Operative Treatment of Thoracolumbar Burst Fractures: Is Fusion Necessary?

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Introduction

Burst fractures of the thoracolumbar junction and upper lumbar spine (T12–L2) are common injuries as a result of high-energy trauma, with potentially devastating consequences including pain, paralysis, and loss of function [8]. The thoracolumbar junction, especially, is highly susceptible to injury as it is a fulcrum for increased motion between the rigid thoracic spine and mobile lumbar spine. Burst fractures can often result in significant spinal instability requiring operative stabilization.

The classification and treatment of these injuries are controversial. Historic surgical indications based on kyphosis, canal compromise, and loss of vertebral body height failed to accurately reflect the dynamic mechanism of the injury and neglected the neurologic status of the patient. The most commonly used classification today is the thoracolumbar injury classification and severity score (TLICS) described by Vaccaro et al. [5], which includes the morphology of the fracture pattern, the integrity of the posterior ligamentous complex (PLC), and the patient's neurologic status.

While these classification systems are invaluable in indicating patients for surgery as well as guiding the surgical approach, one particular area of controversy is whether

fusion is necessary to achieve a good clinical outcome after fixation of thoracolumbar or lumbar burst fractures. There have been several prospective trials comparing patients treated with posterior short segment instrumentation for thoracolumbar and lumbar burst fractures, randomized to fusion or no fusion, with largely similar outcomes [1, 6].

The article discussed here, by Chou et al., describes the long-term follow-up on their randomized cohort, with a mean follow-up of 134 months. In this randomized trial of 46 patients with thoracolumbar or lumbar burst fractures treated with posterior instrumentation with or without fusion, their specific research question was, What are the differences in functional, radiographic, and hardware removal or complication rates between the fusion and non-fusion groups? The purpose of this review is to interpret the outcomes of this study, in which the patients were enrolled and the procedures performed more than 10 years ago, in the context of our now improved understanding of the factors contributing to instability in burst fractures and an evolution in the indications for surgical intervention. Are the conclusions of this randomized trial still valid today?

The Article

Fusion May Not Be a Necessary Procedure for Surgically Treated Burst Fractures of the Thoracolumbar and Lumbar Spine: A Follow-up of at Least Ten Years

Po-Hsin Chou, Hsiao-Li Ma, Shih-Tien Wang, Chien-Lin Liu, Ming-Chau Chang, Wing-Kwong Yu
JBJS 2014;96:1724-31 October 15.

The main research question was, for thoracolumbar and lumbar burst fractures treated with posterior instrumentation, is fusion necessary? The investigators performed a randomized trial in 46 patients treated with posterior transpedicular screw fixation to the levels above and below the injury, with or without fusion. This was a single-surgeon cohort in Taipei, Taiwan.

Fifty-eight patients with burst fractures were enrolled from 1996–2003. Inclusion criteria was any neurologic

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deficit or no deficit but kyphosis $>20^\circ$, decreased vertebral body height $>50\%$, and canal compromise $>50\%$. Patients requiring anterior surgery were excluded. Ten patients were lost to follow-up and two excluded based on age. The final cohort of 46 patients had a mean age of 39.4 at the time of injury. The fractures were all from T12–L2, with 24% Denis type A and 76% type B.

Outcome measures included radiographic (kyphosis, vertebral height, regional segmental motion, adjacent listhesis, appearance of callus), functional (VAS, low-back outcome score), and hardware removal or breakage.

At mean follow-up of 134 months, there was no difference at all time points between the fusion and non-fusion groups in kyphosis or vertebral height. Both groups had significant loss of kyphosis correction over time (10.7° vs. 12.3° , respectively). Regional segmental motion was 0.9° in the fusion group and 4.2° in the non-fusion group ($p<0.05$). Functional outcomes were statistically similar at all time points.

The authors concluded that the long-term outcomes of short-segment fixation for thoracolumbar and lumbar burst fractures with and without fusion are comparable.

