Evidence-based management of traumatic thoracolumbar burst fractures: a systematic review of nonoperative management

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Object. The overall evidence for nonoperative management of patients with traumatic thoracolumbar burst fractures is unknown. There is no agreement on the optimal method of conservative treatment. Recent randomized controlled trials that have compared nonoperative to operative treatment of thoracolumbar burst fractures without neurological deficits yielded conflicting results. By assessing the level of evidence on conservative management through validated methodologies, clinicians can assess the availability of critically appraised literature. The purpose of this study was to examine the level of evidence for the use of conservative management in traumatic thoracolumbar burst fractures.

Methods. A comprehensive search of the English literature over the past 20 years was conducted using PubMed (MEDLINE). The inclusion criteria consisted of burst fractures resulting from a traumatic mechanism, and fractures of the thoracic or lumbar spine. The exclusion criteria consisted of osteoporotic burst fractures, pathological burst fractures, and fractures located in the cervical spine. Of the studies meeting the inclusion/exclusion criteria, any study in which nonoperative treatment was used was included in this review.

Results. One thousand ninety-eight abstracts were reviewed and 447 papers met inclusion/exclusion criteria, of which 45 were included in this review. In total, there were 2 Level-I, 7 Level-II, 9 Level-III, 25 Level-IV, and 2 Level-V studies. Of the 45 studies, 16 investigated conservative management techniques, 20 studies compared operative to nonoperative treatments, and 9 papers investigated the prognosis of conservative management.

Conclusions. There are 9 high-level studies (Levels I–II) that have investigated the conservative management of traumatic thoracolumbar burst fractures. In neurologically intact patients, there is no superior conservative management technique over another as supported by a high level of evidence. The conservative technique can be based on patient and surgeon preference, comfort, and access to resources. A high level of evidence demonstrated similar functional outcomes with conservative management when compared with open surgical operative management in patients who were neurologically intact. The presence of a neurological deficit is not an absolute contraindication for conservative treatment as supported by a high level of evidence. However, the majority of the literature excluded patients with neurological deficits. More evidence is needed to further classify the appropriate burst fractures for conservative management to decrease variables that may impact the prognosis.

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KEY WORDS • conservative management • orthosis • AO Type A3 • spine fracture • thoracolumbar burst fracture • trauma • nonoperative

THORACIC and lumbar spinal fractures are common traumatic injuries that can include compression, burst, flexion-distraction, and fracture-dislocation injuries.^{20,32,41} The majority of thoracic and lumbar spinal fractures occur at or nearby the thoracolumbar junction, a transitional zone of the spine where the kyphotic thoracic spine meets the lordotic lumbar spine.^{32,41} Burst fractures are primarily a result of axial compressive forces and ac-

count for more than 60% of thoracolumbar fractures.^{20,23,41} Despite the increasing literature on the management of thoracolumbar burst fractures, the optimal treatment strategy remains unclear. The presence of neurological deficits is an indication for operative management, but the indications for conservative management continue to be controversial.^{6,21,33,41}

The current goal in the treatment of traumatic thoracolumbar burst fractures is to stabilize the spine to prevent short- and long-term deformity and neurological decline while improving the clinical outcome of the patient. Spine fractures are unstable due to the failure of the middle column, posterior ligamentous complex inju-

Abbreviations used in this paper: ODI = Oswestry Disability Index; RCT = randomized controlled trial; RMDQ = Roland-Morris Disability Questionnaire; SF-36 = 36-Item Short-Form Health Survey; TLSO = thoracolumbar orthosis; VAS = visual analog scale.

ry, or the presence of neurological deficits.^{20,41,60,62} Using these factors to guide operative or nonoperative treatment methods has demonstrated the greatest discordance with burst fractures.³³ Recent studies comparing operative to nonoperative treatment in burst fractures without a neurological deficit have found no differences in the functional outcome between these treatment modalities, and moreover, operative management has been correlated with increased costs and complications.^{1,24,58,65} While operative management was reported to be more effective in preventing the progression of sagittal deformity in stable burst fractures, it has been shown to have no correlation with the functional outcomes reported by patients.⁵⁵

