Controversies in the treatment of cervical spine dislocations

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Abstract

BACKGROUND CONTEXT: Cervical spine dislocations represent an area of great controversy among spine surgeons.

PURPOSE: The purpose of this review is to present the specific areas of controversy and to provide a review of the literature.

STUDY DESIGN: A case of cervical spine dislocation is presented to illustrate the major controversies related to the treatment of cervical spine dislocations.

METHODS: A review of the literature is presented regarding the major controversial aspects of the treatment of cervical spine dislocations.

RESULTS: The major areas of controversy include the choice of imaging, closed versus open reduction and surgical approach.

CONCLUSIONS: Guidelines for the management of cervical spine dislocations are presented based on evidence-based medicine. © 2009 Elsevier Inc. All rights reserved.

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Introduction

Cervical facet dislocations occur as the result of flexion and distraction forces with or without rotational forces acting on the subaxial cervical spine. These injuries have been classified by Allen and Ferguson into four stages: 1) facet subluxation; 2) unilateral facet dislocation with 25\% displacement; 3) bilateral facet dislocation with 50\% displacement; and 4) complete dislocation [1]. Unilateral facet dislocations are often associated with either an intact neurological exam or nerve root injury. Bilateral facet dislocations are more commonly associated with a neurological deficit. These injuries are thought to represent a continuum of pathology with disruption of various osseous and ligamentous structures. Previous imaging studies have revealed that disruption of the posterior musculature, interspinous ligament, supraspinous ligament, facet capsule, and ligamentum flavum occur with both unilateral and bilateral facet dislocations. There is a statistically significant increase in disruption of the anterior and posterior longitudinal ligaments with bilateral facet dislocations as compared with unilateral facet dislocations [2].

Unfortunately, there remains substantial controversy regarding the most appropriate management of these injuries. Many surgeons have traditionally recommended rapid realignment of the spine through closed traction reduction followed by a posterior spinal fixation. Others have recommended an initial magnetic resonance imaging (MRI) followed by treatment predicated on the findings of this study. The safety of each approach to treatment has generated significant debate over the years.

The purpose of this article is to review the controversies surrounding the management of unilateral and bilateral...
cervical facet dislocations and attempt to generate treat-
ment recommendations based on peer-reviewed literature.

Case presentation

A 38-year old male was a restrained passenger in a rollover
motor vehicle collision. He was unconscious in the field and
was intubated for airway protection. At the hospital, a helical
computed tomography (CT) scan was obtained, which dem-
onstrated a unilateral perched facet and contralateral fracture
dislocation of the facet with malalignment of the spinal canal
(Fig. 1). The patient was unexaminable, and therefore his
neurological exam was uncertain.

This case presents various controversies regarding the
appropriate evaluation and management of patients with
cervical spine dislocations. The first question is to deter-
mine what imaging is necessary as a screening study for
cervical spine trauma? Second, if a cervical dislocation is
identified is it necessary to obtain a MRI before further
treatment? Third, should reduction be performed closed
or should the patient be taken directly to surgery for open
reduction? Finally, what is the best surgical approach and
choice of fixation for cervical spine dislocations?

Controversy #1: is helical CT alone an adequate
screening imaging study?

The appropriate imaging analysis of patient with sus-
pected cervical spine injury is widely debated. There are
specific guidelines that are accepted for the clearance of
cervical spine injuries in patients that are awake, alert,
and without distracting injury or evidence of intoxication
[3]. As of 2000, a consensus document published by the
Eastern Association of the Surgery of Trauma still recom-
ended that 3-view cervical films (Anterior/Posterior/
Lateral/Open mouth) be performed for all level-1 trauma
patients with suspected cervical spine injury [4]. The heli-
cal CT scan was reserved for closer examination of suspi-
cious or poorly visualized areas such as the upper
cervical spine or cervical thoracic junction.

