Cervical facet dislocation: techniques for ventral reduction and stabilization

BERNARDO J. ORDONEZ, M.D., EDWARD C. BENZEL, M.D., SAIT NADERI, M.D., AND SIMCHA J. WELLER, M.D.

Neurosurgical Associates, Norfolk, Virginia; Department of Neurosurgery, Cleveland Clinic Foundation, Cleveland, Ohio; Department of Neurosurgery, Marmara University School of Medicine, Istanbul, Turkey; Division of Neurosurgery, Beth Israel Deaconess Medical Center, Boston, Massachusetts; Harvard Medical School, Boston, Massachusetts; and Department of Neurosurgery, New England Medical Center, Tufts University School of Medicine, Boston, Massachusetts

Object. To demonstrate the safety and utility of one surgical approach, the authors reviewed their experience with the ventral surgical approach for decompression, reduction, and stabilization in 10 patients with either unilateral or bilateral cervical facet dislocation.

Methods. Six patients presented with unilateral cervical facet dislocation and four patients with bilateral cervical facet dislocation. There were six male and four female patients who ranged in age from 17 to 72 years (average 37.1 years). The level of facet dislocation was C4–5 in one, C5–6 in four, and C6–7 in five patients. Three patients presented with a complete spinal cord injury (SCI), three patients with an incomplete SCI, three with radicular symptoms or myeloradiculopathy, and one patient was neurologically intact. All patients underwent plain radiography, magnetic resonance imaging, and computerized tomography evaluation of the cervical spine. All patients had sustained significant ligamentous injury with minimal or no bone disruption. All patients underwent ventral decompressive surgery, reduction of the dislocation, and stabilization of the cervical spine. Techniques for performing ventral reduction of unilateral or bilateral cervical facet dislocation are described.

Decompression, reduction, and stabilization of the cervical spine via the ventral approach was accomplished in all but one patient. This patient underwent a ventral decompressive procedure and an attempt at ventral reduction and subsequent dorsal reduction and fusion in which a lateral mass screw plate fixation system was used; this was followed by ventral placement of instrumentation and fusion. There were no surgery-related complications. Postoperative neurological status was unchanged in four patients and improved in six patients. No patient experienced neurological deterioration after undergoing this surgical approach.

Conclusions. The authors conclude that a ventral surgical decompression, reduction, and stabilization procedure provides a safe and effective alternative for the treatment of patients with unilateral or bilateral cervical facet dislocation without significant bone disruption.

KEY WORDS • cervical spine • decompression surgery • dislocation • facet dislocation • spinal stabilization

The management of cervical spine facet dislocation is controversial. Traditionally, these injuries have been treated with closed reduction techniques and either external orthotic immobilization or dorsal arthrodesis. Techniques for closed reduction include manual traction and manipulation, skeletal traction in which incremental increases in traction weight are applied, manipulation using sedation and muscle relaxants, and skeletal traction and manipulation after induction of general anesthesia.5,11,16,23,25,26 The efficacy of these techniques has been confirmed by years of clinical experience. However, closed reduction techniques often fail. Neurological deterioration can occur during or after attempted closed reduction procedures. Open reduction techniques, therefore, have gained in popularity.1,5,8,16,22,24 Open reduction procedures can be performed via the ventral12,15,27 or dorsal approach. Dorsal open reduction is performed most frequently,1,3,5,7,16,22,24,25,26 and the technique consists of a partial or complete facetectomy, reduction of deformity and dorsal fixation, and fusion. Fusion and instrumentation techniques include facet wiring, interspinous wiring, and placement of a lateral mass plate.13,5,6,10,16,22,24,25,26