Nonoperative management is used to stabilize the spine by limiting motion and can consist of recumbent bed rest, closed reduction, orthosis, and body cast with or without ambulation.^{4,5,13,15,36,46,54,57} Two decades ago, results from 2 independent studies contradicted the contention that patients with burst fractures will demonstrate deterioration in neurological function if treated conservatively.^{13,46} These studies showed that neurological deterioration is rare, with most patients reporting minimal to no pain and satisfactory work status. Many subsequent studies demonstrated similar findings with a variety of conservative techniques,^{2,4,10,15,54,57} but the supporting literature is unclear. For example, postural reduction and stabilization with conservative management has been reported to decompress the spinal canal, while others have reported no additional therapeutic benefit.^{4,16,36,42,48,54}

To the authors' best knowledge, there has not been a systematic review focusing on the level of evidence for the use of conservative management in the treatment of traumatic thoracolumbar burst fractures. Current systematic reviews compared operative and nonoperative treatment in neurologically intact patients.^{1,24,58,65} These studies were limited by mainly including randomized controlled trials (RCTs) or using nonstandardized criteria to assess the level of evidence. By assessing the level of evidence in conservative management through validated methodologies, clinicians can assess the availability of critically appraised literature.^{29–31,40} In the following report, we evaluated the level of evidence regarding the nonoperative management of traumatic thoracolumbar burst fractures, specifically in regards to the various nonoperative techniques, operative versus nonoperative management, and the prognosis of patients treated conservatively.

Methods

A systematic review of the English literature over the last 20 years was conducted according to the Cochrane guidelines (<http://handbook.cochrane.org>). An electronic search of the entire PubMed database (MEDLINE) up to December 17, 2013, was performed to identify studies with various combinations of the following search terms: "spine AND burst" or "burst fracture" or "burst AND fracture" or "A3 AND fracture AND spine." The inclusion criteria consisted of burst fractures resulting from a traumatic mechanism, and fractures of the thoracic or lumbar spine. The exclusion criteria consisted of osteoporotic burst fractures, pathological burst fractures, and fractures located in the

cervical spine. When inclusion or exclusion was unclear based on title and abstract, full-text articles were retrieved. Studies between January 1, 1992, and December 17, 2013, were included because the management of burst fractures has evolved significantly over the last 20 years.

Included articles were categorized based on study type and topic. The study type categories included 1) case-control studies, 2) case reports, 3) case series, 4) comparative studies, 5) RCTs, 6) narrative reviews, and 7) systematic reviews. A comparative study was defined as a study comparing two cohorts, but one that did not meet the criteria for an RCT. Similarly, a narrative review article did not meet the standard guidelines for a systematic review. Study topic categories included diagnosis, prognosis, operative versus nonoperative management, and treatment/technique. The treatment/technique category included all studies in which the focus was specifically treating burst fractures (including bracing and nonoperative methods) or the use of a given technique. Further data extracted from each article included the following: publication year, number of patients, study population and etiologies, average follow-up period, assessment or outcome measures, and study conclusions. The following study characteristics were also recorded: prospective or retrospective status, whether nonoperative treatment was used, and if all patients were neurologically intact prior to treatment. Following completion of the entire data set, the articles in which conservative management was used were selected for this review. Studies that investigated solely a pediatric population or that lacked follow-up outcome measures specific to conservative treatment were excluded. Levels of evidence were assigned to the studies according to the criteria set forth in the journal *Clinical Orthopedics and Related Research*, which is adapted from the Oxford Centre of Evidence Based Medicine levels of evidence.^{29–31,40} The level of evidence scale has 5 levels, with Level I being the highest and Level V being the lowest (Table 1). Ambiguity or any disagreements between reviewers was resolved through discussion and the addition of a third reviewer if needed.

Results

Article Selection

The results of the literature search are summarized in Fig. 1. The preliminary search criteria yielded 1098 abstracts, and 447 studies involving traumatic thoracolumbar burst fractures met the inclusion and exclusion

TABLE 1: Criteria for the levels of evidence

Level	Description
I	systematic review of RCTs & individual RCT w/ narrow confidence interval
II	systematic review of cohort studies, individual cohort study, & low quality RCT & outcome research study
III	systematic review of case-control studies & individual case-control study
IV	case series, poor quality cohort, & case-control studies
V	expert opinion

Fig. 1. Flow chart of the systematic literature search and review process.

