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Reduction Technique for Uni- and Biarticular Dislocations of the Lower Cervical Spine

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Study Design. A technical report concerning the methods of reduction of dislocations of the lower cervical spine used in 168 consecutive cases (77 unilateral and 91 bilateral dislocations).

Objectives. To evaluate the efficacy of a reduction protocol comprising three successive phases: reduction by traction, reduction by closed maneuvers with the patient under general anesthesia, and open reduction.

Summary of Background Data. Management of cervical dislocations varies greatly among spine treatment centers, especially concerning the upper limit of traction, the safety of closed manipulations in anesthetized patients, and the approach preferred when surgical reduction is necessary.

Methods. Reduction by gradual traction without anesthesia was attempted first. In case of failure, specific closed manipulations were used with the patient under general anesthesia just before anterior arthrodesis was performed. If this failed, anterior surgical reduction was attempted. Anterior fusion was performed in every patient, even when closed reduction was successful, because of the lasting instability produced by attending ligamentous lesions.

Results. Of the patients in 168 cases of dislocation, the protocol failed in 5, all of whom had longstanding unilateral dislocation. Of the 91 with bilateral dislocation, reduction was achieved by simple traction in 39 (43%), by maneuvers with the patient under general anesthesia in 27 (30%), and by anterior surgery in 25 (27%). Among the patients in 77 cases of unilateral dislocation, reduction was achieved by traction in 18 (23%), by external maneuvers in 28 (36%), and by anterior surgery in 26 (34%). In 7 patients, discal herniation engendering neurologic signs was resected during anterior surgery. No neurologic deterioration during or immediately after reduction by this protocol was observed.

Conclusions. This protocol consists of application of rapidly progressive traction, followed if necessary by one or two reduction maneuvers with the patient under general anesthesia. If both methods fail, specific surgical procedures using an anterior exposure seem to be reliable, in that anatomic reduction was obtained in 163 of 168 patients without neurologic deterioration. [Key words: closed maneuvers, lower cervical spine dislocation, surgical reduction, traction] **Spine 1998;23:949–955**

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In patients with unilateral spinal dislocation, the decrease in spinal canal caliber is slight, explaining the rarity of associated medullar complications. The risk of aggravation by displacement is low enough that certain clinicians believe that reduction is not obligatory and surgical stabilization, even less so. On the contrary, no one denies the necessity and urgency of reduction in cases of bilateral dislocation that menaces medullar alignment and is most often accompanied by severe neurologic complications. Although the use of cranial tongs is accepted by all, the methods of reduction vary according to different groups of investigators and may generally be classified under one of three categories:

- axial traction with gradually increasing weights in unanesthetized patients, advocated by some;
- traction with specific maneuvers depending on the type of dislocation, used by others; and
- surgical reduction using a posterior or, less often, an anterior operative approach.

Once reduction is obtained, arthrodesis of the dislocated segment (especially in bilateral dislocation) would seem logical, given the lasting instability created by such disc and ligament lesions, with a risk of secondary displacement (30% in a series reported by Bohlman[4]).

A homogeneous consecutive series of 168 accident victims with uni- or bilateral dislocation of the lower cervical spine is reported. They were treated with the sequential use of the three techniques just mentioned: A failure in reduction by axial traction led to specific maneuvers carried out with the patient under general anesthesia, just before anterior surgery, which was used for reduction if the two preceding methods had failed. In every patient, interbody fusion was performed, even if reduction had been obtained by closed procedures.

Methods

From 1979 to 1993, 168 patients with uni- or bilateral dislocation affecting cervical levels C2–C3 to C7–T1 were admitted.

Mean age was 40 years (range, 16 to 81 years). There were 114 men (68%) and 54 women (32%). The predominating circumstances were motor vehicle accidents (car: 101 cases = 60%; motorcycle: 4 = 2.4%; and pedestrian: 1). Next were falls (34 = 20%) and sporting accidents (rugby: 11 cases = 6.5%; diving: 12 = 7%; and other: 5 = 3%). Direct trauma was responsible in 3 cases (1.8%).

