Posterior Cervical Arthrodesis
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Indications
Posterior and posterolateral access to the cervical spine:
- Laminectomy for decompression
- Intradural tumor removal, cordotomy
- Arthrodesis, instrumentation, deformity correction, laminoplasty
- Posterior cervical diskectomy

◆ Preoperative

Operative Planning
- Imaging
  - Magnetic resonance imaging (MRI)
  - Computed tomography (CT) myelogram if MRI is inconclusive
  - Flexion/extension x-rays
- Patient counseling regarding surgical risks
  - Postoperative pain
  - Potential joint instability

Equipment
- Basic spine tray
- High-speed drill (Midas Rex with AM-8 bit)
- 1- and 2-mm Kerrison punches

Operating Room Set-up
- Headlight
- Loupes
- Microscope
- Bipolar cautery and Bovie cautery
- Intraoperative x-ray
- Intraoperative fluoroscopy
- Mayfield head holder

Anesthetic Issues
- Consider awake fiberoptic intubation to avoid passive neck extension.
- Assess patient's pulmonary function for ability to tolerate prone position.
- Administer prophylactic intravenous antibiotics (cefazolin 2 g for adults) 30 minutes prior to incision.
- Use Foley catheter for prolonged surgery.
**Intraoperative (Fig. 102.1)**

**Positioning**
- Prone position with appropriate padding to prevent pressure neuropathies
- Arms tucked at sides
- Mayfield head holder or tongs with traction to secure head in capital flexion
- Mild reverse Trendelenburg position for venous drainage
- Intraoperative fluoroscopic imaging used to confirm cervical alignment

**Planning of Minimal Shave**
- Use disposable razor.

**Planning of Sterile Scrub and Preparation**
- Betadine detergent scrub with sterile gloves for 5 minutes
- Alcohol to remove Betadine scrub
- Sterile towel to dry
- Incision is marked

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**Fig. 102.1** Schematic of posterior cervical arthrodesis.
Mark Incision

- Localization using C2 and C7 landmarks
- Intraoperative x-ray
- Mark the midline incision.

Exposure

- Spine exposed via midline incision
- Paraspinal muscles elevated and subperiosteal dissection continued to lateral margin of involved facets
- Localization confirmed with intraoperative imaging
- Retractor placement (curved Weitlaner or Adson-Beckman)

Bone Removal

- Identify junction of lamina and lateral mass to preserve integrity of facet capsule.
- Thin lamina using high-speed Midas Rex with AM-8 bit.
- A small rongeur can be used to complete troughs to level of the dura.
- A curet or thin-footed Kerrison punch can be used to remove ligamentous attachments to the lamina.
- Laminae can then be removed en bloc.
- Bleeding can be controlled with Gelfoam and/or bone wax.

Arthrodesis

- There are several bony posterior elements available to place instrumentation, depending on the patient's anatomy and pathology and the surgeon's experience.
- Targets include spinous processes, facets, lateral masses, pedicles, and laminae.

Interspinous Wiring

- In interspinous wiring, intact posterior elements are needed for fixation, and occasionally uninjured segments must be incorporated into the construct for adequate stabilization.
- Osteopenic bone is not well suited to this technique.
- Multistranded cables made of stainless steel, titanium, polyethylene, or monofilament stainless steel are used.
- The Rogers technique is employed for injuries to the posterior ligamentous complex or facet capsule, or both, in the absence of bony injury.
  - At surgery, a transverse hole is made with a small bur at the base of the spinous processes to be instrumented.
  - The wire or cable is passed through the hole of the superior spinous process, looped around the spinous process superiorly, then passed back through the hole.
  - The wire is next passed through the hole of the inferior spinous process, looped around the spinous process inferiorly, then passed back through the hole.
  - The wire or cable is secured under tension. Fusion is achieved with bone graft placed between decorticated laminar surfaces.
The Bohlman triple-wiring technique is an evolution of the Rogers interspinous wiring technique and imparts greater biomechanical stability.

- First, the Rogers interspinous wiring is performed; two additional wires are then passed through the spinous processes and looped around each respective spinous process, if space permits.
- Each cable is next passed through corresponding holes in two corticocancellous autologous bone grafts placed on either side of the spinous processes.
- The ends of each wire or cable are then secured under tension.

The Dewar procedure or tension band configuration is another variation on interspinous wiring.

- Two corticocancellous strips of bone are placed on the lateral surfaces of the spinous processes and medial laminae of the vertebrae to be fused.
- Threaded Kirschner wires (K-wires) are introduced percutaneously to affix the bone grafts to the spinous processes and cut with 1 cm of overhang laterally.
- The wire is threaded around the K-wires in a Gallie-type fashion. Cervical flexion thus causes medially directed pressure on the bone graft.

**Facet Wiring**

- Facet wiring is used for unilateral or bilateral facet dislocations or in instances in which the posterior neural arch has been damaged or surgically removed.
- Holes are drilled in the inferior facet processes at a 90-degree angle relative to the articular surface while protecting the superior facet processes with a Penfield dissector.
- Wire or cable is then passed through each hole and tightened around longitudinal strut grafts for fusion.
- For improved stiffness in axial rotation, facets are secured to the spinous processes.
  - The inferior facet processes are drilled in a fashion similar to that described, and the wire or cable is passed from the facet to the spinous process of the level below.
  - The wire or cable is then wrapped around the spinous process or looped through a hole drilled at the base of the spinous process of the vertebra below.
  - This technique affords improved stiffness in axial rotation over interspinous wiring or the Robinson and Southwick facet-wiring technique.

