130 Cervical Facet Dislocation: Strategy for Reduction, Decompression, and Stabilization

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SUMMARY OF KEY POINTS

- Cervical facet dislocations are associated with high-energy trauma to the spine.
- Cervical facet dislocations may be treated by closed reduction, open posterior reduction and stabilization, or open ventral decompression, reduction, and stabilization.
- Open posterior reduction can usually be accomplished by drilling away the superior articular processes of the caudal vertebra. A clamp can then be used to pull the spinous process of the rostral vertebra back into alignment.
- Ventral surgery should be strongly considered when a large disc herniation compresses the spinal cord. This allows direct decompression and thereby reduces the risk of iatrogenic spinal cord injury.
- Ventral reduction may be accomplished by either the interbody spreader or vertebral body post techniques.
- The surgeon should be aware that ventral reduction may be unsuccessful and an additional dorsal procedure may be required in some patients. This usually requires dorsal reduction and stabilization then a return to complete the ventral interbody fusion. This is termed 540-degree surgery.
- Spinal cord monitoring may be considered during the reduction of cervical facet dislocations and may provide intraoperative guidance to prevent spinal cord injury.

Much controversy surrounds the management of subaxial cervical subluxations resulting from facet fracture-dislocation.[1-12] Treatment of cervical facet-dislocations can include closed reduction, ventral decompression, reduction, and stabilization, or dorsal reduction and stabilization techniques. Closed reduction with skeletal traction is the quickest way to reestablish normal spinal alignment. The successful reduction of a facet-dislocation immediately reestablishes the patency of the spinal canal and decompresses the spinal cord in the absence of a concomitant disc herniation. An initial attempt of closed reduction, however, is not without risk.[13-19] The most serious complication of cervical traction and closed reduction is the retropulsion of disc fragments into the spinal canal and the resultant spinal cord compression (Fig. 130-1). Several reports of neurologic deterioration after closed reduction in the setting of concurrent disc herniation have been described.[20-25] In addition, late instability is relatively common in patients treated with closed reduction alone, because of the concomitant presence of significant ligamentous disruption associated with these injuries.[1-4,26]

The surgical technique for the open reduction of unstable cervical dislocations varies from surgeon to surgeon. Most reports have described dorsal reduction techniques.[21,22,27-32] However, the ventral surgical approach for reduction has its advocates.[33] Several small series have been published that describe the technique of ventral reduction of locked facets.[20,34-40] Because of the popularization of dorsal fixation techniques (e.g., lateral mass instrumentation and spinous process wiring), ventral reduction has not been widely used in clinical practice. However, an increasing concern has been raised regarding the danger associated with the dorsal reduction of a cervical spine dislocation in the presence of a ventral disc herniation.[20,22-27] Furthermore, because of the common coexistence of significant dorsal bony and soft tissue disruption, a three-vertebral segment (two-motion segment) dorsal fixation is commonly required to stabilize a two-vertebral segment (one-motion segment) instability. In addition, in dorsal reduction of locked facets, it is commonly necessary to remove a significant portion of the involved facet(s), thus often mandating a three-vertebral segment dorsal fixation procedure. Conversely, ventral reduction is followed by arthrodesis of only a single-motion segment, thus sparing additional motion segments from arthrodesis.

Kwon and colleagues[41] concluded that both ventral stabilization and dorsal stabilization for unilateral cervical facet injuries were valid treatment options. In this randomized study of 42 patients with unilateral cervical facet injuries, patients undergoing a ventral approach had a lower rate of wound infection, had a higher rate of radiographically demonstrated union, and healed in a more lordotic alignment. However, they also more frequently had dysphagia and voice changes in the early postoperative period in comparison to the group treated with dorsal stabilization.

The utility of neuromonitoring during reduction is also controversial. Use typically varies from center to center. Du and colleagues[42] recommended the use of spinal cord monitoring in ventral cervical facet dislocations utilizing somatosensory and motor evoked potentials. In their case series of 17 patients, they were able to demonstrate improvement in somatosensory amplitude latency in 12 patients. In addition, they were able to recognize impending spinal cord injury in 1 out of 17 patients during traction. After reduction of the traction weight, the patient recovered signal within 5 minutes. It is, however, important to remember that spinal cord monitoring in severe spinal cord injury may not be possible due to the already incurred damage. Additionally, the availability of monitoring on an emergent basis may be limited in many institutions.