Closed reduction and open dorsal reduction procedures are not without risk. In 1991, Eismont, et al.,5 described several cases of catastrophic neurological injury that resulted from performing closed reduction of cervical facet dislocations.
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TABLE 1
Preoperative characteristics in 10 patients treated for cervical facet dislocation*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Mechanism of Injury</th>
<th>Level</th>
<th>Type of Dislocation</th>
<th>Extent of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17, M</td>
<td>MVA</td>
<td>C5–6</td>
<td>unilat</td>
<td>ICND</td>
</tr>
<tr>
<td>2</td>
<td>21, M</td>
<td>fall</td>
<td>C5–6</td>
<td>bilat</td>
<td>Rad</td>
</tr>
<tr>
<td>3</td>
<td>20, M</td>
<td>MVA</td>
<td>C5–6</td>
<td>bilat</td>
<td>CND</td>
</tr>
<tr>
<td>4</td>
<td>35, M</td>
<td>MVA</td>
<td>C6–7</td>
<td>bilat</td>
<td>CND</td>
</tr>
<tr>
<td>5</td>
<td>72, F</td>
<td>MVA</td>
<td>C6–7</td>
<td>unilat</td>
<td>NND</td>
</tr>
<tr>
<td>6</td>
<td>40, M</td>
<td>fall</td>
<td>C6–7</td>
<td>bilat</td>
<td>CND</td>
</tr>
<tr>
<td>7</td>
<td>36, F</td>
<td>MVA</td>
<td>C5–6</td>
<td>unilat</td>
<td>ICND</td>
</tr>
<tr>
<td>8</td>
<td>35, M</td>
<td>MVA</td>
<td>C6–7</td>
<td>unilat</td>
<td>Rad</td>
</tr>
<tr>
<td>9</td>
<td>63, M</td>
<td>MVA</td>
<td>C4–5</td>
<td>unilat</td>
<td>ICND</td>
</tr>
<tr>
<td>10</td>
<td>45, F</td>
<td>MVA</td>
<td>C6–7</td>
<td>unilat</td>
<td>MRad</td>
</tr>
</tbody>
</table>

* CND = complete neurological deficit; ICND = incomplete neurological deficit; MRad = myeloradiculartomy; MVA = motor vehicle accident; NND = no neurological deficit; Rad = radiculopathy.

locations. Until that report, little attention had been given to traumatic disc herniation in association with cervical facet dislocation. The results of numerous studies indicate that the incidence of this association may be higher than previously believed and that the risk of neurological injury as a result of attempted closed reduction or open dorsal reduction procedures may be greater than previously appreciated.2,4,13,17,19–21,27 A procedure entailing ventral decompression, reduction, and stabilization eliminates the risk of catastrophic neurological sequelae resulting from closed or open dorsal reduction, while providing an effective means of safely decompressing and reducing cervical facet dislocations. Furthermore, it provides the opportunity to treat only one motion segment by fusion and placement of instrumentation compared with the common two–motion segment fusion required when using the dorsal approaches. The ventral approach also provides a method by which long-term spinal stability can be obtained.12 To demonstrate the feasibility and utility of ventral decompression, reduction, and stabilization of cervical spine facet dislocations, we present our experience with 10 patients.

Clinical Material and Methods

From April 20, 1996, through October 6, 1997, 10 patients with either unilateral or bilateral cervical facet dislocation were treated at the University of New Mexico. The six male and four female patients ranged in age from 17 to 72 years (average 37.1 years). Six patients presented with unilateral and four patients with bilateral cervical facet dislocation. Eight of the patients were involved in motor vehicle accidents, and two patients were injured in a fall (Table 1). The level of cervical facet dislocation was C4–5 in one, C5–6 in four, and C6–7 in five patients. Three patients presented with a complete SCI, three with an incomplete SCI, three with radicular symptoms, and one patient was neurologically intact. Patients who presented with complete or incomplete SCIs were treated using the standard high-dose methylprednisolone protocol. Plain radiographs, MR images, and computerized tomography scans of the cervical spine were obtained in all patients. Magnetic resonance imaging revealed a traumatic disc herniation in five of 10 patients. Following radiographic evaluation, all patients underwent a ventral procedure in which decompression, reduction of the dislocation, and stabilization of the spine was performed. No attempt was made to achieve closed reduction before surgery. All patients underwent surgery within 48 hours of admission. Only those patients without neurological deficit or those with an isolated radiculopathy were treated electively; the remaining patients were treated urgently. It is emphasized, however, that convincing evidence regarding the timing of the decompressive procedure does not exist. The follow-up period was longer than 6 months in each case.

Surgical Technique

Positioning of the Patient

Surgery was performed with the patient supine. In patients not already intubated, an awake fiberoptic intubation procedure was performed. A roll was placed beneath the shoulders, and the head was supported on a gel roll. A hip roll was placed beneath the iliac crest donor site. At this point the cervical collar was removed. The neck and iliac crest donor sites were shaved and prepared in a standard fashion.