The diagnosis of cervical dislocation was affirmed immediately (within 3 hours) in 66 patients (39%) and secondarily (from 3 to 12 hours after the accident) in 74 (44%) and was delayed (more than 12 hours and often more than several days) in 28 (17%). Neurologic deficit attended dislocation in 100 patients (60%). These ranged from simple nerve root pain without deficit in patients with unilateral dislocation to complete quadriplegia observed in 55% of those with bilateral dislocations. Unilateral dislocation associated with no neurologic deficit was encountered in 37% of these patients. C5–C6 and C6–C7 were the levels most frequently dislocated (126 patients, or 75%), followed by C2–C3, C3–C4, and C4–C5 (35 patients, or 20.8%). Lastly, C7–T1 was involved in 8 patients (4.8%; Figure 1). There was one patient with uniarticular dislocation of two adjacent levels: C6–C7 on the right and C7–T1 on the left with right fracture–separation of the articular pillar of C7.

Bilateral dislocation was easily diagnosed in 91 patients (54.2%) from standard anteroposterior and lateral films. Traction to the arms or swimmer's views were used as needed to visualize the lower cervical vertebrae. Unilateral dislocation, diagnosed in 77 patients, was suspected when lateral roentgenograms showed vertebral retrolisthesis (averaging 3 mm) and classic "dunce-cap" images.

Determination of the side of unilateral dislocations was more difficult but was essential for indicating subsequent effective reduction manipulations. Anteroposterior roentgenograms most often showed rotation of the spinous process of the upper vertebra toward the dislocated side. To determine with certainty the side of unilateral dislocations, computed tomographic (CT) scans were used to show the abnormal position of the facet joints on one side. The closed and open reduction maneuvers were monitored using an image intensifier placed obliquely.

Among the 168 patients, 8 (4.8%) had additional cervical lesions. Aside from the previously mentioned case of double uniarticular dislocation, one patient also had a fracture of C1, two had fractures of the pedicles of C2, two had thoracic or lumbar vertebral fractures, and two had severe cervical sprains, cephalad to the dislocation, that justified treatment by arthrodesis. Forty-six other lesions (27.4%) were noted: 11 fracture–separations of the articular pillar (6.5%), 13 articular process fractures (7.7%), and 22 diverse fractures (vertebral body, posterior arch; 13%).

Discal herniation at the level of dislocation was detectable in CT scans or magnetic resonance images (MRI) in 7 patients.

Reduction Protocol. Three methods were used, failure of one leading to use of the following technique. With the patient under local anesthesia, Gardner–Wells skull tongs were applied to points located 1 cm behind and 3 cm above the external auditory canal.

First, reduction was attempted by traction administered with the patient under simple sedation. The patient was relaxed by infusion of diazepam. The force applied depended on the level of dislocation. The following formula was used to determine the maximum total weight that was not to be exceeded (P):

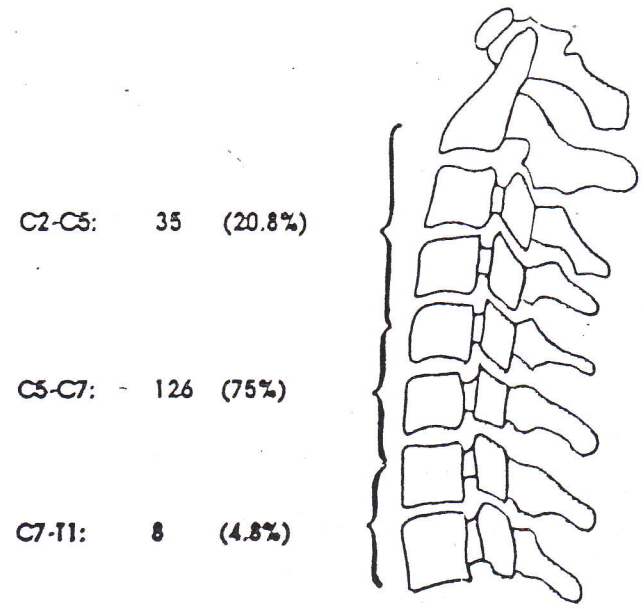

Figure 1. Topographic distribution of lesions.

