# The Timing and Influence of MRI on the Management of Patients With Cervical Facet Dislocations Remains Highly Variable

## A Survey of Members of the Spine Trauma Study Group

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**Background:** Traumatic cervical facet dislocations are potentially devastating injuries. Magnetic resonance imaging (MRI) is an excellent means of assessing ligamentous disruption, disk herniation, and compression of the neural elements. However, despite an improved understanding of these facet dislocations with imaging, treatment remains controversial.

**Purpose:** To survey the timing and influence of MRI on the management of patients with traumatic cervical facet dislocations.

**Study design:** Questionnaire study.

**Methods:** Clinical vignettes, plain radiographs, and computed tomography scans of 10 cases of cervical facet dislocation were presented to 25 fellowship trained spine surgeons. Participants were analyzed as to their next step in diagnosis or treatment: closed reduction, obtaining an MRI, or proceeding directly with open treatment. A revised vignette was then presented; however, on this occasion, an MRI was included with the imaging and had been obtained before a reduction attempt. Participants were then surveyed on their choice of closed or open reduction. Each of the vignettes consisted of 3 different clinical scenarios based on neurologic examination: intact, incomplete, or complete spinal cord injury.

**Results:** The interrater reliability of treatment decisions was very poor, and the reliability after MRI was available and was significantly worse when the patient was considered to have a complete spinal cord injury. After reviewing the MRI, orthopedic surgeons were significantly more likely to choose a closed versus open reduction. Neurosurgeons were significantly more likely than orthopedic surgeons to order an MRI before open or closed treatment.

**Conclusions:** The timing and utilization of MRI for patients with traumatic cervical facet dislocations remains variable. Further outcome analysis in the form of evidence-based algorithms is necessary to optimize patient management and outcomes.

**Key Words:** Questionnaires, cervical vertebrae, trauma, dislocations, magnetic resonance imaging, spine

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The field of spine surgery has advanced through improvements in imaging modalities, understanding of biomechanics, improved spinal instrumentation, and surgical techniques. However, despite continued and rapid advances in spinal surgery, there remains significant variability in the treatment of spine disorders and particularly spinal trauma.[1]

Unilateral and bilateral facet dislocations typically result from a flexion-distraction mechanism and can result in devastating sequela. These injuries are often associated with significant soft tissue disruption, facet fractures, disk herniations, vertebral artery dissection, and compression of the neural elements.[2]

Reduction of these injuries is important to restore spinal alignment and indirectly decompress the neural elements. This goal can be accomplished via closed or open methods and is typically followed with more

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definitive internal stabilization. Closed reduction involves traction applied in an appropriate trajectory with the objective being indirect spinal canal decompression through realignment of the dislocated spinal vertebrae.[3] Open reduction may involve anterior, posterior, or combined approaches with or without a direct surgical decompression of the neural elements.

The risk of closed reduction is the potential to displace herniated disk material further into the canal, which has been reported to have potentially devastating consequences.[4] Follow-up studies have not shown this to have significant clinical consequences if performed in an awake and responsive patient.[5] Nonetheless, controversy exists about the timing of MRI relative to reduction of cervical facet dislocations.

The neurologic status of the patient has also been proposed to be a variable in this decision-making process. For example, patients with complete spinal cord injury (SCI) may have "the least to lose and most to gain" from an immediate closed reduction and expansion of the spinal canal because of the rapid nature of this technique,[6] whereas the neurologically intact patient with a cervical dislocation has a much more profound possibility of iatrogenic neurologic impairment. The effect that neurologic status may have on this decision process has not been well established.

To understand the decision processes among a group of experienced spine surgeons, a series of clinical facet dislocations were evaluated. The purpose of this paper was to assess the utilization and role of MRI on decisions (particularly whether to perform a closed reduction or not) of cervical dislocations.

## METHODS

Ten cases of unilateral or bilateral facet dislocation were collected from a database of trauma patients at a level 1 trauma institution. Approval from the local institution review board was obtained. Clinical vignettes, selected plain radiographs, and representative computed tomography (CT) and magnetic resonance imaging (MRI) images were compiled. The CT images consisted of midsagittal reconstruction, paramedian sagittal reconstructions through the right and left facet joints, and 1 or 2 representative axial cuts through the level of the involved facet articulations. MRI images included T2-weighted axial and sagittal images at the injury level.

These images and associated clinical vignettes were then distributed to 25 members of the Spine Trauma Study Group. This is an international group of experienced spine surgeons with a commitment to the study and treatment of spinal trauma.

Each case was presented as 3 scenarios on the basis of their neurologic examination: intact, incomplete, or complete SCI. Two questions were asked for each of these scenarios.

