Differences Between Neurosurgeons and Orthopedic Surgeons in Classifying Cervical Dislocation Injuries and Making Assessment and Treatment Decisions: A Multicenter Reliability Study

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Abstract

Variability exists in the management of cervical spinal injuries. The goal of this study was to assess the effect of training specialty (orthopedic surgery vs neurosurgery) on management of cervical dislocations.

Twenty-nine spine surgeons reviewed 10 cases of cervical dislocation injuries. For each of the 10 cases, the surgeons evaluated 3 clinical scenarios, which included a neurologically intact patient, a patient with an incomplete spinal cord injury (SCI), and a patient with complete SCI. Surgeons determined whether a unilateral or bilateral facet dislocation was present and whether pretreatment magnetic resonance imaging (MRI) or immediate closed reduction was indicated. Management decisions were re-assessed after review of MRIs. While spine surgeons may agree on what they see on MRI and how they classify certain cervical injuries irrespective of training, significant differences of opinion continue to exist regarding the therapeutic implications of this information, specifically, whether to order a pretreatment MRI and how to manage the injury.

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Optimal management of unstable cervical spinal injuries is poorly defined and has remained controversial for decades.[1-6] Challenges confronting the treating physician include classifying the injury, deciding whether to use closed reduction, deciding whether pretreatment magnetic resonance imaging (MRI) is indicated, and selecting the optimal timing and approach for surgery.[1,4,5,7-9] There is considerable variability in opinions on appropriate management of these problems. One factor in this variability may be the specialty training of the treating surgeon. The primary objective of the study reported in this article was to assess the reliability among experienced spine surgeons in making assessment and treatment decisions in cases involving cervical dislocation injuries. A secondary objective was to assess the influence of specialty training (orthopedic surgery vs neurosurgery) on management of cervical dislocation injuries. This information may be useful as an attempt to establish treatment protocols and algorithms.

Within the past 15 years, there has been a gradual interdisciplinary merging between neurosurgeons and orthopedic surgeons on understanding and managing spine trauma, even though each discipline maintains separate training programs with minimal intertraining integration.[1-3,10,11]

Table I. Questionnaire Presented to Surgeons Assessing Treatment Decisions for Cervical Facet Dislocations

Reviewer Name:
Case #:

Please make the assumption that the patient in question is awake, alert, and cooperative. Assume that the patient has a normal neurological injury (ASIA E[a]).

Question 1. After reviewing the plain x-rays and/or CT images, how would you classify this injury?
a) Unilateral Facet Dislocation, or b) Bilateral Facet Dislocation

Question 2. After evaluating the plain x-rays and/or CT images, would you proceed with a closed skeletal traction reduction, or would you obtain a MRI of the cervical spine prior to open or closed reduction?
a) Proceed with a closed skeletal traction reduction without MRI, or
b) Obtain MRI of the cervical spine prior to open or closed reduction

Question 3. Assuming that a MRI was obtained prior to reduction, after evaluating the provided MRI, do you believe a disc herniation is present at the level of injury?
a) Yes, or b) No

Question 4. Assuming you decided to get a MRI prior to performing a reduction, after evaluating the MRI would you now proceed with a closed or an open reduction?
a) Closed Reduction, or b) Open Reduction

Question 5. Following review of all imaging studies, what type of surgical approach would you recommend as the treatment of this injury if a closed reduction was NOT performed or, if attempted, was NOT successful?
a) Anterior Alone, or b) Anterior-Posterior, or c) Anterior-Posterior-Anterior, or
d) Posterior Alone, or e) Posterior-Anterior

Question 6. If a *successful* closed reduction was performed, what would be your definitive surgical procedure in light of the imaging studies for this case (assume appearance of disc is not altered from the images provided)?
a) Anterior Alone, or b) Anterior-Posterior, or c) Anterior-Posterior-Anterior, or
d) Posterior Alone, or e) Posterior-Anterior

Abbreviation: MRI, magnetic resonance imaging.
[a]American Spinal Injury Association Impairment Scale rating of "E": "normal: motor and sensory function are normal."

Therefore, it is important that treatment paradigms become predictable and reliable so that treatment variability is reduced and optimal treatment is achieved. Although the primary purpose of this study was to determine the variability among surgeons (regardless of specialty) in making diagnostic and therapeutic decisions regarding cervical dislocation, possible interspecialty differences were also of interest.

