Hypermobility accelerates adjacent-segment disease after ACDF?

TO THE EDITOR: We read with great interest the article by McDonald et al.⁵ (McDonald CP, Chang V, McDonald M, et al: Three-dimensional motion analysis of the cervical spine for comparison of anterior cervical decompression and fusion versus artificial disc replacement in 17 patients. Clinical article. *J Neurosurg Spine* 20:245–255, March 2014). The authors compared data of 7 patients who underwent cervical arthroplasty with those of 10 patients who underwent anterior cervical discectomy and fusion (ACDF) and concluded that after surgery there was increased motion at nonoperative segments in ACDF-treated patients. Although the result appears to corroborate most surgeons' inference, there are several caveats.

First, these two groups of patients are not similar. Their cervical spines had variable degeneration. For example, the arthroplasty-treated patient whose images are shown in Fig. 3 had significant spondylosis and anterior osteophytes in both the cranial and caudal adjacent levels. On the other hand, the ACDF-treated patient whose images are shown in Fig. 4 had little spondylotic changes throughout the entire cervical spine. Several studies have demonstrated the differences of cervical arthroplasty among patients with and without spondylosis.¹¹ In non-randomized studies, mildly different indications for arthroplasty could cause variable outcomes.^{9,10} The “less motion” detected in every other level of the cervical discs among the arthroplasty group compared to the ACDF group of this study, as demonstrated in Figs. 5–10, can be attributed to the spondylosis per se, rather than the effect of the artificial disc.

Second, the postoperative motion of adjacent segments after anterior cervical discectomy should be compared to the preoperative condition in the same patient. Comparing two patients who have undergone different procedures inadvertently allows for confounding results. Ideally, the mean difference between pre- and postoperative segmental motion of each patient in the ACDF group could be compared to that of the arthroplasty group.

The authors are commended for shedding light on the change in physiological motion after cervical discectomy. The true incidence and cause of adjacent-segment disease after cervical discectomy is still uncertain.¹² Furthermore, whether artificial disc replacement can overcome adjacent-segment disease remains controversial, despite many randomized control trials having been published.^{1–4,6–8}

Motion analysis of the cervical spine in healthy, ACDF-treated, and arthroplasty-treated individuals might provide insight into future spine care.

PENG-YUAN CHANG, M.D.^{1,2}

YU-SHU YEN, M.D.^{1,2}

JAU-CHING WU, M.D., Ph.D.^{1,2}

WEN-CHENG HUANG, M.D., Ph.D.^{1,2}

TSUNG-HSI TU, M.D.^{1,2}

LI-YU FAY, M.D.^{1,2}

HENRICH CHENG, M.D., Ph.D.^{1–3}

¹Neurological Institute

Taipei Veterans General Hospital
Taipei, Taiwan

²School of Medicine

National Yang-Ming University
Taipei, Taiwan

³Institute of Pharmacology

National Yang-Ming University
Taipei, Taiwan

Disclosure

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RESPONSE: We would first like to thank Dr. Wu and colleagues for their interest in and comments on our article. With regard to heterogeneity between the artificial disc (AD) and ACDF cohorts, we appreciate our colleagues' observations on the figures illustrating the differing levels of spondylosis between two patients. However, we feel that it is difficult to make generalizations on the two patient cohorts based on these two isolated examples that were presented. Given that our inclusion criteria for this study were patients who had single-level disease only, we would submit that the patients in our study, on the whole, would have less overall spondylotic change. In addition, the fact that the average age of the two cohorts is similar (48 ± 10.8 years and 47 ± 7.0 years for the ACDF and AD groups, respectively) would also suggest relatively similar amounts of degeneration between cohorts. Consequently, there is insufficient evidence in this study to support or refute the notion that changes in adjacent-segment motion after surgery are due to baseline differences in spondylosis between the ACDF and AD groups. We would also submit that the best way to remove this confounding factor would have been randomization during the initial enrollment into the study.