This chapter reviews closed reduction, dorsal reduction, and ventral reduction techniques.

TECHNIQUE

Closed Reduction

In the literature, closed reduction is successful in approximately 64% to 91% of patients with cervical facet dislocations.[43-46] Although closed reduction is the quickest way to reestablish spinal alignment, it is not without risk in the

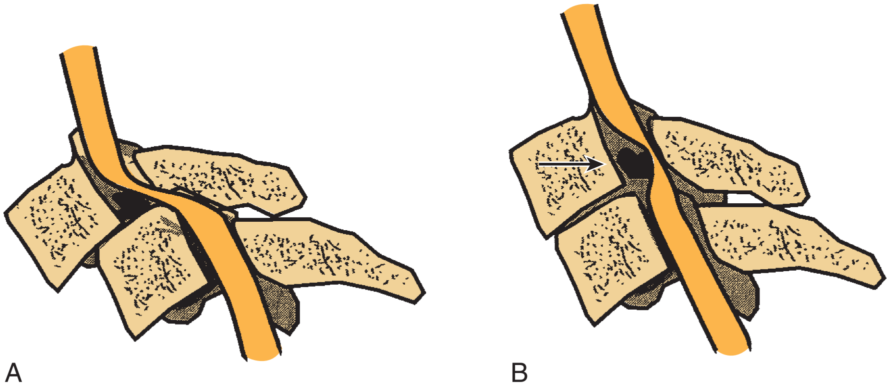

Figure 130-1. A typical bilateral facet dislocation with disc extrusion. A, Note that the spinal cord is compressed predominantly by the dislocated caudal vertebral body and rostral lamina before reduction. **B,** After reduction, the large fragment of extruded disc has been retropulsed into the spinal canal (*arrow*), resulting in spinal cord compression. *(From University of New Mexico, Division of Neurosurgery, Albuquerque, with permission.)*

presence of a concomitant disc herniation. The incidence of extruded cervical disc herniation associated with cervical spine injury has been reported to be 0.7% to 42%.[20-22,24,47] Reduction of the dislocation with the potential for retropulsion of disc material into the reduced and realigned spinal canal may result in significant spinal cord encroachment. This relatively uncommon event may occur with either open or closed reduction strategies, and is avoided by the removal of the potentially offending disc before reduction (see Fig. 130-1). Although magnetic resonance imaging (MRI) is useful in predicting this event, it probably is not universally accurate. In fact, MRI may demonstrate the absence of intracanalicular disc fragments, whereas disc material could be retropulsed through a disrupted annulus into the spinal canal during reduction.[21] Obtaining a prereduction MRI is associated with two major disadvantages. First, the transport of a patient with an unstable facet dislocation to the MRI suite is not without risk—both in terms of patient manipulation and ability to monitor blood pressure and neurologic status during the scan. Second, transport to the MRI suite constitutes a delay in reduction of the dislocation and thereby delays decompression of the spinal cord. A survey of the members of the spine trauma study group has demonstrated that the treatment decision to obtain an MRI prior to closed or open reduction is variable and inconsistent among individual surgeons and between specialties.[48] Koivikko and associates[49] reported on 85 patients treated for cervical fracture and dislocation injuries who did not obtain a prereduction MRI and demonstrated no neurologic deterioration in any patient. However, multiple authors, including Olerud and Jonsson,[50] Robertson and Ryan,[51] and Mahale and colleagues,[52] all have reported neurologic decline after reduction in the setting of a significant disc herniation. Therefore, recommendations on the utility of MRI prior to definitive treatment remain controversial.

Different authors have described multiple closed-reduction techniques.[53-56] It is important to remember that no studies have been done that demonstrate the advantage of any technique over the other.