P = 3 to 4 kg (weight of the head) + 2 kg per vertebral level away from the cranium

For example, for a C7–T1 dislocation, a maximum of 18 kg was applied. This weight was attained by adding increments of 2 or 3 kg followed by lateral radiographic verification every half hour. It was judged preferable to carry out this traction under slight flexion of the neck obtained by placing a cushion under the head. Once the two facets were tip to tip, the neck was reextended. Neurologic status, cardiac rhythm, and blood pressure were monitored at regular intervals. The attempt to reduce by traction should not exceed 2 hours. This was, in practice, the time necessary to obtain a preoperative work-up at the authors' facilities.

Second, when reduction was not obtained, under general anesthesia, closed manual traction maneuvers were performed using skull tongs, after removal of the weights, one or, at most, two times just before proceeding to surgical maneuvers (surgery was, in any event, performed even if reduction had already been achieved). Image intensifier screening was used throughout this procedure, laterally for bilateral dislocations and obliquely for unilateral ones (Figure 2). In patients with bilateral dislocation, traction was applied with the neck slightly flexed until the articular facets were tip to tip, at which time the neck was again extended (Figure 3, A–C).

In unilateral dislocations, the reduction maneuver was more complex. Initially, the head was inclined away from the dislocated articulation. When the articular facets were tip to tip, the head was tilted back toward the dislocated side, and the neck was reextended (Figure 3, D–G). It is important to monitor this maneuver with an image intensifier.

Extreme care must be exercised once the skull tongs have been removed to avoid excessive mobilization of the neck and, in particular, hyperextension while attempting to intubate, which may be avoided by obtaining intubation fiberoptically.

Third, when these closed maneuvers failed, the weights were reapplied to the skull tongs and surgery was used to reduce

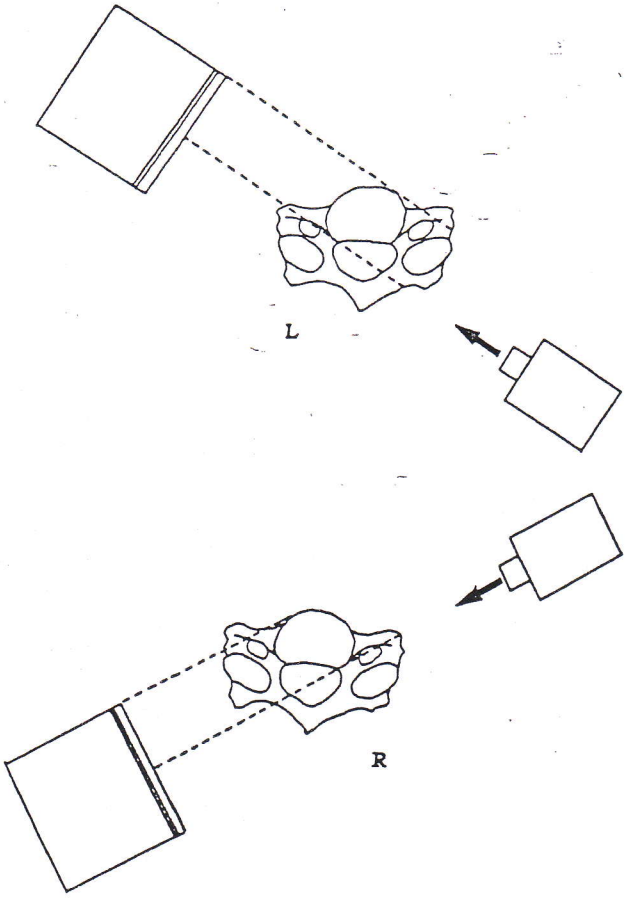

Figure 2. Visualization of articular pillars using obliquely oriented image intensifiers.

dislocations. Contrary to methods used by many teams, the current investigators used an anterior approach for these surgical reductions for several reasons: It was unnecessary to turn the patient; discectomy enabled simple, effective reduction maneuvers under the lateral visual control of the image intensifier;