We agree with Dr. Wu and colleagues' second point regarding a comparison of preoperative and postoperative motion of adjacent segments after both ACDF and AD. Such comparisons as well as long-term follow-up with motion analysis would also give insight into both the overall degenerative process as well as any potential effects as a result of either an ACDF or AD. In addition, an age-matched nonoperative group would prove beneficial as well. Given the literature available, which illustrates largely equivocal rates of radiographic and clinical adja-

cent-segment pathology,^{2–5,7} the possibility remains that any motion changes perceived between ACDF and AD at adjacent segments may in fact not be part of the root cause of cervical spondylotic processes. Given that we are utilizing a state-of-the-art motion analysis technique with high in vivo accuracy, we are confident that we are in a position to study spondylotic processes of the cervical spine.^{1,6}

VICTOR CHANG, M.D.
Department of Neurosurgery
Henry Ford Health System
Detroit, MI

STEPHEN BARTOL, M.D.
MICHAEL BEY, PH.D.

Herrick Davis Motion Analysis Laboratory
Henry Ford Health System
Detroit, MI

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Validating the Thoracolumbar Injury Classification and Severity Score

TO THE EDITOR: We read with interest the article by Joaquim et al.¹ (Joaquim AF, Ghizoni E, Tedeschi H, et al: Clinical results of patients with thoracolumbar spine

trauma treated according to the Thoracolumbar Injury Classification and Severity Score. Clinical article. *J Neurosurg Spine* 20:562–567, May 2014).

In our opinion, the decision making in managing thoracolumbar spinal injuries involves two steps. The first is to determine whether the injury is stable or unstable. The second step involves the appropriate selection of the surgical technique, levels to be fused, and the necessity for anterior column reconstruction in surgical fractures.

Most of the current classification criteria aid in the first step in decision making. The Thoracolumbar Injury Classification and Severity Score (TLICS) system introduced by Vaccaro et al. in 2005 provided a simple and reproducible severity scoring system that aided in differentiating between stable and unstable injuries.³ It takes into account the mechanism of injury, neurological status, and the integrity of the posterior ligamentous complex (PLC). Scores ranging between 1 and 3 are treated conservatively, and fractures with scores of 5 or more are treated with surgical stabilization, leaving fractures with a grade of 4 in a “gray zone.” Multiple studies have been attempted to assess the reproducibility and validity of this system; however, most of these studies involved the institutions of Vaccaro and colleagues.²

In an excellent effort, the study by Joaquim et al. attempted to validate the TLICS system by prospectively applying it to 65 patients treated at a Level I trauma center in a different institution. In their study, patients with TLICS less than 4 points were treated conservatively, and patients with TLICS 4 and higher were treated surgically. Twenty-eight patients with compression fractures and burst fractures (with intact PLC and neurologically normal) in the group of 37 who were initially treated conservatively underwent follow-up. The only outcome measure reported was neurological state. The follow-up time was limited, with a median of 3 months and with some patients being followed for only 1 month. Two patients crossed over from the nonsurgical group after 3 months and 1 year, indicating that adequate follow-up of at least up to 1 year is necessary to validate this system and to draw appropriate conclusions. The difficulty of obtaining high-quality follow-up in a trauma population is understood. However, it is our opinion that radiographic follow-up to track the development of local kyphosis at the site of injury is critical. Posttraumatic kyphosis can occur following successful initial treatments (surgical and nonsurgical), and would cause delayed neurological deficits and pain.

The goals achieved when treating thoracolumbar fractures go beyond preservation or improvement of a patient’s neurological state. A stable spine is a spine that is normally aligned, and free from pain and neurological deficit under physiological loads. This study lacks radiographic and clinical outcomes that would assess critical quality of life measures.