Commentary

This study with 10-year follow-up is a valuable contribution to the literature regarding the management of thoracolumbar and lumbar spine burst fractures. There is a growing body of evidence in favor of non-operative treatment for stable burst fractures. The classic surgical indications based on kyphosis, vertebral body height, and canal compromise on radiographs are now considered with an increased awareness of the importance of the posterior ligamentous complex for overall stability [5]. While the indications for surgery were up-to-date at the time this study was initiated, some of their patients would likely be treated non-operatively today. Nevertheless, the investigators concluded that given the similar functional and radiographic outcomes between the fusion and non-fusion groups, posterior fusion need not be routinely performed in surgically treated thoracolumbar and lumbar burst fractures.

There are a number of notable strengths in this study. Randomized trials are difficult to perform with surgical interventions and can be difficult to interpret with high rates of crossover and intention-to-treat analyses. From that standpoint, this was a methodologically sound study, with good randomization as evidenced by the pre-operative patient characteristics. Furthermore, this study had excellent follow-up, both in terms of length and consistency. A minimum of 10-year follow-up is impressive for a surgical clinical outcomes study.

Nevertheless, this study does have several limitations. First, and most importantly, the more complex injuries including those with progressive neurologic deficits and those requiring anterior surgery were excluded from the study. While the study results are internally valid for simple burst fractures, many of these injuries are now treated non-operatively due to the evolving classification and surgical

indications for these fractures. In addition, the inter- and intra-observer reliabilities of their radiographic outcomes were not measured. They report that the non-fusion group had 4.2° of segmental motion compared to 0.9° for the fusion group; however, it is unclear if this difference is clinically significant and outside the realm of observer variability. Also, one of the secondary outcomes in the study was the incidence of hardware removal or complications. While the rates of screw breakage were statistically similar between the groups, the author reported that the non-fusion group was more likely to undergo hardware removal ($p<0.05$). The authors also note, however, that hardware removal was suggested to the non-fusion group at 1 year postoperatively due to the possibility of implant failure, which invalidates their hardware removal comparison.

Furthermore, solid fusion was defined in the fusion group based on angular change of the fused segments in dynamic flexion and extension lateral radiographs. This is an inferior method to assess fusion status compared to CT scans [2]. Lastly, one of the most interesting results of the study was the progression of kyphosis and loss of correction regardless of whether fusion was performed. Given that the subjects were at an average age of 39 at the time of surgery and were followed for an average of more than 11 years, there is likely a component of age-related natural kyphosis as well.

The results of this study are largely consistent with what has been reported in the literature, as well as previous studies by the investigators [6]. Good functional outcomes following posterior fixation for burst fractures without fusion have been reported in the literature, as measured by VAS, low-back outcome score, or the SF-36 [3, 4]. The progression of kyphosis and loss of correction in both the fusion and non-fusion groups have also been previously described [7]. Based on this body of literature as well as the results from the current study, the investigators conclude that kyphosis may be unavoidable in spite of fusion and that the kyphotic deformity measured on radiographs may not correlate to clinical symptoms.

Despite these limitations, this is nevertheless a strong study with sound methodology. The results of this study, as well as other randomized trials, suggest that in those patients with thoracolumbar burst fractures with mild or moderate canal compromise that are amenable to short-segment fixation, spinal fusion is probably not necessary. A similar trial in patients indicated for surgery using the current TLICS criteria would indeed be informative.

Disclosures

Conflict of interest: Michael C. Fu, MD, MHS and Venu M. Nemani, MD, PhD have declared that they have no conflict of interest. Todd J. Albert, MD reports personal fees from DePuy, Biomet, Facetlink; other from Vertech, In Vivo Therapeutics, Paradigm Spine, Biomerix, Breakaway Imaging, Crosstree, Invuity, Pioneer, Gentis, ASIP, PMIG, Hospital for Special Surgery, MAB United Healthcare, CSRS, Scoliosis Research Society, IMAST, AOA, outside the work.

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