Evaluation of Surgical Treatment and the Relationship between Thoracolumbar Injury Severity and Classification Score and Preoperative Cross-Sectional Area in Patients with Thoracolumbar and Lumbar Burst Fractures

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ABSTRACT

Background: The aim of the study was to establish a correlation between (1) the Thoracolumbar Injury Severity and Classification score (TLICS) and sensory scores and motors scores of the American Spinal Injury Association (ASIA) Scale (surgical outcome); correlation between preoperative cross-sectional area (CSA) and the ASIA; (2) to establish a correlation between the TLICS and the CSA in thoracolumbar and lumbar burst fracture (TLBF) patients and (3) the evaluation of surgical outcome based on the ASIA scale and its relationship to TLICS.
Methods: This was a prospective study and 67 patients (mean age 30.3 ± 8.1 years; 18.2% were female) were assessed. The TLICS was determined and TLICS > 4 was hypothesized to be consistent with an indication for surgery. Nerve injury was assessed according to ASIA. The CSA and the ASIA were measured at two points in time: pre- and postoperative assessments. The surgical outcome and correlations were assessed.
Results: Patients were followed an average of 26.2 months. ASIA sensory scores and motor scores were improved significantly at last follow-up. No patient experienced neurological worsening during follow-up. No significant correlations were observed between the ASIA and the CSA at either the pre- or postoperative periods. However, there was a statistically significant correlation between TLICS and the ASIA motor and ASIA sensory ($P < 0.01$ and $P < 0.02$ respectively).
Conclusion: The findings confirm that a TLICS > 4 may be applied in the decision-making process for surgery for TLBF. However, the CSA is not useful for decision making for this pathology.

Keywords: Cross-sectional area; TLICS; Thoracolumbar; lumbar; burst fractures; AIS; Outcome

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INTRODUCTION

Thoracolumbar and lumbar burst fractures (TLBF) disrupt the anterior column, the middle column, and occasionally the posterior column. They do not always lead to segmental instability and cord compression. It accounts for approximately 15% of all spinal injuries. [1]

To assist with the decision-making process, numerous classification schemes for spinal fractures such as Thoracolumbar Injury Severity and Classification Score (TLICS) have been published over the past 40 years [2-3].

The TLICS system is based on 3 major descriptive categories: injury morphology, integrity of the posterior ligamentous complex (PLC), and neurologic status. It identifies 3 critical injury categories and assigns an injury severity score, based on these categories, which can guide spinal surgeons in surgical decision making of thoracic or lumbar spinal trauma. The TLICS is based on a progressive score for each of the 3 major injury categories: injury morphology, integrity of the PLC, and the neurologic status. The injury severity score is calculated by summation of the individual scores (Table 1) [3]. Some authors retrospectively reported that patients with TLICS > 4 needed operative treatment [3]. However, this issue has been studied prospectively in only one paper in the literature and is required further assessment [4]. On the other hand, the question is whether or not spinal cross-sectional area (CSA) can be help in the decision-making process for surgery in patients with TLBF. The relation between the spinal canal size and its association with neurologic deficit after trauma has been reported in the literature [5-6]. However, the relationship between TLICS and spinal cross-sectional area is controversial in these patients.

The aim of this study was several-fold: (1), to study the correlation between TLICS and the sensory and motor scores of the American Spinal Injury Association (ASIA);[7] (2) to study the correlation between CSA and the ASIA; (3) to study the correlation between TLICS and the CSA in patients with TLBF for choosing an appropriate treatment; and (4) to assess surgical outcome based on ASIA scale and its relationship to TLICS.

Table 1. The TLICS system*.

Variable	Points
Injury Morphology	
compression	1
burst	1
translation/rotation	3
distraction	4
Neurological Status	
intact	0
nerve injury	2
cord, conus medullaris	
incomplete	3
complete	2
cauda equina	3
PLC Integrity	
intact	0
indeterminate†	2
injured	3

*As reported by Vaccaro et al.[3]
†For patients with suggested ligamentous injury on STIR imaging or T2-weighted MRI.