criteria in the last 20 years. Out of 447 studies, 45 articles were identified as primarily investigating conservative management.^{1-19,22,24,25,28,34-37,43-47,49,50,52-59,61,63,64} There were 4 RCTs, 10 comparative studies, 25 case series, 4 systematic reviews, and 2 narrative reviews. The study types included 16 techniques, 20 operative versus nonoperative studies, and 9 prognosis studies. There were 14 prospective and 25 retrospective studies, and the remaining were reviews (not applicable). The level of evidence in hierarchical order was as follows: Level I (n = 2, 4%), Level II (n = 7, 16%), Level III (n = 9, 20%), Level IV (n = 25, 56%), and Level V (n = 2, 4%). Level I and Level II studies are summarized in Table 2. A summary of the level of evidence is found below with an emphasis on higher-level studies (Levels I and II).

Conservative Treatment Techniques

Sixteen total studies investigated conservative treatment techniques. Two of the 16 studies specifically

compared different methods of conservative treatments for thoracolumbar burst fractures without neurological deficits, and were both Level-II RCTs. The most recent Level-II RCT was reported by Bailey et al. in 2013.⁹ They compared treatment with thoracolumbar orthosis (TLSO) to no TLSO in 96 patients with T11-L3 burst fractures. Isolated AO Type A3 fractures with a kyphotic deformity less than 35° were included. Follow-up was planned for as long as 2 years for primary and secondary functional outcome measures. There was no difference in Roland-Morris Disability Questionnaire (RMDQ), visual analog scale (VAS), and 36-Item Short-Form Health Survey (SF-36) scores, satisfaction, and length of stay between the two treatment groups.

The second Level-II RCT was reported by Stadhouders et al. in 2009.⁵⁶ They compared the treatment of a thermoplastic removable brace to a plaster of Paris cast for 12 weeks in 25 patients with T3-L5 burst fractures. Fractures were included if the anterior column compres-

TABLE 2: Level I–II clinical studies that investigated conservative management of traumatic thoracolumbar burst fractures

Authors & Year	Level of Evidence	Study Design (no. of patients)	Mean Follow-Up (yrs)	Study Population	Treatment	Results		
						Functional	Radio logical	
Abudou et al., 2013	I	systematic review	NA	2 trials: Siebenga et al., 2006, & Wood et al., 2003; no neurological deficits	op vs nonop	trials reported opposing results for pain & function-related outcomes at final follow-up, & number returning to work	statistical heterogeneity between the 2 trials, sagittal kyphosis data not pooled	
Siebenga et al., 2006	I	prospective RCT (n = 32)	4.3	T10–L4 fractures, AO Type A1 (n = 5, A1.1 excluded), Type A2 (n = 2), Type A3 (n = 25); no neurological deficits; age 18–60 yrs	short-segment posterior instrumentation & Jewett hyperextension brace (A) vs Jewett hyperextension brace (B)	difference in VAS pain score* (A: 87, B: 72), VAS spine score* (A: 81, B: 61), RMDQ score (A: 3.1, B: 8.9), return to work (A: 85%, B: 38%); no difference in distribution of Type A fractures, complications, time to return to work	difference between groups in local kyphosis (A: 16.8° to 8.6°, B: 15.7° to 19.8°), regional kyphosis (A: 10.9° to 8.4°, B: 13.1° to 19.5°); no correlation of kyphotic deformity w/ functional outcome	
Baily et al., 2013	II	prospective RCT (n = 96)	2	T11–L3 burst fractures, isolated AO Type A3 w/ kyphosis <35°, no neurological deficits, age 16–60 yrs	TLSO (A) vs no orthosis (B)	no difference in RMDQ, VAS, & SF-36 scores, or satisfaction & length of stay	no difference in kyphosis: 15° to 22° (A), 14° to 21° (B)	
Stadthouder et al., 2009	II	prospective RCT (n = 133)	>1†	T3–L5 burst fractures; 108/133 compression fractures, 25/133 burst fractures; AO Type A3 (n = 24), B1.2 (n = 1); <50% height of the anterior column, <30% reduction of spinal canal	brace (A) vs cast (B)	no difference in VAS & ODI scores	no difference or deterioration in kyphosis: 12.6° to 12.3° (A), 11.2° to 11.2° (B)	
Gnanenthiran et al., 2012	II	systematic review	NA	4 clinical studies: Siebenga et al., 2006, Wood et al., 2003, Shen et al., 2001, & Hitchon et al., 1998	op vs nonop	no differences in pain, kyphosis, & RMDQ score; surgery was associated w/ higher complication rates & costs	mean final kyphosis: 16° (A), 11° (B); no correlation of kyphotic deformity w/ functional outcome	
Wood et al., 2003	II	prospective RCT (n = 47)	3.7	T10–L2 single-level burst fractures, excluded posterior osteoligamentous complex disruption, age 18–60 yrs	anterior or posterior instrumentation & fusion (n = 25; A) vs cast &/or thoracolumbosacral brace (n = 23; B)	no difference in VAS score (A: 3.3, B: 1.9), modified RMDQ score (A: 8.16, B: 3.9), & ODI (A: 20.75, B: 10.7); SF-36 physical function & role were greater in Group B, otherwise similar; more smokers in Group A; complications more common in Group A	no difference between groups in kyphosis (A: 10.1° to 13°, B: 11.3° to 13.8°), canal compromise (A: 39% to 22%, B: 34% to 19%), no correlation of kyphotic deformity w/ functional outcome	