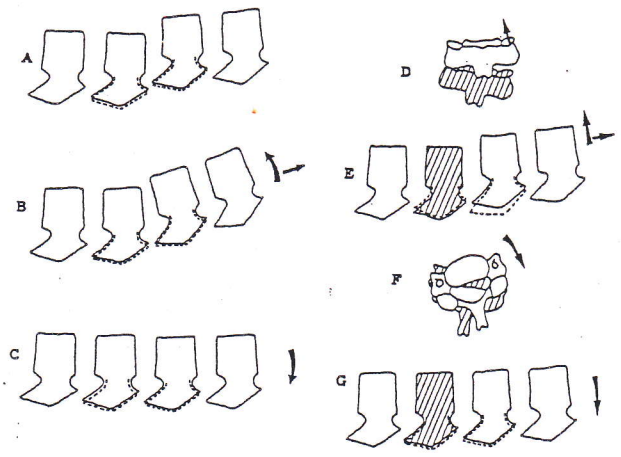

Figure 3. Reduction maneuvers in bilateral (A–C) and right unilateral (D–G) dislocations. Bilateral dislocation (A); flexion–traction (B); extension (C). Right unilateral dislocation: inclination toward opposing side (D); traction–flexion (E); rotation toward dislocation (F); extension (G).

and interbody fusion after reduction offered reliable mechanical stability and promoted rapid taking of graft.

Patients underwent the procedure strictly supine under traction, with a slight downward inclination of the foot of the operating table. At any moment during the operation, a lateral and oblique check was possible with an image intensifier.

A right presternocleidomastoid surgical approach was used. Before intraoperative reduction attempts, discectomy was performed at the level that was dislocated. The disc was always altered, even in unilateral dislocations.

In bilateral dislocations (Figure 4A), an interbody spreader placed as posteriorly as possible was used to bring the articular facets tip to tip (Figure 4B). The overlying vertebral body was then pushed backward (Figure 4C). Removal of the underlying disc was described by Cloward[7] as a maneuver permitting better interbody separation, but the current investigators were obliged to resort to this procedure only once. In unilateral dislocations, it was paradoxically necessary to increase distraction on the side where the vertebral endplates were furthest apart before pushing back the vertebral body once the zygapophyseal facets were tip to tip (Figure 5). The vertebral bodies were realigned using an osteophyte hook by placing the tip on the upper endplate of the underlying vertebral body and by very cautiously applying gentle anteroposterior and upward pressure on the overlying vertebral body with the handle, which served as a lever.

In every patient, regardless of the means used for dislocation reduction, interbody fusion was associated with use of a monocortical autogenous graft taken from the right iliac crest. Stabilization was obtained with a plate, the screws securely fixed through the body into the posterior cortical bone (Figure 4D). In two patients with unilateral dislocation complicating an articular pillar fracture–separation, open surgery by a retrovascular approach was necessary for reduction, with arthrodesis secondarily encompassing the fracture–separation of the articular pillar. Only one bilateral dislocation of C6–C7 with an associated fracture of the pedicles of C7 necessitated a double surgical approach—posterior, then anterior.

Patients wore a Philadelphia collar for 2 months after the operation.

■ Results

Among the 91 patients with bilateral dislocation, 39 (43%) dislocations were reduced by traction without general anesthesia, 27 (30%) by manipulation under general anesthesia, and 25 (27%) by open surgery.

In 31 patients with bilateral dislocation (34%), one side was reduced first. The remaining unilateral dislocation was reduced in 3 patients by traction without general anesthesia, in 10 by manipulation with the patient under general anesthesia, and in 18 by open surgery.

Among the 77 patients involving unilateral dislocation, in 18 (23%), dislocations were reduced by traction without general anesthesia; in 28 (36%), by manipulation with general anesthesia; and in 26 (34%), by open surgery.

