movement in flexion, but are less stable in extension or with rotation

Odontoid compression screw fixation. Essentially only for odontoid Type II fractures <6 months old with intact transverse ligament. Preserves more mobility than C1–2 fusion

Combined anterolateral and posterior bone grafting.

Combining anterior (transoral) decompression with posterior fusion. Indicated when a significant anterior mass is present causing neural compression and/or making passage of sublaminar wires at C1 unsafe.

Techniques of atlantoaxial fusion

Positioning

The patient is placed in a halo ring (with a gap in the back and secured to the table using a Mayfield adapter) or Mayfield pin fixation and is then placed prone on the operating table on chest rolls. The table will usually need to be positioned in a maximal reverse Trendelenburg position to bring up the surgical area. The patient's feet are allowed to rest on a padded footplate on the table to prevent the patient from sliding down. Lateral intraoperative x-rays are taken after patient positioning.

Incision and approach

A midline skin incision is made from just below the inion to the spinous process C5 or C6.

C1–2 transarticular facet screws

C1–2 transarticular facet screws.

see C1–2 lateral mass screws.

C1-3 lateral mass-sublaminar axis cable fixation technique

Ten consecutive patients underwent the combined C1-3 lateral mass-sublaminar axis cable fixation technique. The mean age of the patients was 62.6 years (range 23-84 years). There were six men and four women. Eight patients were treated after traumatic atlantoaxial instability developed (four had remote trauma and previous nonunion), whereas in the other two atlantoaxial instability was caused by arthritic degeneration. All had VA anatomy unsuitable to traditional transarticular screw fixation. There were no intraoperative complications in any of the patients. Postoperative computed tomography studies demonstrated excellent screw positioning in each patient. Nine patients were treated postoperatively with the aid of a rigid cervical orthosis. The remaining patient was treated using a halo fixation device. One patient died of respiratory failure 2 months after surgery. Follow-up data (mean follow-up duration 13.1 months) were available for seven of the remaining nine patients and demonstrated a stable construct with fusion in each patient. The authors present an effective alternative method in which C1-3 lateral mass screw fixation is used to treat patients with unfavorable anatomy for atlantoaxial transarticular screw fixation. In this series of 10 patients, the method was a safe and effective way to provide stabilization in these anatomically difficult patients. [1).

see Anterior transarticular screw fixation.

Screws

Several screw-based constructs have been developed for atlantoaxial stabilization.

Metaanalysis of the existing literature showed that all constructs provided significant stabilization in all axes of rotation, except for the C1 lateral mass-C2 translaminar screw fixation (C1LM-C2TL) construct in lateral bending. There were significant differences in stabilization achieved in each axis of motion by the various screw constructs. These results underline the various strengths and weaknesses in biomechanical stabilization of different screw constructs. There was significant heterogeneity in the data reported across the studies. Standardized spinal motion segment configuration and injury models may provide more consistent and reliable results [2].

Minimally invasive atlantoaxial fusion

Minimally invasive techniques are being increasingly used to treat disorders of the cervical spine. They have a potential to reduce the postoperative neck discomfort subsequent to extensive muscle dissection associated with conventional atlantoaxial fusion procedures. The aim of a paper was to elaborate on the technique and results of minimally invasive atlantoaxial fusion.

Minimally invasive atlantoaxial fusion was done initially in 4 fresh-frozen cadavers and subsequently in 5 clinical cases. Clinical cases included patients with reducible atlantoaxial instability and undisplaced or minimally displaced odontoid fractures. The surgical technique is illustrated in detail.

Among the cadaveric specimens, all C-1 lateral mass screws were in the correct position and 2 of the 8 C-2 screws had a vertebral canal breach. Among clinical cases, all C-1 lateral mass screws were in the correct position. Only one C-2 screw had a Grade 2 vertebral canal breach, which was clinically insignificant. None of the patients experienced neurological worsening or implant-related complications at follow-up. Evidence of rib graft fusion or C1-2 joint fusion was successfully demonstrated in 4 cases, and flexion-extension radiographs done at follow-up did not show mobility in any case.

Minimally invasive atlantoaxial fusion is a safe and effective alternative to the conventional approach in selected cases. Larger series with direct comparison to the conventional approach will be required to demonstrate clinical benefit presumed to be associated with a minimally invasive approach [3].

Videos

<html><iframe width=“560” height=“315” src=“https://www.youtube.com/embed/tjgCJiQUAww” frameborder=“0” allowfullscreen></iframe></html>

This is a surgical technique video demonstrating posterior atlantoaxial fusion (C1 lateral mass - C2 pedicle screw fixation) Goel technique as described by Dr. Goel and Dr. Laheri, which was subsequently modified by Dr. Jürgen Harms.

1)
Horn EM, Hott JS, Porter RW, Theodore N, Papadopoulos SM, Sonntag VK. Atlantoaxial stabilization with the use of C1-3 lateral mass screw fixation. Technical note. J Neurosurg Spine. 2006 Aug;5(2):172-7. PubMed PMID: 16925087.
2)
Du JY, Aichmair A, Kueper J, Wright T, Lebl DR. Biomechanical analysis of screw constructs for atlantoaxial fixation in cadavers: a systematic review and meta-analysis. J Neurosurg Spine. 2015 Feb;22(2):151-61. doi: 10.3171/2014.10.SPINE13805. Epub 2014 Dec 5. PubMed PMID: 25478824.
3)
Srikantha U, Khanapure KS, Jagannatha AT, Joshi KC, Varma RG, Hegde AS. Minimally invasive

atlantoaxial fusion: cadaveric study and report of 5 clinical cases. J Neurosurg Spine. 2016 Dec;25(6):675-680. PubMed PMID: 27420396.