(continued)

TABLE 2: Level I-II clinical studies that investigated conservative management of traumatic thoracolumbar burst fractures (*continued*)

Authors & Year	Level of Evidence	Study Design (no. of patients)	Mean Follow-Up (yrs)	Study Population	Treatment	Results	
						Functional	Radiological
Shen et al., 2001	II	prospective comparative (n = 80)	2	T11–L2 single-level burst fractures; age 18–65 yrs	posterior instrumentation (n = 33; A) vs hyperextension brace (n = 47; B)	initially lower VAS, Greenough low-back scores in Group A; no difference at final follow-up; VAS score (A: 1.8, B: 1.5), Greenough low-back score (A: 61, B: 65); costs 4× higher in Group A & mean hospital time similar	kyphosis: 23° to 12° (A), 21° to 24° (B); poor correlation of kyphotic deformity w/ functional outcome
Hitchon et al., 1998	II	prospective comparative (n = 68)	0.8–1.8	T12–L2 burst fractures	multiple operative approaches & bracing (n = 36; A) vs bed rest & bracing (n = 32; B); angular deformity >20°, >50% residual canal, vertebral height >50% in Group B	initial lower Frankel score in Group A; no neurological deficits in 5/36 in Group A, 26/32 in Group B; Group B higher % of returning to work, lower treatment costs, similar hospitalization times; both groups demonstrated improvement in Frankel scores	kyphosis: 12° to 14.4° (A), 5.6° to 13.5° (B)
Mohanty et al., 2002	II	prospective case series (n = 45)	1	thoracolumbar burst fractures, age 17–60 yrs	reduction & immobilization in polyethylene molded body jacket & recumbency for 3 mos	no significant difference in canal compromise w/ neurological deficit 46.2% or w/o 36.3%; canal compromise w/ neurological recovery 46.1% or w/o 48.4%; canal remodeling who recovered 51.7% & who did not 46.1%	

* Zero indicates severe disability, 100 indicates no disability. NA = not applicable.

† Mean follow-up duration for burst fracture not specifically reported.

sion was less than 50% of the column and reduction of the spinal canal was less than 30%. This study consisted of primarily AO Type A3.1–3.3 fractures and 1 AO Type B1.2 fracture. Follow-up was planned at 6 and 12 weeks and 6 and 12 months, with 1 long-term follow-up visit at least 1 year later. Radiological deformity and functional outcome were set as the primary outcome parameters. There was no difference in kyphotic changes, VAS pain score, and Oswestry Disability Index (ODI) between the treatment groups.

The remaining 14 studies employed and investigated conservative techniques that were not compared with other techniques and were rated Level IV. Of the 14 studies, 11 studies investigated conservative treatment in patients without neurological deficits. Treatment categories included either TLSO, hyperextension or Jewett brace, body cast with or without ambulation, or closed reduction.^{2,4,10,13–15,25,46,47,54,57} These studies demonstrated improved outcomes from initial presentation, with most patients reporting minimal to no pain, satisfactory work level, and a kyphotic change $\leq 4^\circ$. The remaining 3 studies included patients with neurological deficits and demonstrated no neurological deterioration and significant reduction of canal compromise, with most patients reporting minimal back pain or disability.^{45,59,61}