However, there is currently no consensus on the evalua-
tion of obtunded or unreliable patients with suspected cervi-
cal spine injury. This has led to prolonged use of rigid
cervical collars until the patients are capable of standing
for dynamic radiographs, stable for transport to MRI, or alert
enough to participate in a clinical examination. There are sig-
nificant comorbidities related to the prolonged use of the
rigid collar including compromised airway management,
skin ulcers, limited central venous access, increased intracra-
nial pressure, pneumonia and deep vein thrombosis [5–7].

This lack of consensus has led to trauma centers devel-
oping their own individualized criteria for clearing cervical
spines in obtunded patients. The most commonly used
imaging studies include plain radiographs, dynamic radio-
graphs, dynamic fluoroscopy, CT, and MRI.

Several studies have been published that have chal-
lenged the notion that plain X-rays are necessary at all
[8,9]. Daffner et al. noted that helical CT scan of the cervi-
cal spine was much less time consuming than the standard
6-views of the cervical spine. In their series of 156 consec-
tutive patients, the average time for cervical spine CT acquisi-
tion was 11 minutes, which was half the time of standard
6-view radiographs [8]. Another study analyzed the cost-
effectiveness of using helical CT as a screening tool for cer-
vascular spinal injury. The initial set-up and examination costs

Fig. 1. Sagittal computed tomography scan revealing fracture dislocation at the C6–C7 level. (Left) Top of scan, (Middle) midline of scan, and (Right) right
of scan images.
were higher for helical CT than plain radiographs, however if the rate of missed fracture was incorporated into the analysis, the helical CT was shown to be more cost-effective in the long run [9]. One prospective study compared plain radiographs to CT scans in detecting cervical spine injuries in obtunded patients and found that the sensitivity, specificity, and accuracy of plain films were 39%, 98%, and 88% in comparison to the CT scans, which had a sensitivity of 100% [10]. Another large prospective study that analyzed over 400 consecutive trauma patients also found plain radiographs to have a low sensitivity in detecting cervical spine fractures (52%) in comparison to CT scans (98%) [11]. Therefore, there has been a recent trend toward using helical CT scans alone as a primary screening tool in high-risk level-1 trauma patients [12].

This trend toward exclusive use of helical CT does have some pitfalls. One of the most important caveats is that not all helical CTs are the same. Standard lower resolution multi-slice helical CTs can miss subtle spinal fractures. The 64-slice (multidetector/multislice) CT scan has the highest resolution. An example of this difference in resolution is shown in Fig. 2. Fig. 2, top shows a patient with a nondisplaced odontoid fracture analyzed with a standard 4-slice multidetector CT scan. As noted, the fracture is not visualized on the sagittal reconstruction views. The same patient analyzed with a 64-slice multidetector CT scan (Fig. 2, bottom) shows the nondisplaced odontoid fracture missed by the previous scan. The downside of the 64-multi-detector scan is that it exposes the patient to significantly higher radiation than the standard CT scan. It is possible that patients at higher risk for missed fractures, such as those with ankylosing spondylitis or diffuse idiopathic skeletal (DISH), could have missed fractures with lower slice scanner, but this has not been studied [13]. Some centers are equipped with 16 or 32 slice scanners that provide excellent image quality. There are currently no studies comparing the sensitivity and specificity of the various types of CT scanners in detecting cervical spine injuries.

The use of MRI to identify any potential cervical trauma that is missed by the CT scan remains controversial. Tomycz et al. performed a retrospective analysis of 690 obtunded patients that had undergone both cervical CT and MRI following trauma [14]. Of the 690 patients, 180 (26.2%) had normal CT scans. MRI revealed acute traumatic findings in 38 (21.1%) of the patients with normal CT scans. However, none of these injuries identified by MRI were unstable or required additional surgery. There was a mean delay of 4.6 days to obtain the MRI. These results are contradicted by Menaker et al. who performed a similar study of 734 obtunded patients [15]. In their study, additional findings on MRI led to a change in management in 7.9% of patients.

