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Occipitocervical Fixation

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Highlights

Instability of the craniocervical junction may result from a variety of pathological conditions, including trauma, tumor, infection, and a host of abnormalities;[1–6] however, because the stability of the upper cervical spine and craniocervical junction is more dependent upon the lateral masses than the anterior elements, occipitocervical stabilization is usually an integral part of any surgical procedure.

The CerviFix occipitocervical fixation system is a novel fixation device that consists of an occipital plate/rod that bridges the occipitocervical junction and interfaces with cervical lateral mass screws (designed for posterior stabilization of the cervical and upper thoracic spine). This low-profile system possesses the flexibility necessary to ensure optimal implant placement that accommodates varying patient anatomy.[7]

Indications and Contraindications

The CerviFix system for occipitocervical fixation is indicated in patients suffering from suboccipital instability that includes the C1–C2 complex.[8–12] These indications include:

- Bony instabilities resulting from tumors in patients who have life expectancies > 3 months and suffer from neck pain. This includes patients with pathological dens fracture with either or both angulation and displacement, epidural disease with spinal cord compression, disease progression with instrumentation failure, or rotatory atlantoaxial subluxation (Fig. **5–1**).[7] Other causes of bony instability include infection, degenerative joint deformation, and fractures.
- Ligamentous instabilities, resulting from either inflammatory conditions (rheumatoid arthritis) or posttraumatic rupture of the atlantoaxial ligamentous complex
- Iatrogenic instabilities resulting from excessive bone resection during tumor removal or resection of the odontoid[10]

The contraindications include:[7,10]

- Poor health and/or life expectancy < 3 months
- Obese patients with short neck
- Anatomical malformation
- Severe osteoporosis
- Abnormal anatomy of the vertebral artery

Description of System Components

Implants

- Titanium occipital plate/rod (Fig. **5–2**)
- Titanium hooks right/left (Fig. **5–3**)
- 3.5 mm titanium rod, 80 mm/120 mm/240 mm

Instruments

- Bending pliers for 3.5 mm titanium rods (Fig. **5–4**)
- Holding forceps (for titanium rods) (Fig. **5–5**)
- Small hexagonal screwdriver with holding sleeve (Fig. **5–6**)

Clamps/Rods/Screws

- Titanium clamps, medial/lateral/neutral (Fig. **5–7**)
- 3.5 mm/4.0 mm titanium cancellous bone screw, fully threaded, 8 to 40 mm (2 mm increments)

Operative Techniques

Preparation and Positioning

Patients are placed prone on bolsters, and fixation is achieved with cranial pins. In patients suffering from spinal cord compression or significant instability, awake