With closed reduction, tongs (Gardner-Wells or Crutchfield varieties) or a halo ring is applied to the patient's head. Local anesthetic is used to reduce pain at the pin entry sites. Some publications advocate the use of the halo ring, as it allows four-point fixation as opposed to two-point fixation with tongs. The rationale is that this allows more complete control of the head and neck.[53-56] In addition, patients may then be "connected" to a halo vest once closed reduction has occurred. Halo ring placement, however, takes longer to apply and is slightly more challenging in its application. The head circumference is measured and a properly sized halo ring is chosen. In addition, the head of the patient must be carefully lifted to place the two dorsal pins, which may be dangerous in the presence of an unstable injury. Gardner-Wells tongs, on the other hand, can be applied, regardless of head circumference and movement of the patient's head is not required. When two-point Gardner-Wells fixation is used, the tongs are placed 1 cm above the pinna in line with the external auditory meatus. The pins may be placed slightly anterior to allow a flexion moment to be applied to the skull and help with reduction of cervical facet dislocations. The halo or tongs are attached to a rope and pulley system that allows the application of weight. Although never studied, the initial weight used has traditionally been determined as 3 pounds per rostral injury level (i.e., C6-7 fracture dislocation six rostral vertebral levels × 3 pounds = 18 pounds of initial weight). Additional weight is added at 10- to 20-minute increments with radiographs at each of these intervals to assess for reduction; alternatively, fluoroscopy may be utilized for real-time imaging during the reduction. Intravenous muscle relaxation may be given to aid in reduction. It is critical to review the patient's neurologic status as well as assess the radiographs in detail for overdistraction at every weight level added. Once reduction has been achieved or if reduction has been deemed a failure, the patient is immobilized. Depending on surgical necessity, the patient is transported to the operating room for surgical stabilization.

DORSAL REDUCTION AND STABILIZATION

Dorsal reduction and stabilization has been the traditional method of open treatment of cervical facet dislocations. There is a relative contraindication to this technique in the setting of any significant ventral compression by intervertebral disc or bone fragments.[20,22-27] Multiple techniques have been described, which we will summarize here.[57-60] A standard midline dorsal incision is made and subperiosteal dissection is carried down to the dislocation and lateral to the edge of the facet joints. The dislocated facets are identified. Lateral mass fixation is employed above and below the dislocated segment. Then, reduction is attempted by a variety of maneuvers. One may attempt distraction of the dislocated facet joint by use of a small instrument, such as a small curette, placed between the inferior articular process of the rostral vertebra and the superior articulating process of the caudal vertebra (Fig. 130-2). This can be accomplished while simultaneously applying dorsally directed forces on the spinous process of the rostral vertebra with a Kocher clamp. A similar

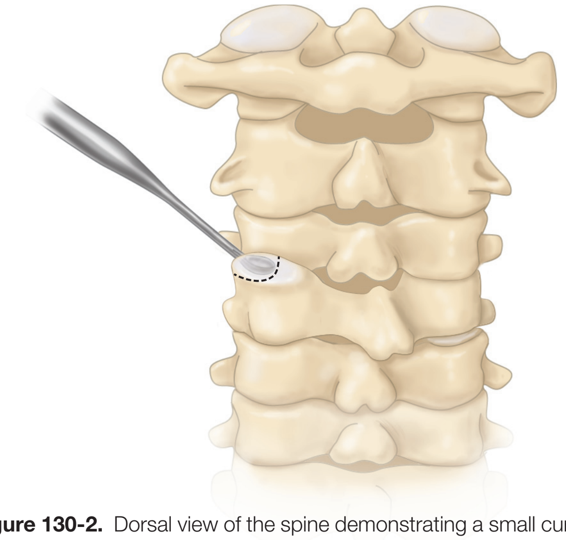

Figure 130-2. Dorsal view of the spine demonstrating a small curette, placed between the inferior articular process of the rostral vertebra and the superior articulating process of the caudal vertebra. Reduction can be attempted by distraction with this instrument with simultaneous dorsal forces on the spinous process of the rostral vertebra. If this fails, a portion of the superior articulating process *(dashed line)* may be drilled away to allow reduction.

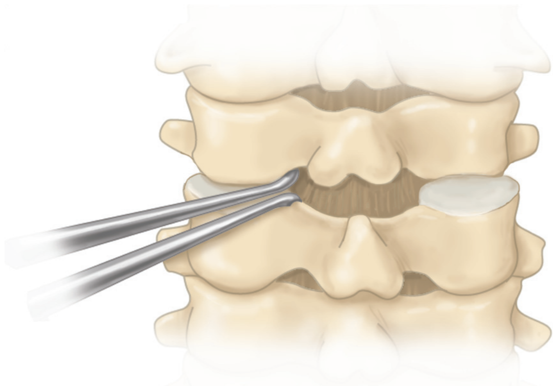

Figure 130-3. Dorsal view of the spine demonstrating an interlaminar spreader to cause distraction and thereby allow reduction of locked facets. Care must be taken to use this technique only when there is complete stability of the laminar ring of both vertebrae.