Dynamic fluoroscopy has been compared to helical CT scan and found to provide no additional information regarding cervical instability. It has been abandoned in most centers as redundant and unsafe [16,17].

The other potential complication associated with cervical spine fracture/dislocation is injury to the vertebral arteries. The incidence has been reported as high as 11% resulting from nonpenetrating cervical spine trauma [18]. A consensus statement by the American Academy of Neurologic Surgeons found insufficient evidence to support either standards or guidelines for either the diagnosis or treatment of these injuries [18]. Angiography was recommended for cervical spine trauma patients with complete spinal cord injury, fracture through the foramen transversarium, and facet dislocation or dislocation. Anticoagulation treatment was recommended in patients with evidence of a posterior stroke. Patients with posterior ischemia could be managed with anticoagulation or observation.

**Controversy #2: MRI or no MRI before reduction?**

The obvious next step for the patient presenting with a bilateral facet fracture dislocation is to quickly and safely re-align the spine. Whether a MRI is necessary before...
a reduction maneuver has been a topic of debate since the early 1990s. As the MRI has become widely available, many have debated whether MRI is necessary to identify potential anterior impingements to the spinal cord (such as a herniated disc) during the reduction maneuver. A case-series report of six patients in 1991 by Eismont et al., [19] highlighted the danger of closed reduction in a sedated patient. One of the patients in this series sustained a new neurological deterioration after a reduction was performed under general anesthesia. Several subsequent reports, including those by Vaccaro et al., [20] have indicated that closed reduction in an awake and alert patient may be safe without obtaining a prereduction MRI. Some recent studies have indicated that even closed reduction in sedated patients may be safe in most cases [21]. An interesting recent study illustrated that a herniated disc may re-constitute itself into the disc space with distraction and reduction, as illustrated by a MRI aided reduction technique [22]. Our patient represents the most controversial scenario where a baseline neurological exam is not available, and the spine remains dislocated. Should a MRI be obtained on this patient before attempting a closed reduction?

A recent survey analysis was performed among the Spine Trauma Study Group (STSG) regarding this type of situation [23]. Those surveyed among the spine trauma group consisted of 25 fellowship-trained neurosurgeons and orthopedic surgeons involved at level I trauma centers with large spinal injury trauma populations. Participants were given ten clinical vignettes that contained case examples of both unilateral and bilateral facet dislocations. Two questions were posed: 1) After reviewing the radiographs and CT scans of a hypothetical patient (images provided), would you obtain a MRI first or proceed directly with a reduction maneuver?; and 2) Assuming that you decided to obtain a prereduction MRI, would you then perform an open reduction or an initial closed reduction? The results of the opinions were highly varied. The kappa value of whether one would order a prereduction MRI was -0.002 to -0.029 (higher for complete vs. incomplete neuro injuries). Once the MRI was obtained, the agreement of how to proceed was also highly varied, with kappa values of 0.068 to 0.159. There was absolutely no consensus on whether a prereduction MRI should be obtained, or following a prereduction MRI, how one should proceed (open vs. closed reduction). Interestingly, neurosurgeons were more likely to order a prereduction MRI (76.7%) versus orthopedic surgeons (57.5%). Also, neurosurgeons were more likely to perform an open reduction than closed reduction.

When further analyzed in those who obtained a prereduction MRI, the decision to perform an open versus closed reduction relied on whether a surgeon believes there is an anterior disc herniation that would potentially cause neurological deterioration with a reduction maneuver. The interpretation of a MRI in the setting of a dislocated cervical spine is very subjective, and as a consequence, this confounder has an effect on treatment decisions. Eismont et al., [19] and Vaccaro et al., [20] have espoused that a “disc herniation” is defined as potentially dangerous when the disc is protruded behind the cephalad vertebral body. However, recent MRI assisted reduction studies have shown that even those discs can successfully be reduced back into the disc space with a closed reduction maneuver [22]. Also, there are no radiological studies to date that explore the sensitivity and specificity of differentiating disc material from hematoma with MRI. Therefore, it again remains highly subjective whether a surgeon interprets an anterior lesion as a “dangerous” disc herniation. The question of how large an anterior disc herniation has to be to cause cord impingement is also unclear.