Materials and Methods

Twenty-nine (29) experienced spine surgeons (9 neurosurgeons, 20 orthopedic surgeons) reviewed 10 separate case scenarios of neurologically intact patients with cervical dislocation injuries (Table I). All surgeons invited to participate were members of the Spine Trauma Study Group (STSG), an international collaboration dedicated to advancing spine trauma patient care through multicenter clinical research. Surgeons were asked to review the initial radiographs and/or computed tomography (CT) images and determine whether a unilateral or bilateral facet dislocation was present. A sample set of images for 1 of these 10 cases is shown in Figure 1. After reviewing these images, surgeons were then asked whether they would perform closed reduction with traction or would first obtain an MRI.

After answering this first set of questions, surgeons reviewed cervical MRIs to determine if a herniated disc was present. Based on their MRI review, surgeons were asked whether an open or closed reduction should be performed. The surgeons were then asked which surgical approach they would choose (anterior, posterior, or both), assuming that a closed reduction was not performed or, if attempted, was unsuccessful in achieving reduction of the deformity. Finally, surgeons were asked their preferred surgical approach after a successful closed reduction (without alteration in appearance of disc herniation, if any).

Overall interrater reliability and interrater reliability within (ie, intraspecialty) and between each specialty (ie, interspecialty) were calculated using SPSS (Statistical Package for the Social Sciences) Version 13.0 (Chicago, Ill). Both Cohen's κ and percentage agreement were applied as indices of reliability.[11-16] Kappa statistics were treated as correlation coefficients to calculate *P* values for the orthopedic-versus-neurosurgeon comparisons.[14] Percentage agreements were compared by a test of independent proportions. Similarly, the percentage of cases in which MRIs were ordered by specialty were compared by a test of independent proportions. *P*s were computed for differences in percentage agreement and κ, comparing orthopedic interrater reliability with neurosurgery interrater reliability. GraphPad Prism Version 4 (San Diego, Calif) was used for all graphing.

Results

For the intact clinical scenarios, there was good reliability among all surgeons regarding injury classification (unilateral vs bilateral facet dislocation, $\kappa = 0.56$) and whether a disc herniation was present or absent on MRI ($\kappa = 0.58$) (Table II). There was fair agreement among all surgeons on whether to

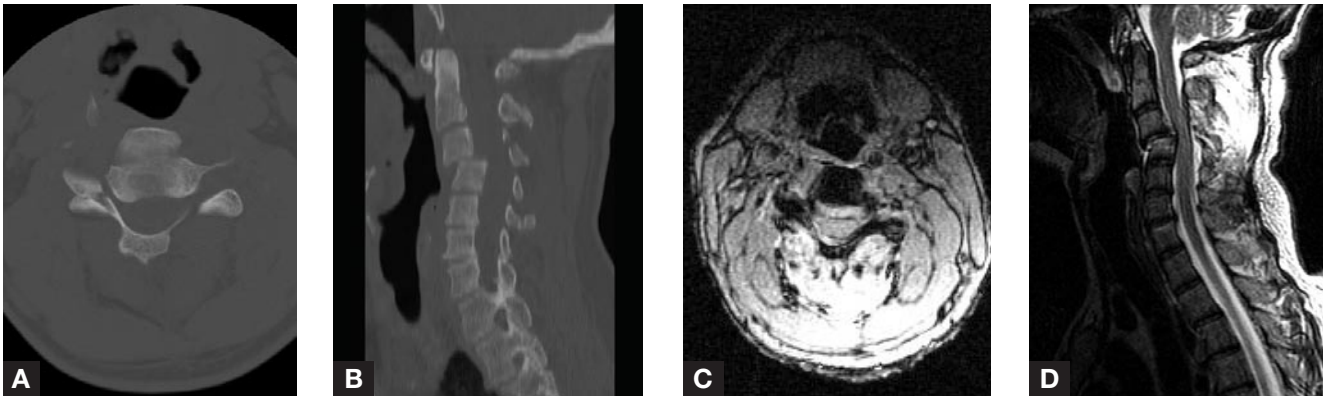

Figure 1. Sample images from a case evaluated by the rating surgeons: **(A)** axial computed tomography (CT), **(B)** sagittal CT, **(C)** axial magnetic resonance imaging (MRI), **(D)** sagittal MRI, and **(E)** lateral radiograph.