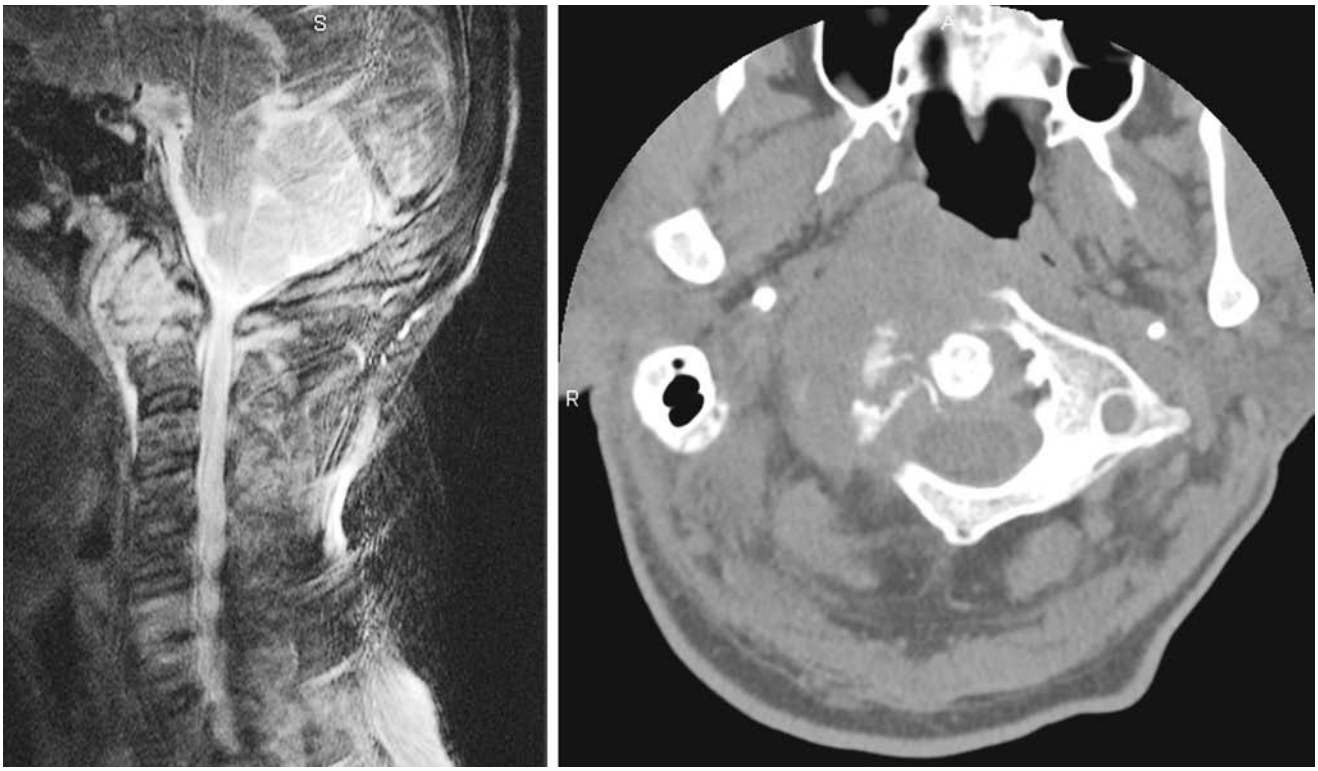

FIGURE 5–1 Imaging studies obtained in a 43-year-old man who presented with neck pain, torticollis, and lower cranial nerve deficits; a renal cell carcinoma metastatic to the right occipital condyle and lateral mass of C1 caused a rotatory atlantoaxial subluxation. **(A)** sagittal T2-weighted magnetic resonance image demonstrating lytic tumor and **(B)** axial computed tomographic scan.

FIGURE 5–2 Occipital plate–rod.

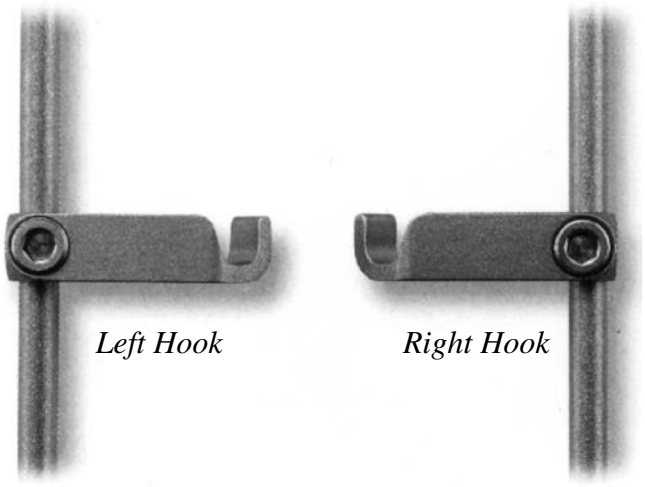

FIGURE 5–3 Titanium hooks.

FIGURE 5–4 Bending pliers.