Currently, there is no literature to guide the treating surgeon on this topic. It is generally recommended that in an unexaminable patient who cannot cooperate with the examination, a prereduction MRI is prudent to get an understanding of the status of the spinal cord and any potentially offending soft-tissue or bony structures placing the spinal cord at risk.

Controversy #3: closed versus open reduction?

The decision to perform an open or closed reduction is largely dependent on two factors: 1) Is it safe?; and 2) Is closed reduction possible? The question of whether a closed reduction is “safe” boils down to whether a surgeon believes that he or she can monitor the patient safely during the closed reduction process (in this case example, no), or following a prereduction MRI, does the surgeon believe there is a significant anterior space occupying lesion, which can cause cord damage during the reduction. With a lack of an exact definition of what a dangerous disc fragment is, it is no surprise that there is very little agreement on whether a closed reduction is safe.

Currently, there are several level IV evidence articles that conclude that closed reduction in an awake and alert patient is relatively safe [20,24,25]. There is, however, no agreement on whether such a maneuver is safe in an obtunded or intubated patient. The case report by Eismont et al., [19] would suggest that closed reduction in an obtunded patient is unsafe.

A consensus statement by the American Academy of Neurological Surgeons determined that there was insufficient evidence to support either treatment standards or treatment guidelines in regards to reduction of cervical facet dislocations [26]. The incidence of permanent neurological complications after closed reduction in awake patients was approximately 1%, whereas transient injury occurred in 2% to 4%.

At present most would agree that a closed reduction should not be attempted on an obtunded patient in most circumstances. Most would agree that an open reduction with or without a decompression can be considered in patients following a failed closed reduction after a MRI is obtained or in the presence of what is considered a dangerous
herniated disc on a prereduction MRI. Most would also agree that MRI should be obtained before taking a patient to surgery for an open reduction to make sure that the potential for spinal cord injury can be minimized by removal of a disc herniation if necessary.

Controversy #4: surgical approach and fixation

The options of surgical approach for unilateral or bilateral facet injuries include a stand-alone anterior approach, a stand alone posterior approach, a combined anterior and posterior approach, or a staged anterior/posterior/anterior approach. Which approach is chosen seems to be dependent on several factors: 1) How unstable is the fracture/dislocation?; 2) Is there an anterior disc herniation?; and 3) Is the dislocation reducible from the anterior approach alone? There is no consensus in the literature on how unilateral or bilateral facet injuries should be treated [27–35]. A survey analysis of the STSG again shows extreme variations in the choice of approach for unilateral or bilateral facet fracture dislocations [36]. The kappa value of whether a unilateral or bilateral facet injury is treated anteriorly, posteriorly, or with a combined approach was less than 0.1. This only improved slightly (kappa = 0.15) if the patient was assumed to have a complete neurological injury. When patients were neurologically intact, the anterior approach was more commonly chosen than posterior approaches, and combined approaches were more commonly chosen for bilateral facet injuries. Again, a key point in opinion divergence stemmed from the interpretation of the MRI. Surgeons varied tremendously on how they interpreted the MRI (whether there is a dangerous disc herniation or not), which then influenced the chosen approach.

Consensus recommendation

Based on the literature, our patient would have no consensus recommendation on how he should be treated. As there is no consensus recommendation available, many of the currently available treatment algorithms are at the discretion of the treating surgeon. Based on the American Academy of Neurologic Surgeons consensus statement this patient would be recommended to obtain an MRI before reduction based on the inability to obtain a neurologic examination. However, this is a treatment option only, not a standard or guideline because of lack of evidenced-based research.

References