Reduction was not obtained in 5 patients (6.5%) with unilateral dislocation: 3 who were referred to the current team after long delays (3 months, 6 months, and 7 months), 1 with associated fracture of the upper articular process of the underlying vertebra, and 1 in whom non-

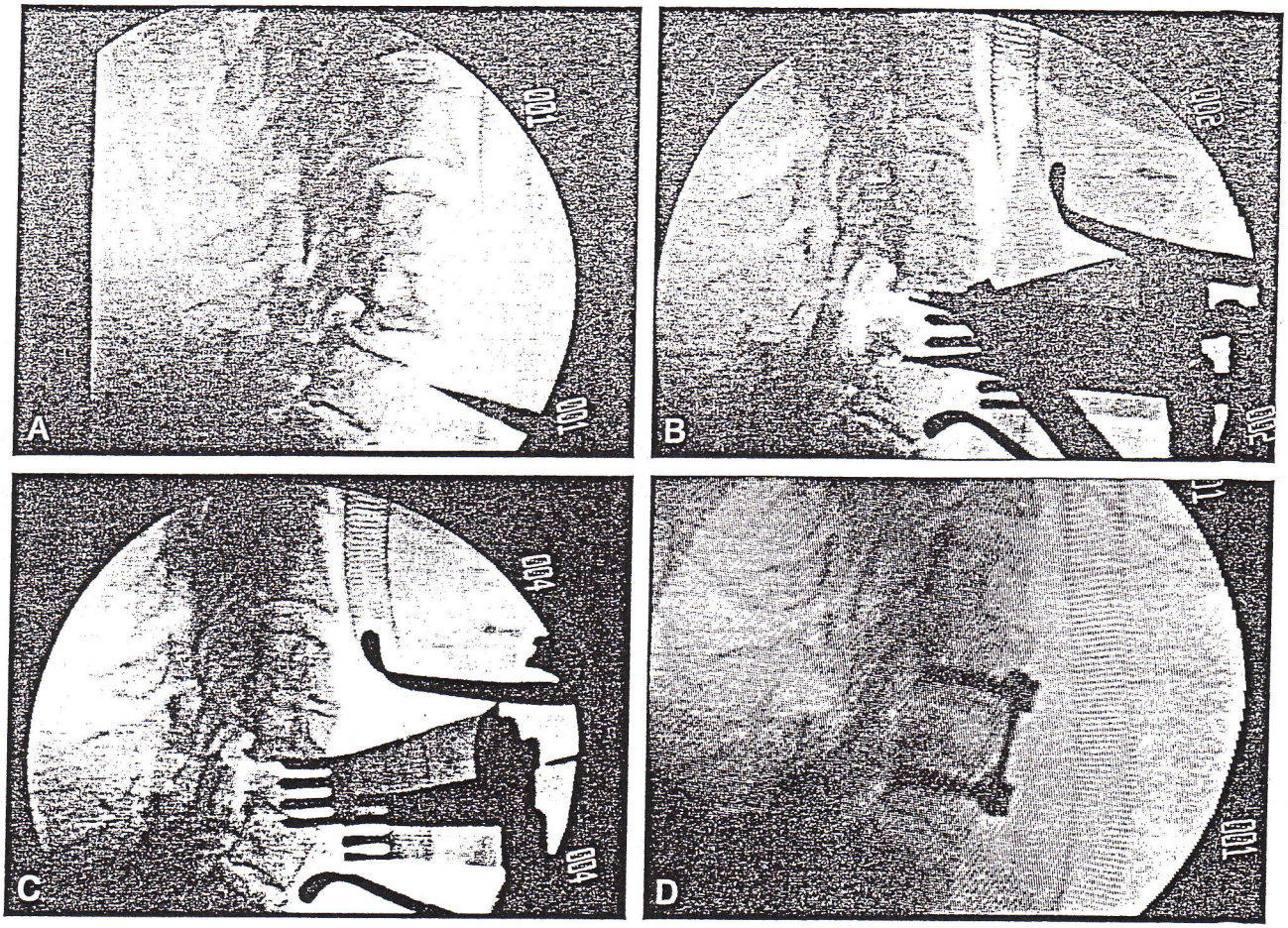

Figure 4. A, Initial visualization on image intensifier of a bilateral dislocation. B, Articular processes tip to tip. C, Verification after reduction of dislocation. D, Graft and plate in place.

reduction was misjudged by the surgeon. These five unilateral dislocations were treated by arthrodesis in a dislocated position with satisfactory final clinical and anatomic results.