Operative Versus Nonoperative Management

Twenty papers were found to compare operative to nonoperative management. Two Level-I, 3 Level-II, 4 Level-III, 2 Level-IV, and 1 Level-V studies excluded neurological deficits, whereas 1 Level-II, 5 Level-III, 1 Level-IV, and 1 Level-V studies included neurological deficits. The most recent Cochrane review published in 2013 by Abudou et al.¹ was rated as Level I. These authors included 2 RCTs (discussed below) that reported contrasting results for pain and functional outcomes at final follow-up and number of patients returning to work. The authors reported that both trials have an unclear risk of selection bias and a high risk of performance and detection bias.

The second Level-I study was an RCT by Siebenga et al. in 2006.⁵⁵ The authors compared bed rest followed by mobilization with a Jewett-type orthotic device to short-segment posterior instrumentation in 32 patients with T10–L4 burst fractures. The cohort consisted of AO Type A3 (n = 25), A2 (n = 2), and A1 (A1.1 excluded, n = 5) fractures. Data collection involved radiological and functional outcomes with a mean follow-up of 4.3 years. The operative group had superior VAS pain, VAS spine, and RMDQ scores, a higher percentage with return to work, and lower kyphotic deformity; complications were similar in both groups.

The second RCT by Wood et al. in 2003 was rated at Level II.⁶³ The authors compared the application of a body cast or orthosis to anterior or posterior instrumentation with fusion in 47 patients with T10–L2 burst fractures. Burst fractures with posterior column disruptions were excluded. Data collection involved radiological and functional outcomes with a mean follow-up of 3.7 years. There were no statistical differences in return to work, kyphotic deformity, VAS scores, ODI, and RMDQ scores

between the two groups. The conservative group scored higher in SF-36 subsections of physical function and role. Complications were more prevalent in the surgical group.

The second clinical study addressing operative versus nonoperative management in neurologically intact patients rated as a Level-II study was a prospective comparative trial by Shen et al. in 2001.⁵³ The authors prospectively compared the treatment of a customized hyperextension orthosis to posterior instrumentation by variable screw placement or Texas Scottish Rite Hospital rods in 80 patients with single-level T11–L2 burst fractures. Fracture dislocations and pedicle fractures were excluded. The study was initially randomized but 7 participants assigned to the operative group refused surgery and were reassigned to the nonoperative group. Data collection involved radiological and functional outcomes with a mean follow-up of 2 years. In the operative group, the kyphosis angle was improved initially by 17° , but this was gradually lost. At 1- and 3-month follow-up evaluations, VAS pain and Greenough Low-Back Outcome Scale scores were significantly lower in patients treated surgically. This difference was not observed at 1- and 2-year follow-up assessments.

A systematic review by Gnanenthiran et al. in 2012 that was rated Level II included the above trials (Table 2).²⁴ The authors pooled the results in a meta-analysis and found no differences in pain, kyphosis, RMDQ score, and return to work rates between the operative and nonoperative groups. The surgical group did have better radiographic correction (-3.3° in the nonoperative group vs 1.8° in the operative group) at final follow-up, but there was a higher rate of complications and higher costs associated with surgery.

The remaining Level-II study was conducted by Hitchon et al. in 1998, in which they prospectively compared TLSO to multiple operative approaches in 68 patients with T12–L2 burst fractures.²⁸ Patients were selected for conservative treatment if the kyphotic deformity was less than 20° , residual spinal canal was greater than 50%, and anterior vertebral body compression was less than 50%. The operative group contained significantly more patients with neurological deficits. The Frankel score classification improved by 0.5 ± 0.7 Frankel grades in the surgical group compared with 0.2 ± 0.4 Frankel grades in the conservative group. In comparison, the nonoperative group had a higher percentage of patients returning to work, lower treatment costs, and similar hospitalization durations.