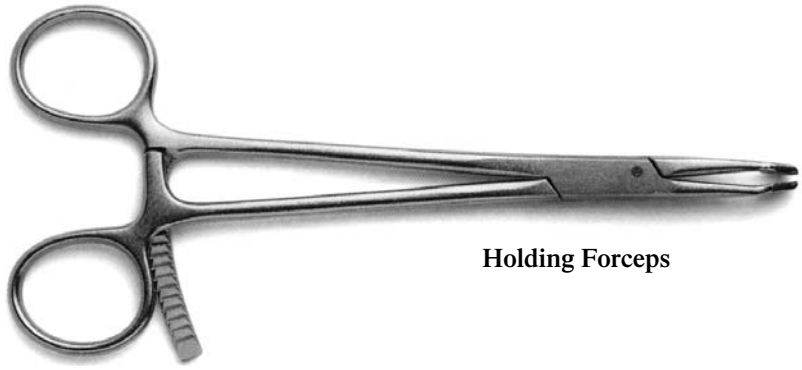

FIGURE 5–5 Holding forceps that hold the 3.5 mm titanium rods.

FIGURE 5–6 Small hexagonal screwdriver with holding sleeve that tightens the clamp and hook to the rod. This is used to insert the 3.5 mm and 4.0 mm cancellous screws.

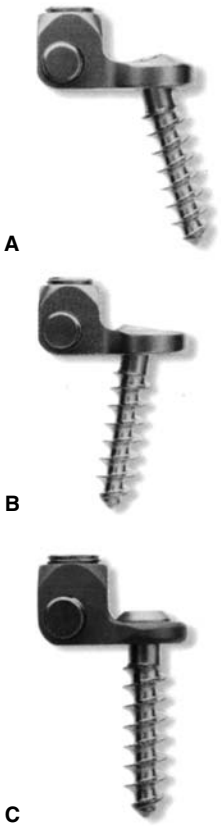

FIGURE 5–7 Titanium clamps, **(A)**, medial **(B)**, lateral and **(C)** neutral.

fiberoptic intubation and positioning are recommended. Following positioning, intraoperative radiography is used to ensure ideal cervical alignment, and somatosensory and motor evoked potential monitoring is performed to evaluate the functional status of the spinal cord.[4] In the event of instability, reduction of C1 on C2 is assessed under fluoroscopy following positioning, and, if necessary, closed reduction is performed.[13]

Exposure

A midline incision and subperiosteal exposure of the occipital region and the cervical spine are performed (Fig. **5–8**). The following structures are exposed: the occiput, posterior ring of the atlas, posterior elements of C2, spinous processes, vertebral archers, and articular masses of those vertebrae that will be included in the fusion. As necessary, decompression of the spinal cord is performed by way of laminectomy and posterior tumor debulking. In the event that transarticular screw fixation of C1–C2 is necessary, bilateral exposure of the isthmus of C2 is necessary.[13]

Template

A template is shaped such that its cranial end is adjacent to the midline, just caudal to the occipital protuberance.

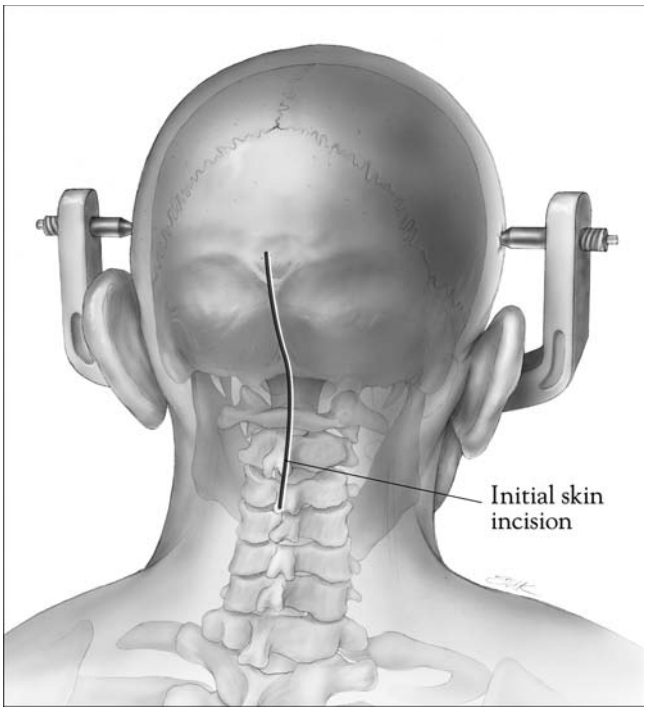

FIGURE 5–8 An artist's rendering of the incision location and patient fixation.