In the overall series, it must be reiterated that only one reduction necessitated a posterior approach followed by anterior arthrodesis—the bilateral dislocation of C6–C7 with associated fractures of the pedicles of C7 mentioned earlier.

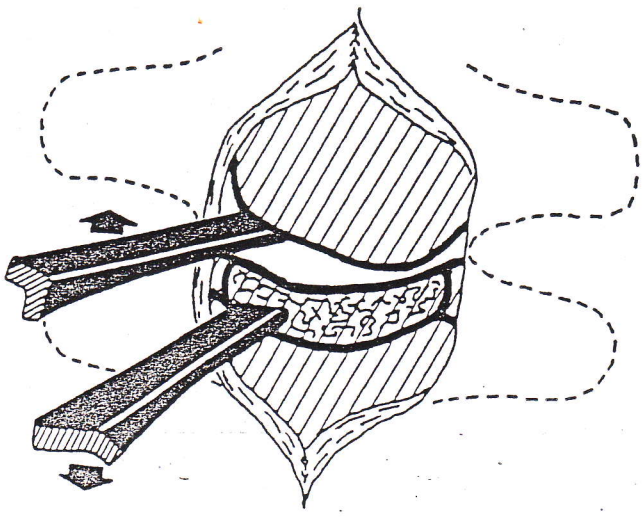

Figure 5. Operative reduction of a unilateral dislocation (distraction on the side of the dislocation).

■ Discussion

An algorithmic approach consisting of three successive options is used by the current team to reduce cervical dislocations.

The first method, axial traction without general anesthesia, was considerably facilitated by the introduction of skull tongs by Crutchfield[10] and Gardner.[14] Crutchfield clearly stated that the force of traction depended on the level of the vertebral dislocation. In his opinion, traction applied to a lesion of C1–C2 should not exceed an average of 4.5 kg (10 pounds), whereas a C7–T1 dislocation should not be reduced by more than 5.9 kg. Venter[29] proposed using traction of 5 kg/vertebral level. The maximum value not to be exceeded varies greatly: 30 kg according to Yashon et al;[31] one third of the weight of the body without exceeding 32 kg (65 pounds) according to White and Panjabi;[30] 45 kg (97 pounds) according to Newton,[19] with a 90% success rate; and even 140 pounds for Cotler et al[9] and Rizzolo;[22] 50 kg according to Star et al,[28] without neurologic aggravation; and rapid

traction as high as 68 kg according to Lee et al.[16] In the current investigators' opinion, these values are dangerously high, especially in cases of medullar lesion. Breig[6] showed that traction of 5 kg stretched the spinal cord 10 mm and that any medullar lesion was aggravated by that much weight. In addition, Cotler et al[9] showed that excess flexion was dangerous for the cord, because it is pressed against the posterior aspect of the vertebral bodies in this position.

The current investigators propose a traction equal to 3–4 kg plus 2 kg/vertebral level, gradually applied with serial radiographic monitoring. With this method, no neurologic aggravation was observed and more than one third of the bilateral dislocations were reduced. Unilateral dislocation was less readily reduced with this technique. This progressive, but relatively brief traction was performed in the time it took to obtain a preoperative work-up.

The second method, reduction using specific maneuvers according to the type of lesion involved, with the patient under general anesthesia, is the object of debate. Durbin[12] considers it to be dangerous. Other groups recommend using only moderate traction for such maneuvers (a maximum of 5–10 kg recommended by Louis et al[17]). According to Braakman and Vinken,[5] this is a highly satisfactory and regularly successful procedure (82 reductions in 101 dislocations reported by Kleyn[15]).

Cotler et al[8] have given a good description of the reduction maneuvers, flexion–traction for bilateral dislocation and flexion–inclination to the side opposite unilateral dislocations, followed by rotation toward the dislocation.

Two notions must be emphasized. First, given that manual traction can reach 30 to 40 kg, its prolongation should be avoided. Second, these maneuvers must be constantly monitored by image intensifier screening until the facets are tip to tip and the neck is extended, realigning the facets. Removing the weights before manual maneuvers further reduces the danger of excessive distraction and facilitates flexion, extension, and lateral inclination applied by the physician. The current team attempts these specific maneuvers once or twice just before surgery.