1. After evaluating the plain radiographs and/or CT images, would you proceed with a closed skeletal traction reduction or would you obtain an MRI of the cervical spine before open or closed reduction? The possible responses were to obtain an MRI, perform a closed reduction without an MRI, or proceed directly to surgery.
2. Assuming you decided to get an MRI before performing a reduction, after evaluating the MRI would you now proceed with a closed or an open reduction? The possible responses were to perform a closed reduction or open reduction.

Fliess κ value was used to assess interrater reliability. The standards suggested by Landis and Koch for interpreting κ values were applied.[7] As such, κ values below 0.2 are considered poor agreement, κ values between 0.2 and 0.4 are considered fair agreement, κ values between 0.4 and 0.6 are considered moderate agreement, and κ values above 0.6 are considered substantial agreement.[7] Fleiss κ was calculated using SPSS v13.0 (Chicago, IL). All other data analyses were performed using MEDCALC Software Version 8.1.0 (Mariakerke, Belgium). For significance tests on κ coefficient comparisons, all unweighted coefficients were converted into Fisher $z$-scores. The comparison of MRI rates in orthopedic and neurosurgeons was treated as a test of independent proportions. α-level was set at 0.05 ($\Delta Z/SE \geq 1.96$).

## RESULTS

The interrater reliability of both of the decisions queried was very poor, and the reliability of the second question, where an MRI was already available, was significantly worse when the patient was considered to have an incomplete or complete SCI (Fig. 1). For

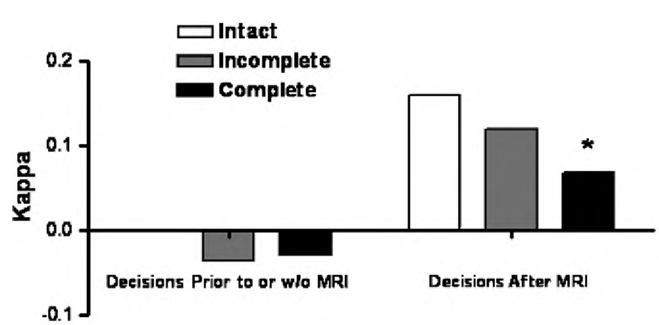


**FIGURE 1.** Interrater agreement on making decision related to the assessment and treatment of cervical dislocation injuries. The question before MRI was: "After evaluating the plain radiographs and/or CT images, would you proceed with a closed skeletal traction reduction or would you obtain an MRI of the cervical spine prior to open or closed reduction?" The question after MRI review was: "Assuming you decided to get an MRI prior to performing a reduction, after evaluating the MRI would you now proceed with a closed or an open reduction?" See text for further details. *$P<0.05$ for difference between "complete" and "intact;" $P<0.01$ for difference between "complete" and "incomplete." CT indicates computed tomography; MRI, magnetic resonance imaging.

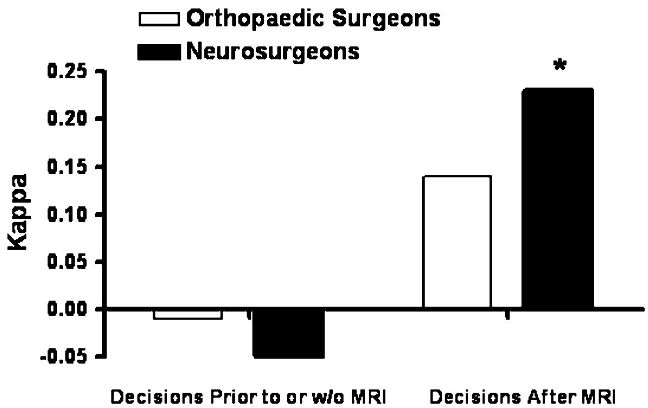


**FIGURE 2.** Interrater agreement: orthopedic surgeons versus neurosurgeons. The question before MRI was: "After evaluating the plain radiographs and/or CT images, would you proceed with a closed skeletal traction reduction or would you obtain an MRI of the cervical spine prior to open or closed reduction?" The question after MRI review was: "Assuming you decided to get an MRI prior to performing a reduction, after evaluating the MRI would you now proceed with a closed or an open reduction?" See text for further details. *$P<0.05$ for difference between orthopedic and neurosurgeons. CT indicates computed tomography; MRI, magnetic resonance imaging.

decisions before or without MRI, κ values were − 0.002, − 0.036, and − 0.029 for intact, incomplete, or complete patients, respectively (Fig. 1). For decisions after MRI, κ values were 0.159, 0.119, and 0.068 for intact, incomplete, and complete patients, respectively (Fig. 1).