MATERIALS AND METHODS

Patients and data collection

This was a prospective study. Between January 2007 and April 2012 a sample of newly diagnosed patients with TLBF seen at two large teaching hospital in Tehran, Iran, was investigated. The diagnosis of TLBF was performed using clinical symptoms, neurological examinations, and imaging studies including plain radiography, CT and MRI of the thoracolumbar or lumbar spine. Classifying the patient's injury was performed based on the TLICS [3]. Nerve injury was evaluated based on ASIA standards for neurological classification of spinal cord injury.[7] Surgical treatment for TLBF was chosen according to comprehensive status such as degree of injury or damage type and typical imaging also was performed, if needed. Only patients who had a TLICS greater than 4 and who were alert and cooperative with neurologic testing were included in the study. Injuries were also classified such as thoracolumbar (T10–L2), or lumbar (L3–5) spinal trauma. The characteristics including age, gender and body weight were recorded.

Sample size and power calculation

The sample size was based on improvement in pre and post-treatment outcomes. An improvement of 20% in ASIA score was thought based on previous study [8]. It was estimated that a study with a sample of 70 patients would have a power of 90 at 5% significance level.

Additional measure

Total canal cross-sectional area was defined according to Keynan et al.,[9] The cross-sectional areas were calculated by computerized tomography (CT) using an electronic digitizer to outline the perimeter of the spinal canal and computer software to calculate the precise cross-sectional area at two levels of interest above and at the level of injury (Figure 1, A and B). The calculations were performed by two independent radiologists and were blinded to each other's.

Statistical analysis

The weighted Kappa coefficient between two radiologists was used for inter-observer reliability assessment at two points in time: the pre- and postoperative assessments (at last follow-up). Kappa value of 0 to 0.20 indicated slight agreement, 0.21 to 0.40 fair agreement, 0.41 to - 0.60 moderate agreement, 0.61 to 0.80 substantial agreement, and ≥ 0.81 was regarded as almost perfect agreement according to the interpretation by Landis and Koch [10]. In this study, the average values of the CSA