The 14 remaining studies comparing operative and nonoperative management were rated Level III–V. These studies used selection criteria that resulted in more patients with neurological deficits or severe burst fractures (based on canal compromise, kyphosis, and others) in the operative management group, making direct comparisons difficult. Seven of the studies demonstrated either similar or superior functional outcomes in the nonoperative group when excluding patients with neurological deficits.^{11,12,35,37,49,50,58} Five studies included patients with neurological compromise and demonstrated no neurological deterioration with similar or superior functional or radiological outcomes in the nonoperative group.^{7,8,43,52,61} Two reviews recommended surgery for the presence of significant neurological compromise and spinal instability.^{6,17}

Evidence-based conservative management of burst fractures

Prognosis of Conservative Management

Nine papers (1 Level II and 8 Level IV) investigated the prognosis of conservative management. The Level-II study was reported by Mohanty and Venkatram in 2002.⁴⁴ The authors evaluated the radiological and clinical outcomes in 45 consecutive patients with thoracolumbar burst fractures treated by reduction and immobilization in a polyethylene-molded body jacket for 3 months. Data on the extent of canal compromise, initial neurological deficit, and final recovery were collected, with a mean follow-up duration of 1 year. The mean canal compromise had no correlation with neurological compromise, neurological recovery, or remodeling. Of the 8 Level-IV studies, 4 demonstrated no correlation between canal compromise, neurological deficit, and recovery.^{18,19,22,34} The remaining 4 Level-IV studies have shown that a higher Load Sharing Score (> 6) has a poor prognosis or that the location of fracture (thoracolumbar or lower lumbar) can impact the prognosis.^{3,5,16,36}

Discussion

Nonoperative management offers many benefits, including decreased costs and complications with improved functional outcomes.^{1,24,53,63} The literature has investigated conservative management with diverse groups of patients, fracture patterns, treatment modalities, and outcome measures. Therefore, most published studies are excluded from recent high-level systematic reviews.^{1,24} To the best of the authors' knowledge, the level of evidence for the use of conservative management in patients with traumatic thoracolumbar burst fractures has not been previously reported. In the current study, 20% of the studies published in the last 20 years meeting the inclusion/exclusion criteria demonstrate a high level of evidence (Level I or II).

Many conservative techniques stabilize the spine by limiting motion. Multiple techniques were investigated by low-level studies, whereas only 2 Level-II studies were found that compared techniques.^{4,5,13,15,36,46,54,57} The Level-II studies were both RCTs and found no difference between the conservative techniques employed when treating AO Type A3 thoracolumbar burst fractures. Stadhouders et al. demonstrated no difference in the use of a brace or a cast;⁵⁶ the body cast can restrict movements in all directions, while a brace maintains more flexibility in all directions. Bailey et al.⁹ demonstrated no difference in the use of a custom brace or no brace. The results question the need for a supportive orthotic device in isolated AO Type A3 fractures (subtypes were not specified). While the authors reported an improved functional outcome for most of the patients in the cohort, 6 patients required surgical stabilization. This may be the result of the study authors' relying on radiographic findings of fracture morphology because it has been shown that the inclusion of CT and MRI helps the identification of posterior column disruptions.^{38,39,51} This phenomenon was observed in another study in which AO Type B fractures were found intraoperatively that were originally diagnosed as AO Type A fractures preoperatively.⁵⁵

The Level-I studies selected in this review that compared operative and nonoperative management without

neurological deficits mainly reported no differences in the functional outcomes. However, the Level-I study by Siebenga et al.⁵⁵ reported superior outcomes in the operative group. These authors did not use MRI with all their patients and found 2 AO Type B1.1 fractures intraoperatively, showing evidence of posterior ligamentous complex disruption. The unrecognized Type B fractures in the nonoperative group are unknown. Furthermore, Siebenga et al. analyzed fewer fractures at the thoracolumbar junction than the other studies, and included L-3 (2/17) and L-4 (1/17) fractures in the operative group as opposed to 1 L-3 fracture (1/15) in the nonoperative group. There is low evidence that lumbar burst fractures may have a different prognosis, and this is discussed further below.^{7,10,11,14,35,43,52} The other clinical studies reported no differences in the functional outcomes between management and were rated Level II.^{53,63} Wood et al.⁶³ compared more than one nonoperative and operative technique. Furthermore, Wood et al. and Shen et al.⁵³ investigated isolated burst fractures as opposed to Siebenga et al. While the study of Wood et al. excluded posterior ligamentous disruption, the Shen et al. study did not rely on radiographic parameters, and neither used MRI. Shen et al. reported a load share score less than 6, in contrast to the mean load share score greater than 6 reported by Siebenga et al. There is low evidence that a higher load share score may correlate with a lower functional outcome in patients treated conservatively.^{5,16,36} Two high-level systematic reviews reported a high risk of performance and detection bias in the above studies without a recommendation for either operative or nonoperative management.^{1,24,58} All authors reported that costs associated with operative management are approximately 4 times greater than conservative management.^{28,53,55,63} These studies used surgical procedures not currently in use, and there is no literature on comparing conservative management to minimally invasive surgical approaches.