Decompressive Procedure

A standard ventral approach to the cervical spine was performed. Once adequate exposure had been obtained, a discectomy was performed. Because the ventral spondylolisthesis of the rostral vertebra body occasionally obscured visualization of the disc space, removal of the caudal margin of the rostral vertebral body was required (Fig. 1). This removal is facilitated by applying slight distraction with a disc interspace spreader or a vertebral body post distractor (see Reduction section). Once the discectomy was completed, the posterior longitudinal ligament was incised and resected, with care taken to remove all intracanalicular disc material, thereby reducing the risk of complications involved in open reduction procedures.

Reduction Procedure

Vertebral body posts (Caspar or equivalent devices) were placed at approximately a 10 to 20° divergent angle with respect to each other (Fig. 2A). Angling the vertebral body posts provides for the application of a bending moment when distraction is applied. This, in turn, allows the locked facets to be disengaged prior to the application of distrac-
tion forces. Dorsally directed pressure to the rostral vertebral body can be applied using manual pressure or a curette (or similar device). Alternatively, a force may be applied by a curette to the mid-endplate region of the caudal vertebral body. The curette is used as a lever arm that forces the rostral vertebral body into normal alignment (Fig. 2B–D). Interbody disc spreaders placed into the disc space (at an angle), which are then rotated rostrally, can also be used (Fig. 3).9,12

In cases of unilateral facet dislocation, in which there is an accompanying rotational deformity, the patient can be additionally managed by placing the Caspar pins at an angle with respect to each other in the coronal plane (Fig. 4). This permits a biomechanical advantage regarding the correction of the rotational component of the deformity.

Removal of distraction forces and the posts thus allows the facets to resume a normal position. An intraoperative radiograph is then obtained to confirm that the deformity has been adequately reduced. Alternatively, fluoroscopy may be used if the need for multiple intraoperative radiographs is predicted. Because such findings as comminuted facet fractures are associated with difficulty in achieving adequate reduction, the multiple radiographs or fluoroscopy are required.

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If satisfactory alignment of the spine is not obtained, the aforementioned maneuvers are repeated. Once adequate reduction has been obtained, iliac crest bone graft is harvested, fashioned to fit the disc space, and positioned. A ventral cervical fixation device is then placed, and wound closure is performed in a routine manner.

Results

Satisfactory reduction of deformity was achieved in nine of 10 patients. There were no surgery-related complications. Follow-up radiography revealed satisfactory sagittal plane alignment in eight of the 10 patients. In one patient a residual unilateral perched cervical facet was demonstrated after successful fusion. This was asymptomatic. However, vertebral body alignment was normal, and the cervical spine showed no signs of instability on follow-up flexion–extension radiographs. Follow-up radiographs obtained in a second patient revealed splaying of the dorsal elements and a

FIG. 5. Radiographic and MR studies. Upper Left and Right: Demonstration of C5–6 bilateral locked facets in a patient with an incomplete myelopathy and radiculopathy, as observed on plain lateral radiography (upper left), and sagittal T₂-weighted MR imaging (upper right). Note the disc herniation, spinal cord compromise, and significant interspinous soft-tissue injury. Lower Left: Radiograph demonstrating the use of disc interspace spreaders to reduce the dislocation after a complete discectomy was performed. Lower Right: Radiograph obtained following reduction of the deformity, a ventral interbody fusion, and placement of instrumentation.

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slight focal angulation at the site of the previous cervical facet dislocation (Fig. 5). This may have been related, in part, to the use of a nonconstrained (nonfixed moment arm) plate. There was no evidence of subluxation, and the construct was shown to be stable on flexion–extension radiographs, with a solid arthrodesis. In another patient, ventral reduction of the dislocation could not be achieved. Therefore, following discectomy and attempts at ventral reduction, a dorsal reduction and fusion procedure was performed in which a lateral mass plate system was used. In this case, the rostral and caudal endplates were denuded of all soft and cartilaginous tissue prior to closure of the ventral wound. Following dorsal reduction and fusion, the ventral wound was reopened. Because the rostral and caudal endplates were denuded and firmly juxtaposed, interbody fusion was not performed. A ventral cervical fixation device was applied. Anatomically, this is not an ideal scenario and should be avoided if possible. Nevertheless, radiculopathy was not observed postoperatively.