but anatomically different technique was initially described by Fazl and colleagues[59] and employs an interlaminar spreader to cause distraction and thereby allow reduction (Fig. 130-3). Integral to this technique is complete stability of the laminar ring of both vertebrae, which is not always available in facet dislocations. Such techniques may be ineffective. An alternative technique requires the removal of the superior articular processes of the caudal facet. Once performed, an attempt is made to pull the spinous process of the rostral vertebra into proper alignment with a Kocher clamp. This will almost always reduce the spine. If, however, this is not successful, lateral mass screws may be used as anchors to reduce to a rod and thereby restore alignment. Surgeons familiar with this technique can also use cervical pedicle screws.

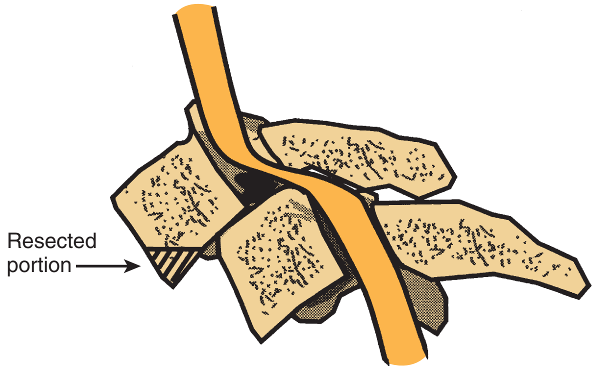

Figure 130-4. The ventrocaudal aspect of the rostral vertebral body obscures visualization of the disc interspace, necessitating partial resection. *(From University of New Mexico, Division of Neurosurgery, Albuquerque, with permission.)*

VENTRAL DECOMPRESSION, REDUCTION, AND STABILIZATION

Discectomy

The standard ventromedial approach is used through a transverse skin incision. After radiographic confirmation of the operative level, a discectomy is performed. A special consideration in the case of facet dislocation is the ventral translation (ventrolisthesis) of the rostral vertebral body on its caudal counterpart. This is often associated with some degree of kyphotic angulation and a resultant obscuration of the disc space, necessitating removal of the ventral aspect of the caudal end plate of the rostral vertebral body with a high-speed drill (Fig. 130-4). Care must be taken not to remove so much of the vertebral body as to preclude ventral screw-plate fixation. After exposure of the disc space, a standard discectomy is performed. The posterior longitudinal ligament is always removed, thus exposing the dura mater and ensuring adequate decompression.

Reduction

After completion of the discectomy, deformity reduction is attempted. Often, simple distraction is successful, because a potentially significant obstruction to reduction (the disc and anulus fibrosus) has been removed. However, if this maneuver fails, one of two intraoperative maneuvers may be used to facilitate reduction through the ventral approach: the interbody spreader technique or the vertebral body post technique. Failure to use either technique appropriately may result in failure of reduction.

Interbody Spreader Technique

A Cloward interbody spreader, or an equivalent device, is inserted into the disc interspace at a 30- to 40-degree angle (Fig. 130-5A). Failure to place this device at an angle, as opposed to parallel to the end plates, results in achieving only distraction force application (as simple distraction with tongs achieves). This does not result in the application of a bending moment, which results in a change in facet alignment (clearance for the dorsal migration of the rostral facet past the caudal facet) that is favorable for reduction.

Although distraction is gradually applied via the disc interspace spreader (applied in the midvertebral body region) (Fig. 130-5B), the spreader is rotated rostrally. This applies a bending moment to the dislocated vertebral body while the facet dislocation is reduced by distraction. If the locked facets