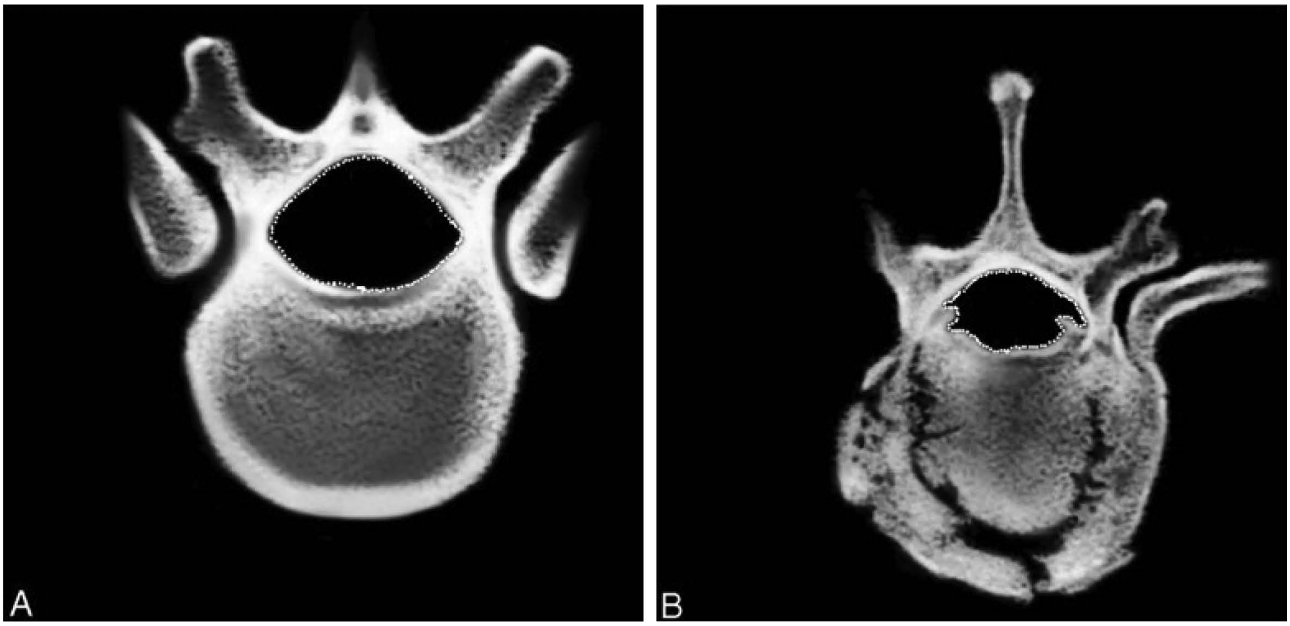

Figure 1. Transaxial CT showing direct measurement of the cross-sectional area (CSA) of the canal at adjacent levels (A) and at the level of injury (B) using an electronic digitizer.

were considered at two points in time.

The CSA and the ASIA were measured at preoperative and at last follow-up. Significant difference found between CSA at pre- and postoperative at the level of injury include those who underwent laminectomy. Continuous variables are reported as median and standard deviation. The correlation was calculated by Pearson correlation test. The probability level was set at $P < 0.05$. All statistical analyses were performed using the PASW Statistics 18 Version 18 (SPSS, Inc., 2009, Chicago, IL, USA).

Ethics

The Ethics Committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran, approved the study and agreed with the consent procedure.

RESULTS

In all, 79 patients were assessed. Of these 4 patients were excluded due to previous spine surgery and 8 patients due to loss to follow-up. The remaining 67 patients who underwent a posterior spinal fusion by two surgeons were entered into the study. The mean age of patients was 30.3 ± 8.1 (24 to 65) years; and 18.2% were female. Automobile accident was the predominant cause of trauma (36 patients, 53.7%), followed by fall from height (19 patients, 28.4%). All patients were surgically treated by posterior fusion with instrumentation. The median period from admission to operation was 4.7 days (SD=11.6). Regarding injury level, 12 patients (17.9%) had thoracolumbar fractures (T10), 45 (67.1%) had thoracolumbar fractures (T11–L2), and 10 (14.9%) had lumbar fractures (L3–5). The total number of patients with thoracolumbar and lumbar burst fractures was 57 and 10 respectively. All patients had a TLICS > 4 and were primarily treated surgically. The TLICS ranged from 5 to 10 points (median 7.2 points). All distractive and rotational injuries had a concomitant PLC injury. Patients were followed an average of 26.2 months (ranging from 24 to 47 months).

Comparison between pre- and postoperative outcomes was performed based on the ASIA. The ASIA sensory score improved from 168.4 (SD=20.4) at preoperative to 211.1 (SD=19.8). The ASIA motor score improved from 52.8 (SD=6.1) at preoperative to 83.1 (SD=11.9). ASIA sensory scores and motor scores were improved significantly at last follow-up ($P < 0.001$). Fourteen patients (20.9%) had complete paralysis at pre-operative time. The last follow-up examination did not show any improvement with respect to the neurological status of the patients with complete paralysis. None of these patients had neurological worsening during follow-up. Complications directly related to surgery included 4 patients with pedicle screw revision for asymptomatic misplacement and 5 patients with wound infections, 2 of whom required revision surgery for debridement without instrumentation removal or revision.

The Kappa statistic was calculated for CSA. The kappa values of the CSA for inter-observer were 0.89 (0.87–0.96) and 0.88 (0.86–0.96) at pre- and postoperative, respectively, indicating substantial perfect agreement. The mean CSA at the level of injury in preoperative, postoperative without laminectomy and postoperative with laminectomy were 1.24 (SD=0.13), 1.63 (SD= 0.17) and 1.76 (SD= 0.21) cm^2, respectively. Significant differences were found between the CSA at pre-and postoperative at the level of injury ($P < 0.001$). In addition, significant differences were found between the CSA at the two levels above and at the level of injury ($P<0.001$).