proceed with open versus closed reduction after MRI review ($\kappa = 0.19$), and there was poor agreement on which surgical approach was best (anterior, posterior, or combined, $\kappa < 0.10$) (Table II). These interrater reliability findings were similar for orthopedic surgeons as a group and neurosurgeons as a group (Figures 2A, 2B). However, some reliability comparisons across specialties did reach statistical significance. Interrater agreement as assessed by both Cohen's κ and percentage agreement was significantly higher in orthopedic versus neurosurgeons for injury classification ($P<.0001$; Figures 2A, 2B) and in selecting surgical approach ($P<.05$; Figures 2A, 2B) in the intact clinical scenario. In contrast, interrater agreement as assessed by Cohen's κ was significantly higher among neurosurgeons versus orthopedic surgeons in selecting open versus closed reduction after MRI review in the intact clinical scenario ($P<.001$; Figure 2A).

In the incomplete and complete spinal cord injury (SCI) scenarios, overall interrater reliability was again the highest for injury classification ($\kappa = 0.58$ in both incomplete and complete SCI scenarios; Table II) and identification of disc herniations ($\kappa = 0.59$ in incomplete SCT scenario, $\kappa = 0.58$ in complete SCI scenario; Table II). Intraspecialty reliability was also compared in the incomplete and complete SCI scenarios. In both scenarios, there was higher interrater reliability among neurosurgeons than among orthopedic surgeons in identifying disc herniations ($\kappa = 0.76$ vs $\kappa = 0.49$ in incomplete SCI, $P<.01$ [Figure 3A]; $\kappa = 0.76$ vs $\kappa = 0.51$ in complete SCI, $P<.01$ [Figure 4A]). These differences in intraspecialty reliability with respect to identification of disc herniations also reached significance when assessed by percentage agreement (Figures 3B, 4B). Orthopedic surgeons tended to have higher reliability in selecting surgical approach in the complete SCI cases, but this reached statistical significance only when assessed by percentage agreement (39.9% agreement vs 28.9% agreement, $P<.05$; Figure 4B). Neurosurgeons had higher interrater percentage agreement on the decision to order pretreatment MRI (58.9% agreement vs 46.7% agreement, $P<.05$; Figure 3B). No other comparisons between specialties reached statistical significance.

Interrater agreement between orthopedic surgeons and neurosurgeons was also evaluated (interspecialty reliability). These interspecialty reliability statistics were similar to the overall reliability data. There was good interspecialty reliability regarding injury classification (unilateral vs

Table II. Overall and Interspecialty Reliability (as Assessed by Cohen's κ and Percent Agreement) Are Similar, Regardless of Neurology

	Intact		Incomplete SCI		Complete SCI	
	Overall	Interspecialty	Overall	Interspecialty	Overall	Interspecialty
Injury classification	0.56 (79.2%)	0.54 (78.2%)	0.58 (80.3%)	0.57 (80.1%)	0.58 (80.3%)	0.57 (80.1%)
Closed reduction vs magnetic resonance imaging	0.00 (52.3%)	0.02 (54.3%)	–0.03 (49.4%)	–0.00 (50.4%)	–0.03 (47.1%)	0.01 (48.9%)
Disc herniation	0.58 (79.7%)	0.59 (79.7%)	0.59 (80.3%)	0.64 (82.4%)	0.58 (79.7%)	0.63 (82.0%)
Open vs closed reduction	0.19 (58.2%)	0.22 (59.0%)	0.12 (56.9%)	0.16 (58.9%)	0.07 (53.4%)	0.11 (54.9%)
Surgical approach	0.10 (32.7%)	0.09 (30.4%)	0.13 (34.5%)	0.14 (34.3%)	0.15 (37.2%)	0.16 (36.2%)
Surgical approach after successful closed reduction	0.09 (39.2%)	0.06 (36.5%)	0.12 (38.4%)	0.14 (40.4%)	0.14 (39.0%)	0.16 (40.7%)

Abbreviation: SCI, spinal cord injury.