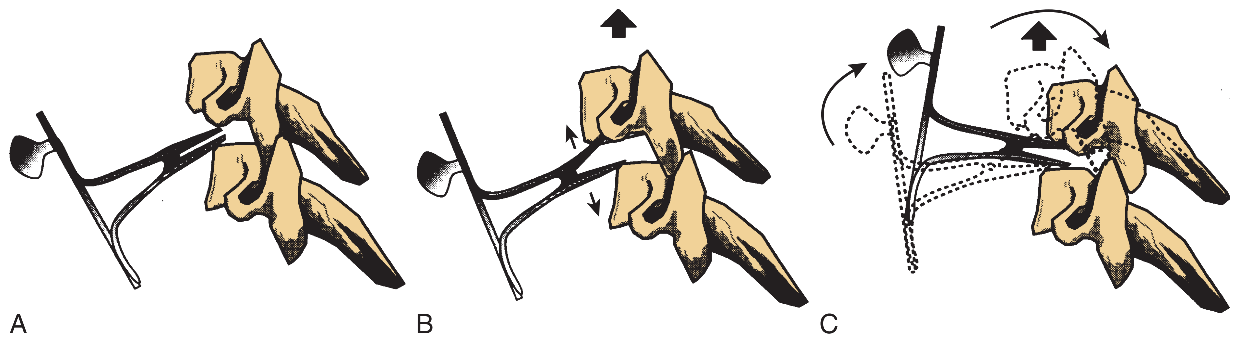

Figure 130-5. The interbody spreader technique for reduction of locked facets. After completion of discectomy, the spreader is placed into the disc interspace at a 30- to 40-degree angle. **A,** Note that the blades of the spreader should be placed deep enough to provide an adequate bending moment. **B,** The application of traction (*thick arrow*) and the simultaneous opening of the appropriately placed spreader (*thin arrows*) create a bending moment and distraction of the disc interspace. **C,** The application of a dorsally directed force by the spreader on the ventrocaudal aspect of the rostral vertebral body results in the realignment of the disengaged vertebrae. *(From University of New Mexico, Division of Neurosurgery, Albuquerque, with permission.)*

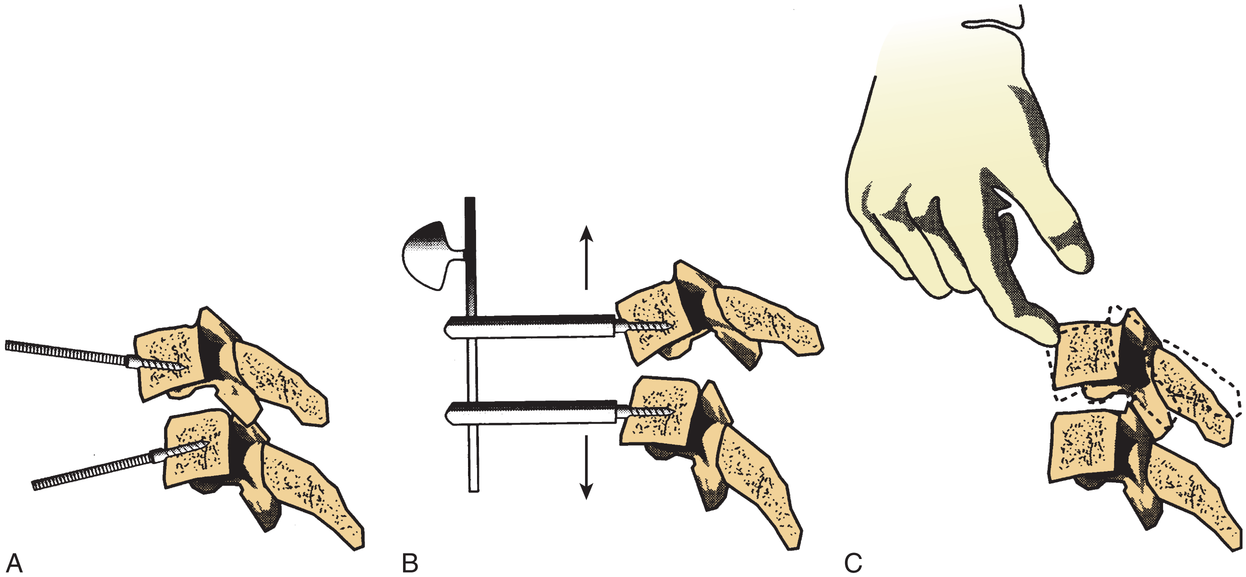

Figure 130-6. The vertebral body distractor post technique. A, Placement of the posts convergent to one another allows for the application of a bending moment that helps disengage the dislocated facet joints. **B,** The application of distraction forces (*arrows*) results in realignment. Relaxation of the distraction can lead to reengagement of the facets in their normal position. **C,** Relaxation can be aided by the application of a dorsally directed force on the rostral vertebra. *(From University of New Mexico, Division of Neurosurgery, Albuquerque, with permission.)*

are disengaged, the vertebrae should realign. Distraction is then relaxed in the aligned position, and the spreader is removed (Fig. 130-5C).