Follow-up evaluation revealed no change in neurological status in four patients and improvement in six patients. In the three patients who presented with complete SCIs, there was no improvement in neurological status postoperatively, except for recovery of nerve root function at the level of injury. The only patient who was neurologically intact preoperatively remained so following surgery. The two patients who presented with unilateral facet dislocations and radiculopathy experienced improvement of their radiculopathies after undergoing the decompressive, reduction, and stabilization procedure. In the patient who presented with a unilateral facet dislocation, hyperreflexia, and radiculopathy (myeloradiculopathy) complete neurological recovery was achieved postoperatively. Of the three patients who presented with incomplete SCIs, in two a central spinal cord syndrome had also been diagnosed; one patient experienced persistent weakness in the distal upper extremities postoperatively. The second patient had persistent unilateral deltoid and biceps muscle weakness only, but was otherwise neurologically intact. Another patient presented with no voluntary motor function below the level of injury, but sensation in her lower extremities was preserved. At follow-up examination, this patient experienced return of normal sensation and is now able to ambulate with assistance. There were no surgery-related complications and no perioperative deaths. Three patients suffered respiratory distress secondary to pneumonia and/or respiratory failure. One patient recovered after undergoing antimicrobial therapy, and two patients required tracheotomy because of prolonged ventilator dependency.

Discussion

Traditionally, unilateral or bilateral cervical facet dislocations have been treated with closed reduction techniques followed by either external orthotic immobilization or open arthrodesis, or by open dorsal reduction of the deformity.1,3,5,6,11,16,18,22–25 These treatment modalities have proved efficacious through years of clinical experience. However, in recent years greater attention has been placed on the association between cervical facet dislocation and traumatic disc herniation. In numerous articles the authors have suggested that the incidence of this association may be higher than previously believed.4,13,14,17,19–21,27 In the literature, the incidence of this association has ranged from 0.7% to 42%.27 Rizzolo, et al.,20 have claimed that the incidence of disc disruption may be as high as 40% in cases of unilateral cervical facet dislocation and 80% in cases of bilateral cervical facet dislocation. In five of our 10 patients there was radiographic evidence of traumatic disc herniation associated with facet dislocations: two with bilateral cervical facet dislocations and three with unilateral facet dislocations. Several authors have described devastating neurological sequelae resulting from attempted closed reduction or open dorsal reduction of cervical facet dislocation, presumably caused by retropulsion of disc material into the spinal cord.4,13,14,17,19–21,27 As a result, numerous authors have advocated obtaining MR images of the cervical spine before attempted reduction of cervical facet dislocations.4,13,14 This is despite the fact that devastating neurological sequelae are uncommon following a closed reduction procedure (without previously performed MR imaging) and that neurological recovery usually occurs following closed reduction.

Magnetic resonance imaging provides an effective means by which to identify traumatic disc herniations in association with cervical facet dislocations. However, MR imaging may not necessarily be predictive of the development of disc herniation during attempted closed or open dorsal reduction of cervical facet dislocations because the disc may be severely disrupted but not herniated before reduction is attempted. The mechanism of reduction-induced disc retropulsion is depicted in Fig. 6.

Ventral decompression, reduction, and stabilization of cervical facet dislocations eliminates the risk of extruded...
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disc fragments encroaching the spinal cord, provides an
effective method of reducing cervical facet dislocations,
and provides a method for stabilizing a single motion seg-
ment. Although effective, ventral reduction can fail, as
illustrated by a single patient in this series. Patients and
families should be counseled that a combined ventral/dor-
sal procedure may be required. Risk factors that appear to
be associated with failed ventral reduction procedures
include significant dorsal element disruption and commin-
uated fractures of the facet complex.
The results achieved in the patient population presented
here, although small in number, serve to illustrate an alter-
native technique by which patients with either bilateral or
unilateral facet dislocations can be effectively treated with
promising results.

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Address reprint requests to: Edward C. Benzel, M.D., De-
partment of Neurosurgery, Cleveland Clinic Foundation, 9500 Euclid
Avenue/S80, Cleveland, Ohio 44195.