No significant correlations were observed between the ASIA sensory and CSA and also between ASIA motor and CSA (cm^2) at pre- and post-operative time frames ($P>0.05$). In addition, there was no statistically significant correlation between TLICS and the CSA at the level of injury ($r=0.143$, $P=0.213$). There was statistical significant correlation between TLICS and the ASIA motor and ASIA sensory ($P < 0.01$ and $P < 0.02$, respectively).

DISCUSSION

This is the second paper to prospectively use the TLICS to guide surgical in the treatment of patients with TLBF [4]. This study showed that the TLICS system could safely guide surgeons to make appropriate clinical decisions in performing surgical procedures.

Relations between the TLICS score and the CSA have not been studied before. Several authors did find a significant correlation between the initial fracture pattern or the amount of spinal canal compromise, determined by CT, and neurologic injury;[11-19] however, several groups did not observe such,[20-29] which is in line with our findings.

The findings from this study showed that there was a strong association between TLICS and ASIA scores. Since some clinicians suggested that measuring ASIA is a bit difficult, the findings from the current study suggest that one could use TLICS instead. The TLICS is a ‘user-friendly’ scale that can be applied in clinical settings without difficulty. The study presents a prospective assessment that validates, in part, the grading system, giving some validation to the grading system. However, although TLICS has many advantages over other systems, one potential weakness is the possibility that all “4“s are not equivalent, meaning there are certain fracture patterns that necessitate surgery (i.e., distraction), while other “4”s may not.

It has been reported that most of the neurological improvement occurs in the first 6 months after trauma [4,30]. It appears from our data that the prospective utilization of the TLICS system is both accurate safe with regard to surgical decision making and neurological outcomes; no patient worsened after treatment and all 10 patients with incomplete deficits had some improvement [4]. In addition, there is motor and sensory improvement when comparing pre- and post-operative time frames.

The TLICS system is a decision support system for classification of patients with TLBF. It has a consensus that the surgical treatment is optimal when the score was greater than four and conservative treatment when less than 3. However, surgery or conservative treatment for TLBF was chosen based on many variables, including degree of injury, injury type and imaging. Some authors have addressed the value of MRI, but others found that MRI may over diagnose PLC injury, especially when the radiologist’s interpretation is used as the definitive radio-graphical analysis [31-33]. However, in this study all distractive and rotational injuries had a concomitant PLC injury.

Pneumaticos et al suggested the condition that serious anterior and middle vertebrae fractures of the thoracolumbar spine, with intact PCL and normal neurological function, warranted surgical treatment – in spite of the fact that the TLICS score was less than 3. In these cases, the vertebral column was extremely instable with ligamentous disruption [34]. However, in this study, no patient underwent surgery with a TLICS less than 3. Therefore, future studies are needed to clarify this issue.

This is the second prospective study respecting the TLICS criteria and showed that the TLICS > 4 can be applied in the decision- making process for surgery and is safe with regard to the neurological status of patients treated for TLBF,[3-4] while the CSA cannot, due to the lack of significant correlation between the CSA and the ASIA scale. However, the CSA may be used to prognosticate regarding prognosis. Finally, parameters such as a TLICS > 4 will never replace human expert decision-makers. However, it can be used to assist the surgeon as an additional tool in routine decision-making process.

The study had some limitations. Firstly, the study was limited by its short follow-up period. Secondly, we did not assess the possible divergence among different observers for evaluating TLICS. Thirdly, all the patients improved from an ASIA score perspective; however, we do not know how they would have done without surgery. As correctly stated, the fracture pattern often mandates surgery for stability so the patient can be mobilized. Fourthly, the anecdotal “50% canal compromise” may need surgery could potentially be addressed by employing

CSA. We did not discuss what the CSA was relative to the immediate adjacent normal segments. Finally, due to the limited number of patients with thoracolumbar fractures, and lumbar fractures; we could not compare these CSAs with TLICS.

CONCLUSION

Our findings demonstrate that all the patients improved with respect to ASIA score and a TLICS > 4 may be applied in the decision- making process for surgery for TLBF. It is both accurate and safe – in that it predicted good outcomes with surgery. However, the CSA is not useful for decision making for this pathology.

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