When comparing orthopedic surgeons to neurosurgeons, the interrater reliability of choosing an open versus closed reduction after reviewing the MRI was significantly higher among neurosurgeons (Fig. 2). For decisions before or without MRI, κ values were − 0.01 and − 0.05 for orthopedists and neurosurgeons, respectively. For decisions after MRI, κ values were 0.04 and 0.23 for orthopedists and neurosurgeons, respectively. Neurosurgeons were significantly more likely than orthopedic surgeons to order an MRI before making any treatment decisions. Neurosurgeons ordered an MRI in 76.7% of cases whereas orthopedic surgeons ordered an MRI in 57.5% of cases ($P<0.01$, Fig. 3).

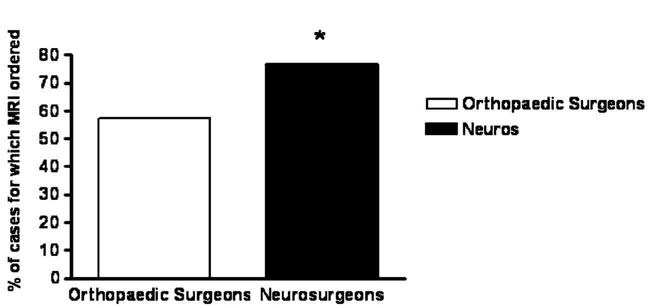


**FIGURE 3.** Neurosurgeons are more likely to order an MRI before treatment. *$P<0.01$ for difference between orthopedic and neurosurgeons. MRI indicates magnetic resonance imaging.

## DISCUSSION

The timing and need of a cervical MRI in the initial evaluation of patients with facet dislocations have been debated in the literature, and unfortunately, there are no established treatment algorithms at present. Accordingly, this analysis was performed to assess the practice patterns of a group of experienced spine surgeons for the initial management of patients with cervical facet dislocations and the potential impact of MRI on the decision-making process.

The results of this survey study demonstrated very poor interrater reliability for treatment with closed reduction, obtaining an MRI, or proceeding directly to open treatment of facet dislocations. Additionally, after obtaining an MRI before a reduction attempt, there was poor interrater reliability on proceeding with open versus closed treatment.

These findings contradict "a priori" expectations that agreement would be higher for intact and complete SCI patients than incomplete SCI patients and that agreement would improve when MRI imaging was available for review. These issues are very fundamental and profound from both patient management and medico legal perspectives for these treatments with potentially high neurologic risks.

Closed reduction provides the advantage of rapid restoration of alignment, but is associated with the potential displacement of a herniated disk further into the spinal canal.[5] MRI before reduction provides additional information to the surgeon, but may be associated with significant delays in reduction in most centers and the not insignificant risk of patient transfer and movement related to obtaining the MRI. There may also be significant variability in the interpretation of imaging studies. Clearly, the addition of MRI information did not improve the interrater variability in making decisions as to whether to proceed with closed versus open reduction in this study.

The poor correlations in therapeutic decision making among this group of "spine trauma experts," and the fact that further diagnostic information did not substantially improve the agreement, would suggest that the lack of agreement is not necessarily related to inadequate clinical information. Rather, the lack of agreement may be because of varying interpretation of the imaging studies and varying appreciation and also evidence regarding the risks of the possible interventions.

This lack of agreement may lead to more extensive surgery (an anterior, posterior) in some cases because of the concern over the presence of a disk herniation on MRI. Proceeding directly with open reduction with out an MRI offers early definitive treatment, but does not provide for assessment of information (ie, neural compression) desired by many surgeons.

Compounding difficulties in interpreting imaging studies may result in the perceived need for early decompression of the spinal cord. Animal studies have suggested that the time to decompression of the spinal cord may have significant effect on outcome and should be accomplished within a few hours for maximal recovery.[8,9] However, prior clinical studies have failed to show a correlation between time to reduction of cervical facet dislocation and neurologic outcome.[10] These prior clinical studies may simply have not evaluated early enough time points to detect a significant difference in outcome. Furthermore, decompression within 8 hours of injury may only be possible in up to 10% of acute spinal cord injured patients.[11]

Certainly there are many variables associated with clinical decision-making. It seems that training may relate to the decisions made in this survey, as indicated by differences observed between orthopedists and neurosurgeons. However, the differences observed are difficult to reconcile in this era of evidence-based medicine.

There are limitations to this study. As with any survey study, results are subject to cases that are selected and biases of those asked to participate in the survey. However, the cases in this study represent a spectrum of unilateral and bilateral facet dislocations, and the participants surveyed are experienced spine surgeons with a commitment to spine trauma.

In summary, there is very poor agreement on whether to initiate treatment of cervical facet dislocations with closed reduction, to obtain a prereduction MRI, or to proceed directly to open treatment. Furthermore, even after obtaining an MRI, this variability in treatment recommendations was maintained; therefore, illustrating the need for more defined treatment algorithms as have been suggested by others in the past.[12,13]

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