The remainder of the template should pass over the lateral rims of the articular processes of the levels that are to be fused. The template is subsequently used to shape the occipital rod.[13]

Bending of the rod–plate complex is perhaps the most difficult part of the procedure. First, the plate portion of the rod–plate device should be bent while keeping the construct in the same plane so that the plate can be positioned as close to the midline as possible while the rod portion is positioned laterally to be able to attach to the lateral cervical mass screws and if necessary to the C1–C2 trasarticulator or C2 pedicle screws. Craniocervical contouring is then achieved by bending the rod–plate device at the junction to ~110 degrees in the sagittal plane. At this point, the rod is attached to the lateral cervical mass screws loosely, and the plate is advanced to the occiput to be flush with the bone. Bicortical occipital screw holes are then drilled with a preset drill guide to avoid dural penetration. After fixation to the occiput, usually by three screws on each side, rods are fixed on the lateral mass screws by tightening nut attachments. If desired, a cross-connecting device can be used to achieve further rotational stability.

Screw Insertion

The holes that will contain the C1–C2 transarticular screws are the first to be drilled. The drill bit is left inside on one side as the instrumentation proceeds on the other side to provide for temporary stabilization. The most caudal screw hole in the vertebrae in need of stabilization is then drilled. The intended clamps are subsequently tentatively mounted on the rod, and the C1–C2 transarticular screw is the first to be inserted through its clamp, followed by the most caudal screw. The next step involves drilling through the occipital plates and inserting the appropriate screws. To ensure optimal purchase, care should be taken to place the cranial ends of the occipital plates as close to the midline as possible. Next, the intermediate lateral mass clamps are positioned and the holes are drilled, and after measuring the depth the screws are inserted. After instrumentation in this fashion has been performed bilaterally, a cross-link is applied, and a mixture of allograft bone chips and demineralized bone matrix is applied on the decorticated vertebral components: the decorticated laminae and articular masses. In addition, a corticocancellous bone graft is inserted between the occiput and the C2 spinous process (Figs. **5–9**, **5–10**, and **5–11**).[7,13]

Complications and Avoidance

- Dural penetration during occipital screw fixation: A preset drill guide and gradual advancement usually help avoid this complication. If cerebrospinal fluid is encountered, then the insertion of the appropriate length screw usually stops the leak. Patients should be closely monitored postoperatively to make sure they do not develop a posterior fossa hemorrhage.
- Suboptimal contouring of the rod–plate combination: The surgeon needs to be very diligent not to overextend or overflex the head to avoid any difficulty breathing or swallowing, or voice change. Optimal angle is ~110 degrees, with the head slightly translated anteriorly.
- Vertebral artery injury: During the insertion of either the C1–C2, C2 pedicle, or cervical lateral mass screws, if arterial bleeding is encountered, no screws should be placed on the opposite side to avoid potential bilateral injury that could be fatal; however, insertion of ipsilateral screws is recommended to stop bleeding along with a postoperative angiogram to rule out pseudoaneurysm formation, which requires balloon embolization of the parent vessel.[7]

Discussion

Occipitocervical fixation is a technically demanding procedure. The CerviFix device allows insertion to the lateral mass, C2 pedicle, and C1–C2 transarticular

