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Review

Minimally invasive spinal surgery for the treatment of traumatic thoracolumbar burst fractures

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ABSTRACT

The optimum management of traumatic thoracolumbar burst fractures is cause for much debate in the literature. Although minimally invasive surgery (MIS) approaches are increasingly used in the management of degenerative spinal pathology, their role in treating burst fractures is unknown. Assessing the level of evidence (LOE) for use of MIS approaches in vertebral burst fractures may impart better understanding of how to integrate MIS in the treatment schema for these fractures. A comprehensive literature review was conducted using MEDLINE for all articles published on traumatic thoracolumbar burst fractures through to July 2013. LOE was assigned according to the standards set forth by the Journal of Clinical Orthopaedics and Related Research and the Oxford Centre for Evidence Based Medicine. Full texts were reviewed to select only those articles discussing MIS approaches as a treatment modality. A total of 501 articles met both inclusion and exclusion criteria, and 403 of those were published within the past two decades. Among those, 35 articles detailed the use of MIS approaches in the management of traumatic thoracolumbar burst fractures. Only three studies provided high LOE: one level 1 study and two level 2 studies. Thirteen studies described the use of vertebroplasty or kyphoplasty, but all were level 4 or level 5 studies. Currently, the LOE for utilization of MIS approaches to manage traumatic thoracolumbar burst fractures is low. Further work in the form of prospective randomized controlled trials is needed to ascertain how MIS may be integrated into the treatment scheme for thoracolumbar burst fractures.

1. Introduction

Vertebral burst fractures can represent up to 64% of all fractures of the thoracolumbar spine [1]. Under the Denis classification system, burst fractures are defined as fractures of the anterior and middle spinal columns [2]. Depending on the specific mechanism and location of injury, these fractures were initially subdivided into five distinct types (A–E) [2]. In 1994, Magerl and colleagues further designated thoracolumbar burst fractures as A3 compression fractures under the AO classification system [3]. Often resulting from high-energy axial loads, the etiology for this fracture type is usually traumatic, with vertical falls, automobile accidents, and sporting injuries being the most common inciting factors [4–6]. Certain high-risk populations, such as military personnel suffering from ballistic wounds, can also be prone to burst fracture injuries [7].

Best management practices for thoracolumbar burst fractures remain controversial, and the debate fundamentally revolves around the need for conservative *versus* operative intervention, specifically in patients that are neurologically intact on presentation [6,8–12]. This lack of consensus erects substantial barriers to optimizing management protocols. In that manner, it is worth considering the potential role of minimally invasive surgery (MIS) in the treatment algorithm for traumatic thoracolumbar burst fractures. Undoubtedly, in the modern health care climate, precedence is placed on emphasizing patient quality of life while minimizing morbidity and mortality. Given its minimally invasive nature, MIS is a treatment modality that could potentially bridge the gap between operative and non-operative management. Importantly, MIS has emerged over the past decade as an effective method for managing spinal pathology, particularly degenerative diseases [13–16]. Furthermore, evidence points to improvements in perioperative factors such as blood loss or operative time with MIS approaches, which translate into reduced hospitalization and lower costs [14,17,18].

However, critical and substantial evaluation of MIS techniques in the setting of spinal trauma is scant. Anecdotally, the benefits of applying MIS techniques in spinal trauma have been unclear. For example, the senior authors (N.S.D. and Z.A.S.) have employed

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the MIS technique of percutaneous "internal bracing" for thoracolumbar trauma patients. However, this has been done in select patients with appropriate fracture characteristics and load sharing scores. Other patients during this same period have been treated with open pedicle screw fixation and fusion. Lack of available data on this topic invites exploration of the current available data. Although MIS approaches have been used to manage traumatic thoracolumbar burst fractures [19,20], no study to our knowledge has analyzed the level of evidence (LOE) advocating for the utilization of MIS approaches in traumatic thoracolumbar burst fractures. Because studies that offer high LOE (such as randomized controlled trials [RCT]) can shape the management decision-making process, addressing this gap in the literature is imperative. The primary objective of the present study was therefore to conduct a comprehensive systematic literature review to ascertain the LOE for use of MIS in the treatment of traumatic thoracolumbar burst fractures, with specific weight and discussion placed on those studies providing high-level evidence.