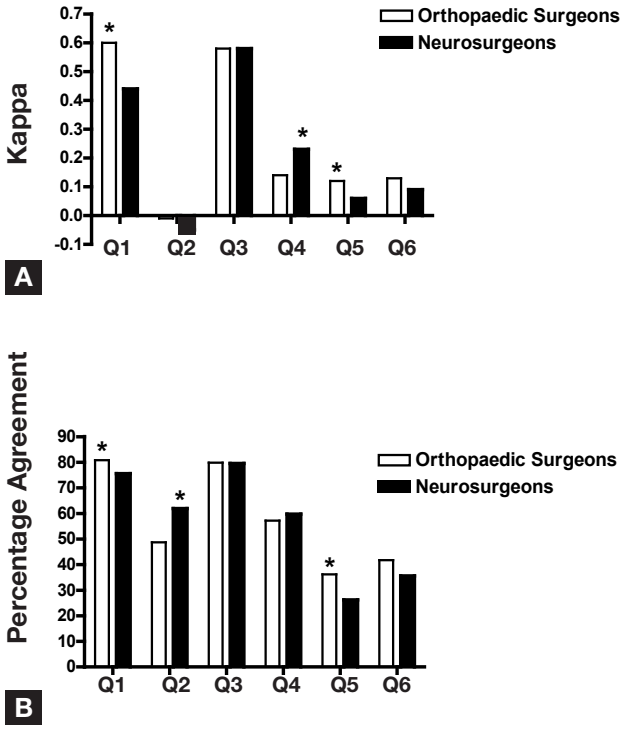

Figure 2. Orthopedic surgeons versus neurosurgeons (*P<.05) in intact scenario: **(A)** interrater agreement (assessed by Cohen's κ) and **(B)** interrater percentage agreement.

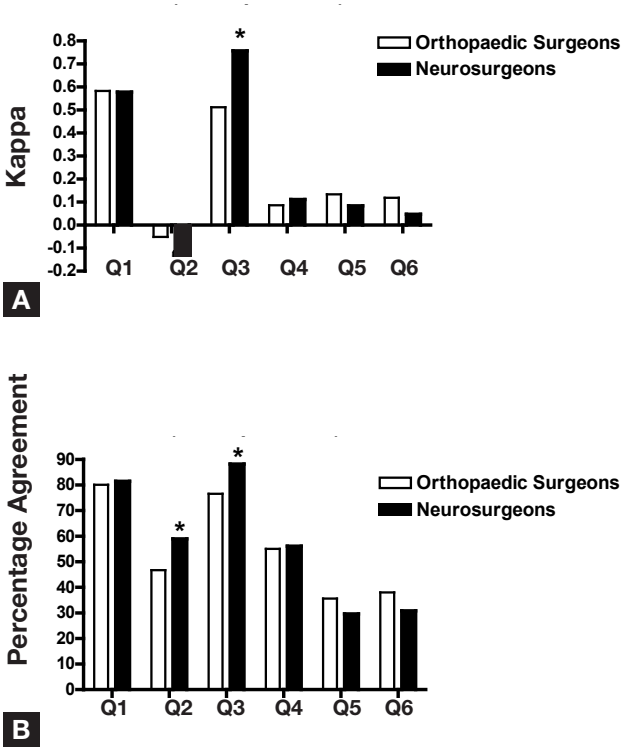

Figure 3. Orthopedic surgeons versus neurosurgeons (*P<.05) in incomplete spinal cord injury scenario: **(A)** interrater agreement (assessed by Cohen's κ) and **(B)** interrater percentage agreement.

bilateral facet dislocation, κ = 0.54 in intact, κ = 0.57 in incomplete, κ = 0.57 in complete; Table II) and in identifying disc herniation on MRI (κ = 0.59 in intact, κ = 0.64 in incomplete, κ = 0.63 in complete; Table II). Regardless of clinical scenario, there was only fair interspecialty agreement on whether to proceed with open versus closed reduction after MRI review (κ ≤ 0.22), and there was poor interspecialty agreement on which surgical approach was best (anterior, posterior, or combined, κ ≤ 0.16).