For bilateral facet dislocations, the intervertebral spreader should be placed in the midvertebral body region. For unilateral dislocations, the spreader should be placed on the side of the dislocation to facilitate the application of a torque about the long axis of the spine via the spreader. Placement of the intervertebral spreader too far ventrally may result in fracture of the end plate.

Vertebral Body Post Technique

If the aforementioned technique fails, the vertebral body post technique may be attempted. This technique uses a vertebral body distractor post. It is important to remember that parallel distraction via the vertebral body posts is equivalent to simple traction, in that these techniques do not apply a bending moment.

The vertebral body post technique usually involves placing the posts convergent to one another, as opposed to the traditional parallel or slightly divergent manner (Fig. 130-6A). This facilitates the application of a bending moment that unlocks the facets before the application of distraction forces (Fig. 130-6B). Distraction should then allow for complete disengagement of the locked facets. Manual reduction via the placement of the dorsally directed pressure on the rostral vertebral body encourages reduction if the facets have been adequately disengaged (Fig. 130-6C). Relaxation of the distraction forces then allows reengagement of the facets in a normal position. The placement of dorsally directed pressure on the rostral vertebral body, as described previously, may also be applied with the interbody spreader technique.

As an aside, unilateral facet dislocation reduction through a ventral approach may be achieved in a similar manner with the application of torque about the long axis of the spine, thus facilitating the reduction of the rotatory component of the

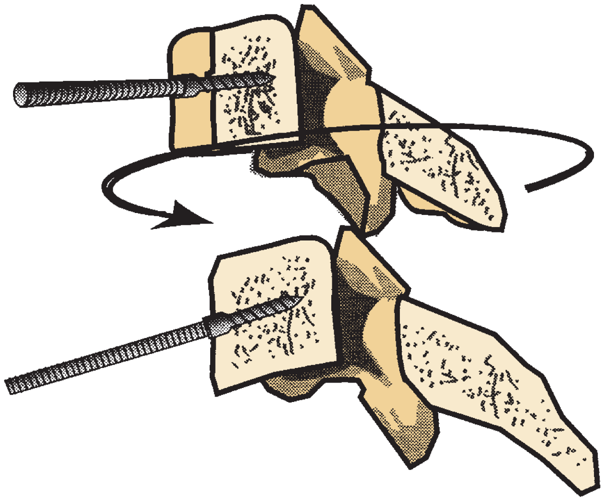

Figure 130-7. Appropriately placed posts and the application of torque about the long axis of the spine (*arrow*) can reduce the rotational component of a deformity. *(From University of New Mexico, Division of Neurosurgery, Albuquerque, with permission.)*

deformity (Fig. 130-7). This tends to reduce the rotational component of the dislocation.

Special Considerations

In contemplating a ventral approach to the dislocated and unstable cervical spine, at least four factors must be considered: (1) the advantage of first performing a ventral discectomy before an attempt at reduction, (2) the feasibility of achieving a reduction by using a ventral approach, (3) the potential need for an accompanying dorsal procedure (failure of ventral reduction), and (4) the ability to obtain a stable construct through an isolated ventral approach. We emphasize that each of these factors must be thoroughly addressed preoperatively (Fig 130-8).

Ventral Decompression before Reduction

Several authors have recommended a ventral decompression before reduction when they suspect the potential for reduction-induced spinal cord encroachment.[20-22,24,61] A ventral decompression with discectomy should, therefore, be considered in the setting of a cervical facet dislocation with concomitant disc herniation.

Reduction Feasibility

Previous reports have addressed the ventral reduction of cervical spine dislocations.[19,20,34-37] The only relatively large series of ventral reductions of locked facets was by de Oliviera,[35] who reported ventral reduction in 15 cases. He reported no failure with this interbody spreader technique. An understanding of the case-specific anatomy and fundamental biomechanical principles allows ventral reduction to be much more successful than was generally thought. The key is facet joint disengagement before an attempt at reduction. This requires the application of a bending moment to the unstable motion segment, followed by distraction, reduction, and finally relaxation of the distraction.