In this systematic review, 18 papers (40%) included patients with an initial neurological deficit. Other systematic reviews limited their inclusion criteria to burst fractures without a neurological deficit.^{1,24,50,58} The presence of a neurological deficit may not be an absolute contraindication for conservative treatment of thoracolumbar burst fractures.^{8,16,35,45} Hitchon et al. have shown that nonoperative treatment can achieve similar neurological recovery to surgical management in a Level-II study.²⁸ Numerous low-level studies have also demonstrated that conservative treatment rarely leads to neurological deterioration.^{16,26,45,59,61} The evidence that surgical intervention is needed to decompress the spinal canal or remove retropulsed bone to improve neurological status is also questionable. Mohanty and Venkatram demonstrated in a Level-II study that there was no correlation between the initial neurological deficit and subsequent recovery with the extent of spinal canal compromise in thoracolumbar burst fractures treated conservatively.⁴⁴ There are no high-level RCT studies comparing conservative treatment of burst fractures with neurological deficits. Given that surgery is commonly used in burst fractures with neurological deficits, it is understandable why this has not been further investigated.

As stated above, lower lumbar burst fractures may re-

spond differently to conservative treatment. Although the current level of evidence is low (Level IV), this warrants further investigation because it could impact the results of grouped thoracolumbar cohorts.^{3,36} Anatomically, the thoracic spine differs from the thoracolumbar junction, which differs from the mid and lower lumbar spine. Lower lumbar burst fractures are rare and are commonly included in the thoracolumbar studies.^{10,14} Interestingly, 9 low-level studies (20%) were included in the present review that investigated the conservative management of lumbar burst fractures separately from thoracolumbar burst fractures. The functional outcomes of treating lumbar burst fractures conservatively were relatively higher than those reported by grouped thoracolumbar fractures.^{7,10,11,14,35,43,52}

This review is not without limitations. While several relevant high-level studies have been published, the majority include a heterogeneous population of burst fractures due to differences in age, level, and number of fractures, neurological status, and diagnostic imaging modalities used for the classification of the type of fracture. However, this may reflect the diversity of burst fractures that is clinically encountered and managed. Summarizing the discrepancies in the population of burst fractures and in clinical outcomes may help decrease the heterogeneity of future clinical studies. Extrapolation of the data to long-term consequences may be limited, because there are no high-level studies reporting on clinical outcome greater than 5 years. Another limitation is the use of the PubMed database (MEDLINE) as our only database in constructing this review; the inclusion of other databases may have yielded more thoracolumbar burst fracture studies. However, the MEDLINE database has been reliably and consistently used as the sole source of studies in systematic reviews, and is well accepted as a comprehensive source of relevant literature.²⁷ Strengths of the current study include the highly systematic nature of the review in accordance with the Cochrane Collaboration Handbook on systematic reviews (<http://handbook.cochrane.org>). Furthermore, all studies related to traumatic thoracolumbar burst fractures within the MEDLINE database were located, consisting of a total of 447 studies in the last 20 years. Therefore, all the studies in which conservative management was used were obtained from this time period.

Conclusions

Based on the current systematic review, there are 9 high-level studies (Level I or II) that have investigated the conservative management of traumatic thoracolumbar burst fractures. In neurologically intact patients, there is no superior conservative management technique over another as supported by a high level of evidence. The appropriate method can be based on patient preference, comfort, and access to resources. There is a need for a high-level study comparing conservative techniques in neurologically compromised patients. A high level of evidence demonstrates similar functional outcome with conservative management when compared with open surgical operative management in patients who are neurologically intact. While the majority of the literature excluded pa-

tients with neurological deficits, its presence may not be an absolute contraindication for conservative treatment as supported by a high level of evidence. More evidence is needed to further classify the appropriate burst fractures for conservative management to decrease variables that may impact the prognosis. This could help standardize future burst fracture characteristics, thereby allowing pooling of results in future meta-analyses to provide a higher level of evidence for conservative management.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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