**Sublaminar Wiring**

- Sublaminar wiring is used extensively for instrumentation of the subaxial cervical spine.
- Braided cable is the preferred material to use for passing wire into the neural canal because it may be doubled over on itself and the blunt end passed more safely beneath the laminae.
- After bilateral cable placement, a bone graft is placed in the interspinous space or along the laminar surface, and the cable is tightly secured by crimping.
- Sublaminar cables may be used as fixation points for segmental instrumentation.
  - A Luque rectangle, a variant of facet wiring, consists of a metal rod in the shape of a rectangle that is affixed to the facets in a manner similar to the Robinson and Southwick facet-wiring technique.
  - Sublaminar wires are then placed one level cephalad and one level caudal to the levels of fusion and tightened to the horizontal portion of the metal rod.
  - This method has improved biomechanical stiffness and decreased range of motion compared with facet wiring alone.
• It may be used after surgical decompression with laminectomies that span multiple levels.

Lateral Mass Screw Fixation

— Careful preoperative consideration of the patient’s anatomy is needed, especially in degenerative cases where the anatomy is distorted, thereby risking potential vascular injury with screw placement.
— Lateral mass screw fixation is particularly useful in cases in which the spinous processes and laminae are compromised or absent, and fixation of the posterior neural arch is not possible with interspinous wiring or other techniques.
— The boundaries of the posterior surface of the lateral mass serve as a guide to the screw entry point (the lateral facet edge, the medial facet line, and the articular lines superiorly and inferiorly).
— Any one of several lateral mass screw placement techniques may be used, each with a different entry point and trajectory.
  • The Roy-Camille method begins with an entry point at the center of the lateral mass with 10 degrees of lateral angulation and 0 degree of cephalad angulation, although it may lead to a higher risk of facet violation than other techniques.
  • The Magerl technique uses an entry point 2 to 3 mm medial and cephalad to the midpoint of the lateral mass with 25 degrees of lateral angulation and a cephalad angulation that is parallel to the articular surface of the facet joint.
  • A modified technique uses an entry point located 1 mm medial to the midpoint of the lateral mass with 30 degrees of lateral angulation and 15 degrees of cephalad angulation. It represents the lowest risk of neurovascular injury with bicortical purchase.
— Lateral mass screws ranging in diameter from 2.7 to 4.5 mm may be used, and screw length may be 10 to 16 mm.
— Fusions supplemented with lateral mass screws and rods or plates are associated with an overall fusion rate of 80 to 95%, depending on the indication for fusion.

Transpedicular Screw Fixation

— Other than at C7, transpedicular screw fixation is technically more difficult and associated with more potential risks to neurovascular structures than lateral mass screw placement.
— Indications include deformity or instability in patients with poor bone quality, particularly those with osteopenia or rheumatoid arthritis, especially if instrumentation spanning several segments is needed.
— The entry point for cervical transpedicular screws at C3 to C6 is slightly lateral to midline of the posterior surface of the lateral mass and just inferior to the articular line.
— A high-speed bur is used to create the screw entry point, followed by insertion of a pedicle probe under fluoroscopic guidance.
— The suggested trajectory is 25 to 45 degrees medially in the axial plane and parallel to the superior end plate in the sagittal plane.
— Transpedicular screws are placed more frequently at C7 because the lateral masses of C7 are often unsuitable for placement of lateral mass screws, and the C7 pedicle is a wider target than the C3–C6 pedicles.
— The screw entry point for C7 is halfway between the medial facet line and the lateral facet edge in the mediolateral dimension and 1 mm inferior to a horizontal line bisecting the base of the transverse process in the craniocaudal dimension.
• The base of the transverse processes should be exposed; alternatively, a limited laminectomy may be performed to palpate the C7 pedicle to aid in accurate screw placement.
• Once the proper entry point has been located, the cortical surface is perforated with a bur to a depth of 5 mm.
• The pedicle is then cannulated to an appropriate depth at a medial angulation of 35 to 45 degrees and a caudal angulation of 5 degrees from the inferior end plate of C7.

Laminar Hooks

— Laminar hooks require the presence of intact posterior elements; however, they expose the patient to the risk of neural injury because of the presence of the hook in the spinal canal.
— If placed properly, hooks have higher resistance to pullout than either lateral mass or transpedicular screws.
— Other than at C7, the use of laminar hooks is technically more difficult and associated with more potential risks to neurovascular structures than lateral mass screw placement.
— Indications include deformity or instability in patients with poor bone quality, particularly those with osteopenia or rheumatoid arthritis, especially if instrumentation spanning several segments is needed.

Other Fixation Techniques

— A hook plate is a seldom used internal fixator applied for posterior stabilization over one or two motion segments for discoligamentous injury not involving the vertebral body.
  • The hook is placed under the lamina of the lowest level, where a notch is made to resist movement.
  • A bone graft is placed in the interspinous space, and the hook is secured at the cephalad level with a lateral mass screw (Magerl technique).
  • Tightening of the screw creates axial compression, whereas the bone graft resists extension forces.
— Another seldom used technique of posterior cervical instrumentation is the interlaminar or Halifax clamp.
  • In this technique, the clamp is placed unilaterally or bilaterally and tightened until no movement is detected.
  • Bone graft is placed in the interspinous region to allow bony fusion.

Closure

— Standard closure for layers
— Irrigation of wound with saline
— Marcaine (0.25%) with 1:100,000 epinephrine injected into paraspinal muscles to diminish postoperative pain
— Hemovac drain for 24 hours

◆ Postoperative

— Soft collar as needed
— Antibiotics given for 24 hours postoperatively
— Obtain upright lateral x-ray to assess alignment.
Complications

- Kyphosis
- Nerve root injury
- Infection
- Epidural hematoma
- Cerebrospinal fluid leak
- Vertebral injury
- Segmental instability