Finally, frequencies of ordering MRI before commencing treatment were compared between specialties. Neurosurgeons were significantly more likely to order pretreatment MRI in the intact clinical scenarios (77% of case decisions vs 58% of case decisions, P<.001; Figure 5) as well as in the incomplete SCI scenarios (76.3% vs 50.6%, P<.001; Figure 5) and the complete SCI scenarios (60.0% vs 42.3%, P<.05; Figure 5).

Discussion

Evidence-based treatment planning has become common practice among physicians using well-designed and universally accepted management algorithms for the decision-making process. This study was designed to assess the similarities and differences among experienced spine trauma physicians on how they would manage a particular, common, complex cervical spine injury and to see what, if any, consensus existed. Several variables are pertinent to optimal management of cervical dislocation injuries, and one possible factor is the specialty training of the treating physician.[3,11,15,17]

In the past few years, several studies have examined the influence of training specialty (orthopedic surgery vs neurosurgery) on surgical treatment and management decisions.[3,11,15,17] Some investigators have concentrated on thoracolumbar trauma and degenerative spine disease.[1-3,6,10-13,15,17-19] Only a few studies on cervical spine trauma have been conducted. Glaser and colleagues[2] reported only slight agreement (κ = 0.09-0.14) among 31 orthopedic surgeons and neurosurgeons regarding the appropriateness of several management techniques for 5 cervical spine trauma cases, but no specific analysis was conducted to directly compare the responses of neurosurgeons and orthopedic surgeons. In a survey of the STSG, Grauer and colleagues[3] found considerable agreement in the specific decision whether to operate or not when surgeons were presented with 8 short case scenarios. Five of the 8 cases were cervical spine injuries. Grauer and colleagues also noted that neurosurgeons were significantly more likely to obtain preoperative MRI—a finding similar to ours in the present study. Our study concentrated specifically on surgeons' ability to classify the injury and to determine the presence of a traumatic disc protrusion[1-4,7-9,20]; their decision to obtain MRI and to proceed with closed reduction[18,21,22]; and their choice of surgical approach.[1-6]

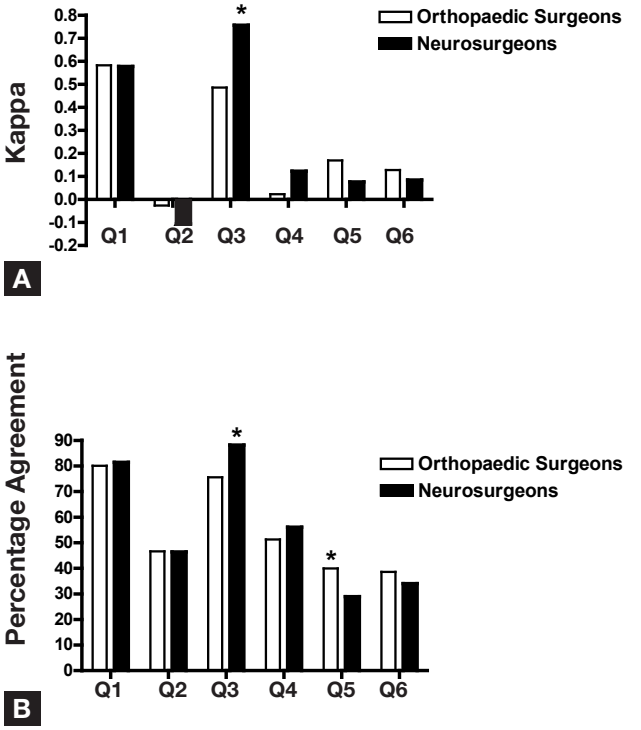

Figure 4. Orthopedic surgeons versus neurosurgeons (*P<.05) in complete spinal cord injury scenario: **(A)** interrater agreement (assessed by Cohen's κ) and **(B)** interrater percentage agreement.

This study differed from others in that it was focused on a specific traumatic injury (unilateral or bilateral facet dislocation) and on the various decision points as new information became available.

This study and others measure the likelihood that spine surgeons, regardless of orthopedic or neurosurgical training, will agree on the optimal treatment. When there is disagreement on a specific decision, such as selecting surgical approach, most of these differences cannot be accounted for by differences between specialties. There may be increasing collaboration of spine physicians across disciplines, as witnessed by combined scientific meetings, multispecialty refereed journals and spine societies, and collaborative clinical research, and this may gradually reduce variability in diagnostic and therapeutic decision-making.