2. Materials and Methods

2.1. Literature search strategy

This systematic review was performed in accordance with Cochrane guidelines [21]. A comprehensive electronic search on PubMed (MEDLINE) was conducted using the following terms: (spine AND burst) or "burst fracture" or (burst and fracture) or (A3 AND fracture AND spine). The most recent search was done in July 2013. Duplicates were discarded and two blinded reviewers independently screened articles by title and abstract. Inclusion criteria were limited to (1) burst fractures of the thoracic or lumbar spine, and (2) caused by traumatic etiology. Once the final data set was constructed, articles over the past 20 years were included in the current study (1 January 1992–13 July 2013). This temporal restriction was placed because anecdotal evidence suggests that management of burst fractures has evolved tremendously within this epoch. Exclusion criteria included (1) cervical fractures, (2) osteoporotic fractures, and (3) pathological burst fractures. When articles did not clearly meet these criteria, full texts were reviewed. All other ambiguities were resolved through consensus or the addition of a third reviewer, as necessary.

2.2. Data extraction and study classification

All articles were categorized based on study type, which included case reports, case series, cadaver studies, comparative studies, and RCT. Comparative studies were defined as those investigating two or more cohorts without meeting criteria for RCT. Articles focused on anatomical exploration or technical approaches using cadavers were classified as cadaver studies. Data pertaining to publication year, population size, pre-operative neurologic status, treatment type (MIS *versus* open *versus* conservative), use of kyphoplasty or vertebroplasty, primary outcome measures, and follow-up were extracted from each report. MIS was defined as any study directly mentioning an MIS method or the use of any less invasive technique. Any discrepancies pertaining to use of MIS techniques were resolved through consensus or the addition of a third reviewer. The standardized reporting scheme provided by the Journal of Clinical Orthopaedics and Related Research [22], which is an adaptation of the Oxford Centre for Evidence Based Medicine LOE [23–25], was used to assign the appropriate LOE to each study. Studies were ranked on a scale of 1 (highest) to 5 (lowest). Again, ambiguities or discrepancies were resolved through consensus or the addition of a third reviewer, as necessary. Following the construction of the final dataset over the past 20 years, all studies identified as using an MIS treatment modality were selected and included in this review.

3. Results

3.1. Article selection

The results of our search strategy are portrayed in Figure 1. Preliminary literature search resulted in 1054 abstracts, and 501 studies involving traumatic thoracolumbar burst fractures met inclusion and exclusion criteria, with 403 over the past 20 years. Out of the 403 studies, 35 articles were identified as using an MIS technique [19,20,26–58]. All studies were technique-based, with most in the format of a case report or series (n = 28, 80%). There were four comparative studies, two cadaver studies, and a single RCT. Twenty studies were retrospective, 10 were prospective, and five either did not specify or were indeterminate. LOE breakdown, in decreasing order of importance, was: level 1 (n = 1, 3%), level 2 (n = 2, 6%), level 3 (n = 2, 6%), level 4 (n = 28, 80%), and level 5 (n = 2, 6%). Of the three level 1 or level 2 studies, two were comparative studies and one was an RCT. These three studies are summarized in Table 1.

3.2. Evidence for MIS interventions in thoracolumbar vertebral body fractures

3.2.1. Level 1 evidence

The single level 1 study was a prospective RCT published in 2012 by Jiang and colleagues [20]. Within a cohort of 61 patients,

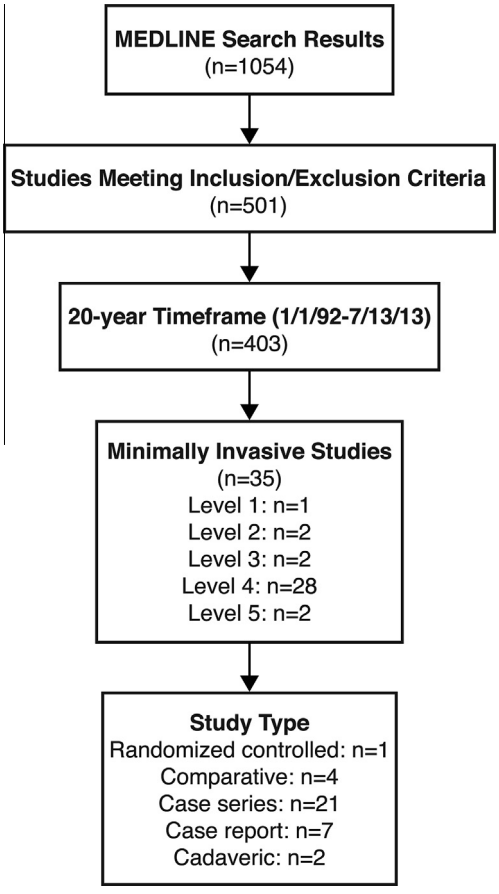

Fig. 1. Step-by-step depiction of the article selection process for the literature review. A total of 35 articles discussed minimally invasive approaches for the treatment of traumatic thoracolumbar burst fractures.