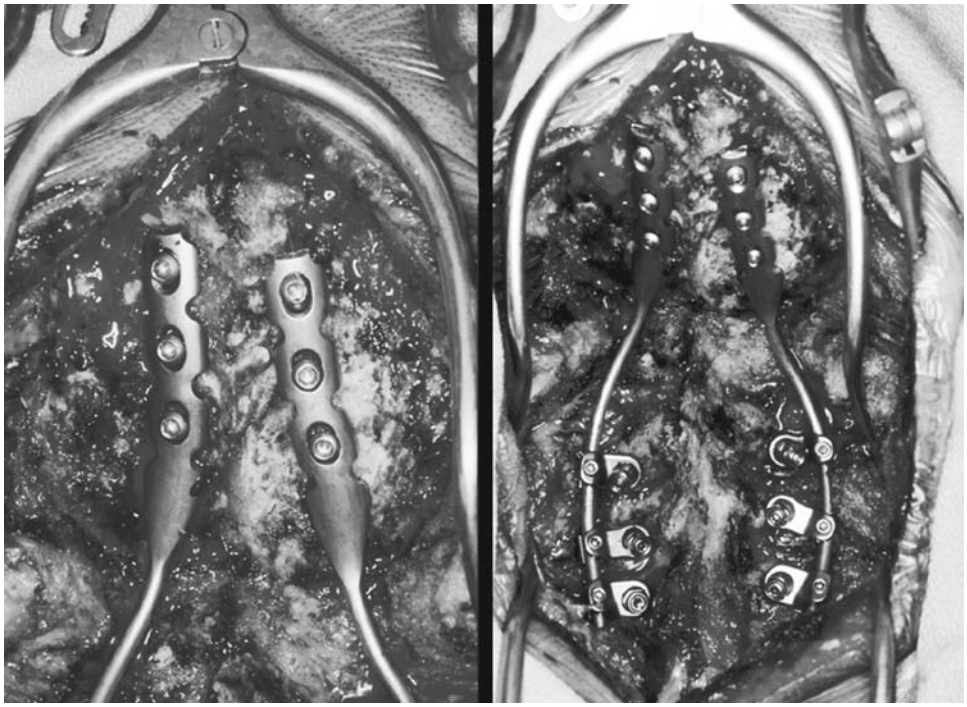

FIGURE 5–9 Intraoperative photographs demonstrating the instrumented occipitocervical fusion.