Despite this encouraging trend, significant differences still remain on several key aspects of the treatment algorithm for cervical facet dislocations. Although there was good agreement among all surgeons regarding what they saw (ie, classification of whether a unilateral or bilateral facet dislocation existed as well as the presence or absence of a herniated disc), there was only fair or poor agreement on several management decisions, including whether to order pretreatment MRI, whether closed reduction with traction was indicated, and which surgical approach (anterior, posterior, or combined) was indicated.

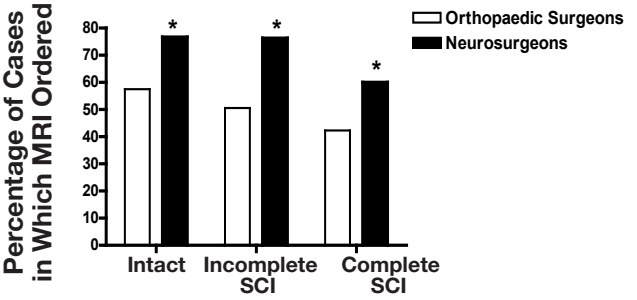

Figure 5. Orthopedic surgeons versus neurosurgeons (*P<.05) in frequency of ordering magnetic resonance imaging scans before treatment. Abbreviation: SCI, spinal cord injury.

These discrepancies in management decisions may be a result of several factors, including practice location, patient factors, time from injury, time of presentation, surgeon factors (age and familiarity with a particular procedure), lack of good data to guide treatment, surgeon training experience, surgeon experience with cervical dislocations, referral patterns, case mix, operating room access, and regional practice variation, as well as specialty training.[1-3,6,8,10-13,15,19] Some of the latter factors, such as operating room access and previous experience managing a particular injury pattern, may have an increased influence on case management regardless of training background.

However, the differences observed in some of the management issues in the present study may reflect the specialty training of the treating physicians. Neurosurgeons were significantly more likely than orthopedic surgeons to order pretreatment MRI—a finding also noted by Grauer and colleagues.[3] This may be because of their frequent use of MRIs for intracranial pathologies. Neurosurgeons were also more likely to proceed with open reduction versus closed reduction after MRI review. However, it should be noted that, though there were differences on some issues between specialties, there was more variation within each group than between neurosurgeons and orthopedists.

This study had a few limitations. Of the 29 surgeons who completed the study, only 9 were neurosurgeons. A variation of one specific injury pattern was presented 10 times, not a spectrum of cases, as were offered in previous studies. A third potential weakness was the homogeneity of the group; all the surgeons were experienced spine surgeons who managed a significant number of spine injuries. Similarly, surgeons who participated in the study do not represent a random sampling of either the neurosurgeon or orthopedic surgeon population. Rather, the raters were all STSG members and, as such, academic clinicians with significant research experience. Although they might be representative of the subpopulation of academic orthopedic surgeons and neurosurgeons, they are probably not representative of the general spine trauma care spectrum. As such, it may not be appropriate to generalize these results

to all orthopedic surgeons and neurosurgeons. There is also a possible bias wherein neurosurgeons may have practices in which they do predominately cervical as opposed to thoracolumbar work; seeing more cervical spine cases might bias their responses.

Conclusions

Spine surgery is an emerging subspecialty with more commonality than differences among orthopedic surgeons and neurosurgeons. In this study, the overall difference in management is larger between individuals than it is specialty based. In addition to type of residency training, other factors influence our decision making. Because the variation was similar within specialties and between specialties, we can say that practice variation, at least for members of this research group, has little or nothing to do with training background. Overall, the findings in this study demonstrate good consensus between neurosurgeons and orthopedic surgeons on the interpretation of what specific injury exists and how to classify that injury as well as on the interpretations of MRIs. Significant differences, regardless of training, exist on how to manage the particular injury and whether pretreatment MRI is indicated. These differences highlight the fact that there is no consensus or perceived optimal treatment for cervical facet dislocations and underscore the need for further study of this and other related matters, as well as the continued need for collaboration between orthopedic surgeons and neurosurgeons.

Authors' Disclosure Statement

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