Failure of Ventral Reduction

The failure of attempts at ventral deformity reduction is a reality. Therefore, it behooves the spine surgeon to

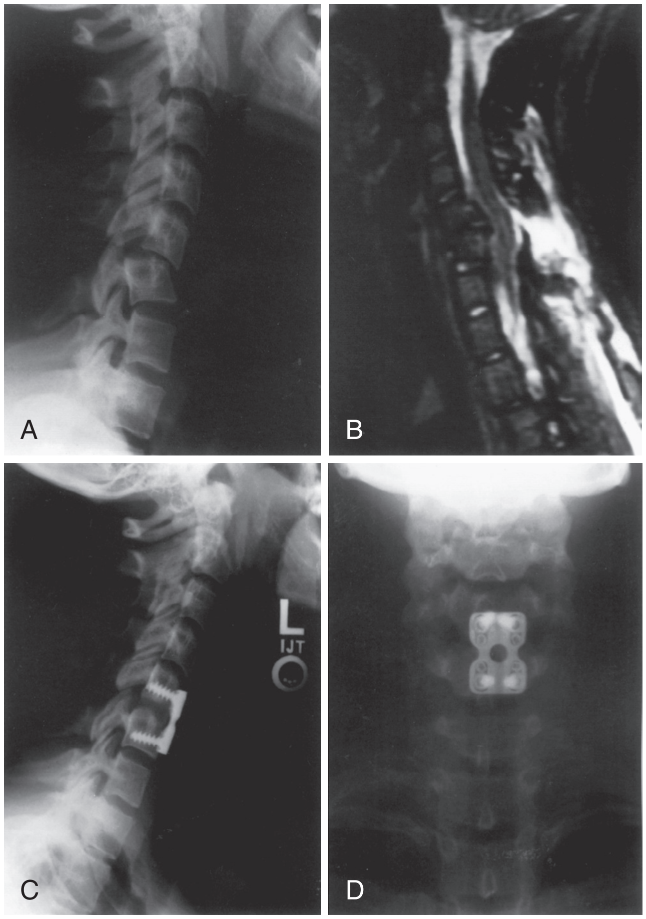

Figure 130-8. Lateral cervical radiograph of a neurologically intact 18-year-old woman who was involved in a diving accident, demonstrating a bilateral C5-6 facet dislocation (unilateral jumped facet, contralateral perched facet). Note the significant focal kyphosis with resultant obstruction of the ventral access to the disc space (**A**). Preoperative T2-weighted sagittal magnetic resonance image demonstrating a traumatic disc herniation at the level of the dislocation (**B**). Postoperative lateral (**C**) and anteroposterior (**D**) radiographs after ventral decompression, reduction, and stabilization.

appropriately counsel the patient and family preoperatively regarding the possible need for a combined ventral and dorsal (and possibly an additional ventral, 540 degrees) approach. Although the latter might seem to be an excessive amount of surgical intervention, it provides the greatest chance for preservation and improvement of neurologic function. Significant comminution of the facets appears to be a risk factor for failure of ventral reduction. Therefore, in patients with this risk factor, consideration should be given to a dorsal reduction and arthrodesis if a disc herniation is not present.

Stability Acquisition Using a Ventral Approach

Some authors have addressed the concern for stability acquisition in the circumferentially unstable spine (severe three-column injury)[62] via an isolated ventral approach.[63] Most of these concerns have been directed at dislocations involving two or more motion segments (one or more vertebral body fractures) or after the use of dynamic fixation systems. However, with one-motion segment circumferential instability, the short bending moment applied by the implant (short implant) by way of the spine allows for greater stability acquisition potential.

SUMMARY

Cervical facet dislocations are associated with high-energy trauma to the spine. The surgical management of these injuries may be accomplished by closed reduction, open posterior reduction and stabilization, or open ventral decompression, reduction, and stabilization. Closed reduction facilitates realignment of the spine. However, in the setting of a concomitant disc herniation, closed reduction may result in neurologic compromise. Prereduction MRI is controversial but should be strongly considered in patients with neurologic function. Dorsal reduction is a familiar technique to most spine surgeons and can be used to restore normal spinal alignment via a variety of methods. However, dorsal approaches should be carefully reconsidered in the setting of a large ventral disc herniation.

A ventral approach to cervical dislocation and instability may be appropriate in more cases than was previously thought. The ventral approach facilitates (1) ventral decompression before reduction (thus minimizing the chance for iatrogenic neurologic injury), (2) single-motion segment fixation (in contrast to two-motion segment fixation using a dorsal approach), and (3) stability acquisition through the application of effective ventral fixation techniques.

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