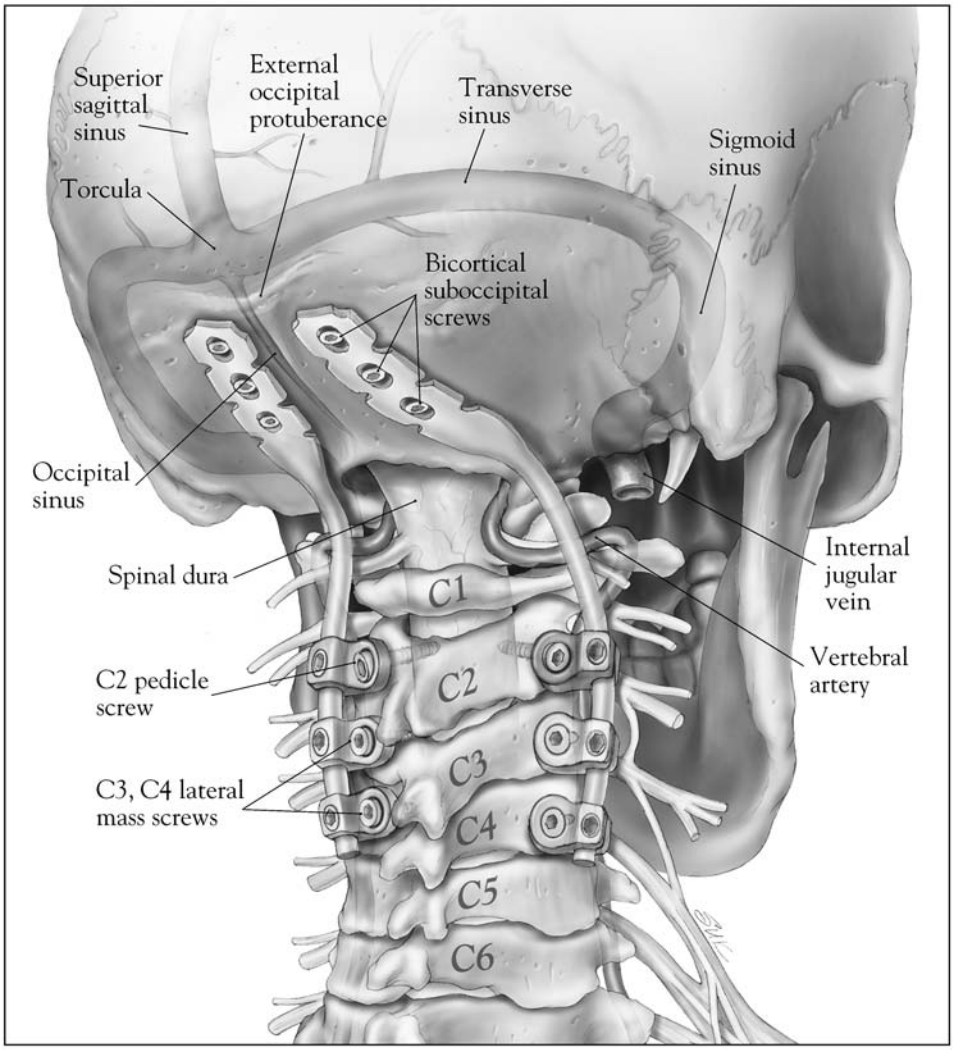

FIGURE 5–10 An artist's rendering of the occipitocervical fixation construct. Bicortical occipital and lateral mass screw purchase is obtained, and C2 pedicle screws are placed.

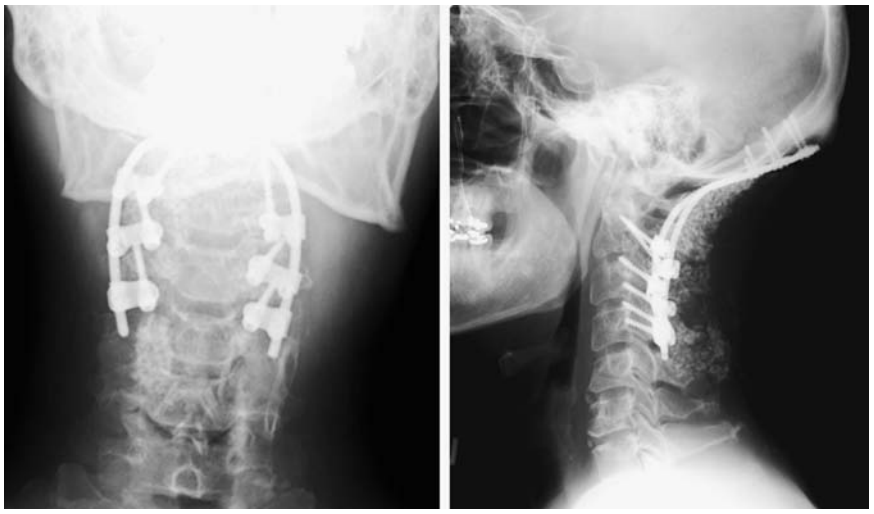

FIGURE 5–11 (A) Postoperative anteroposterior and **(B)** lateral plain x-ray films revealing the bicortical occipital and lateral mass (C3 and C4) screws, as well as the C2 pedicle screws.

screws in optimal anatomical positions. The multicomponent features of the device offer a great deal of flexibility. The most challenging aspect of the procedure is proper bending of the rod–plate fixation device. Significant attention should be paid to the proper positioning of the head with respect to the cervical spine to avoid significant long-term complications.

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