It is pretty straightforward to manage both extremes in the continuum of spinal fractures. Single-column fractures (that is, compression fractures) are treated conservatively and 3-column injuries (flexion/extension distraction injuries and fracture dislocations) are treated with surgical stabilization. On the other hand, “gray zone” fractures (burst fractures and TLICS 4 fractures) are always

a topic of debate in terms of decision making on whether to operate and also in terms of surgical strategy. It was our understanding that patients with a TLICS score of 4 were “intermediate.” However, in the current study all of these patients were taken to surgery. Treating TLICS 4 fractures with surgery might be viewed as appropriate by some and aggressive by others. Future studies directed at answering this question are of immense importance.

Although the current classification system aids in segregating stable and unstable fractures, we believe that it does not address the truly most controversial, and interesting, trauma patients. These are the patients who fall in the “gray zone” of stability. Only studies with long-term functional and radiographic outcomes will shed light on the optimal way to treat these patients.

ZACHARY A. SMITH, M.D.

NADER S. DAHDALEH, M.D.

Northwestern University Feinberg School of Medicine
Chicago, IL

Disclosure

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RESPONSE: We thank Drs. Smith and Dahdaleh for their interest in our manuscript. Their comments are an excellent opportunity to clarify some very important issues and misconceptions in the management of thoracolumbar injuries, specifically in thoracolumbar burst fractures.

We surely agree that longer follow-up would be important to avoid underreporting failures of conservative treatment as well as for reporting long-term complications of both surgical and nonsurgical treatment. We also agree that independent, patient-reported clinical outcomes would be a useful measurement in this population. We respectfully disagree with the authors’ contention that “radiographic follow-up to track the development of local kyphosis at the site of injury is critical.” We agree that radiographic follow-up to assess fracture healing is of benefit, but suggest that the clinical symptoms of a patient, especially their neurological status, is a better indicator of clinical outcomes than imaging.

The literature demonstrates that local kyphosis can be expected to occur routinely with many fracture pat-

terns, even stable compression and burst fractures, without reproducible correlation to patient outcomes.^{5,6} This normal posttraumatic radiographic finding is often used, despite a lack of evidence, to support early and aggressive surgical intervention even in stable injury patterns, either to safeguard against early neurological compromise or to prevent late long-term pain.

Our study, as well as many other studies and systematic reviews, has demonstrated that conservative treatment can be a safe option.^{1,2,7} We do agree with the great concern voiced by the authors for development of long-term kyphosis. However, we believe that symptomatic posttraumatic deformity is secondary to a misdiagnosis of PLC injuries in unstable burst fractures or in misdiagnosed distraction injury patterns.³ In this setting, surgical treatment would be the better option and would be likely to prevent the development of painful and possibly neurologically detrimental kyphosis.

Another common error is the grouping of burst fractures (TLICS score of 2 points) with injury patterns of a TLICS score of 4 into the same “gray zone.” Patients with a total TLICS score of 4 can have the following: 1) burst fractures with complete neurological deficits without PLC injury; 2) burst fractures with radiculopathy and intact PLC; 3) burst fractures with suspected PLC injury; and 4) compression fractures with concomitant incomplete neurological deficits (a highly unlikely clinical scenario).⁴ The other potential injury patterns that can result in a TLICS of 4 points are a pure Chance fracture (with only bone injury) or a distractive injury in extension, both necessarily without any suspected PLC injury and without neurological deficits. In these injuries, surgical management is driven by the neurological status of the patient as well as the potential for painful deformity associated with unstable injury patterns. For these reasons, we decided to treat patients with TLICS 4 surgically. Burst fractures (TLICS 2), on the contrary, would not require routine surgical management.

We agree that the TLICS, like many classification systems, is not perfect; the aforementioned injury patterns with a TLICS score of 4 fall into a gray zone that can continue to be discussed. However, with regard to the most controversial of topics in thoracolumbar trauma—the management of thoracolumbar burst fractures—the TLICS system when correctly understood and used is

highly effective at determining stable from unstable patterns and guiding surgical decision making.

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ANDREI F. JOAQUIM, M.D., PH.D.
State University of Campinas (UNICAMP)
Campinas-SP, Brazil
ALPESH A. PATEL, M.D.
Northwestern University
Chicago, IL

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