Surgical reduction is the final alternative. Most surgeons recommend a posterior approach for surgical reduction.[4,25] The current investigators and others use an anterior approach for indirect reduction.[2,7,11,26,27] When this anterior approach is used, discectomy permits an interbody separation sufficient for the tip-to-tip positioning of the facets, which is necessary before the upper vertebral body is pushed backward into alignment. To reduce a uniarticular dislocation, distraction must be applied to increase the separation of the side of the endplates already farthest apart, and the procedure has to be controlled by an image intensifier placed at the proper oblique angle. Reduction is sometimes difficult to achieve, especially when a certain delay is exceeded or when a fracture complicates a dislocation.[19]

It must be stressed that this series included many patients treated before MRI was widely available. Currently, MRI is requested in every case of cervical facet dislocation. If possible, the operation is deferred until the paraclinical work-up, which includes MRI, is completed. During this waiting period, titanium skull tongs with progressively increasing weights are applied in an attempt to reduce the dislocation before the systematic anterior intervention. If discal herniation is evidenced by MRI, no further weights are added and no manual closed maneuver is attempted before surgery. Otherwise, the current investigators prefer beginning the cervicotomy with the facet dislocation already reduced, if this can be achieved by progressive weights during the preoperative interval or by one gentle manual closed maneuver after induction of anesthesia just before surgery. Before MRI was available, extreme caution was exercised during both of these closed procedures to avoid lesions by excessive traction to the cord rather than out of fear of impingement by herniated disc material, because such cases were rare, and would have been surgically evacuated in the time it took to access the disc and remove it. Achievement of reduction by progressive traction was, and continues to be, followed by surgery as quickly as possible whether or not there is disc herniation.

Reduction was not obtained in five of the currently reported patients. Nevertheless, interbody fusion was carried out and a satisfactory clinical result was observed. Because of the graft's thickness, the foramen was indirectly enlarged and the preoperative root pain present in four of these patients diminished. This difficulty in reducing uniarticular dislocations, especially excessively long-established ones, is widely reported. Rorabeck et al,[24] for example, failed to obtain reduction in 6 of a series of 26 patients. In four of these, stabilization was achieved through a posterior surgical approach. Although only indirect operative reduction procedures are possible when the anterior approach is used, dislocations are successfully reduced with remarkable regularity.

Argenson et al[1] reported a case in which reduction by such an approach was complicated by thrombosis of the vertebral artery. However, the possibility of removing discal material extruding into the spinal canal during discectomy, which is systematically associated with this anterior technique, represents an enormous advantage. Indeed, discal herniation and dislocation is not an exceptional association.[13,21] The current team encountered this situation seven times in this series (4.2%). It constitutes a considerable risk of neurologic aggravation at the moment of reduction.[3,20,23,29] Mahaley et al,[18] in a report of 16 cases of aggravation after closed reduction by traction, suggested MRI, even in the absence of neurologic abnormalities, and the current investigators believe that this policy is entirely justified.

■ Conclusion

Three techniques of reduction were successively performed in a series of 168 consecutive cases of uniarticu-

lar or biarticular lower cervical dislocations. Axial traction using a force dependent on the cervical level of the dislocation, never more than 18 kg in adults, resulted in reduction in more than a third of the patients (43%) with bilateral dislocation but was somewhat less successful in unilateral dislocations (23%). It was applied progressively and for no more than 2 hours. Manipulation in patients under general anesthesia was effective in one third of the remaining cases of bilateral and unilateral dislocation. This was attempted once or twice just before surgical maneuvers. The current team opted for an anterior operative approach making use of discectomy and enlargement of interbody separation. Failure of operative reduction was observed in only five patients with unilateral dislocation, three seen after excessive delays and two involving articular process fractures. Anterior arthrodesis was carried out after reduction in all patients. This gradual, cautious management, which proceeds from one stage to the next as necessary, successfully achieved reduction in 163 of 168 consecutive patients and permitted safe resolution of the problem of associated disc herniation when it occurred (in 7 of the 168). No neurologic deterioration was observed during or after this reduction protocol.

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