Measuring the impact of the Thoracolumbar Injury Classification and Severity Score among 458 consecutively treated patients

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Context: The Thoracolumbar Injury Classification and Severity Score (TLICS) was proposed to improve injury classification and guide surgical decision-making of thoracolumbar spinal trauma (TLST), but its impact on the care of patients has not been quantified.

Study design: Retrospective study.

Patient sample: Analysis of 458 patients treated for TLST trauma from 2000 through 2010 at a single center.

Outcome measures: Neurological status – ASIA Impairment Scale (AIS), failure of conservative treatment, and surgical complications.

Methods: Clinical and radiological data were evaluated. Patients were grouped according to the period before (2000–2006) and after (2007–2010) utilization of the TLICS.

Results: From 2000 to 2006, 148 patients were initially treated conservatively (C) and 66 were surgically (S) treated. In the C group, the TLICS ranged from 1 to 7 (median 1; mean 1.57). In the S group, the TLICS ranged from 2 to 10 (median 2; mean 4.14). The TLICS matched treatment in 97.9% of conservatively treated patients. From 2007 to 2010, 162 patients were initially treated C and 82 were treated S. In the C group, the TLICS ranged from 1 to 4 (median 1; mean 1.48). In the S group, the TLICS ranged from 2–10 (median 4; mean 4.4). The TLICS matched treatment in 98.8% of C-treated patients. Overall, failure of C treatment occurred in nine patients; most failures (7/9) and all three missed distracting injuries occurred prior to use of the TLICS.

Conclusions: After introduction of the TLICS, there was a trend towards more successful conservative treatment with fewer conversions to surgical treatment.

Keywords: Fractures, Vertebral, Burst fractures, Spinal cord injuries, Spinal trauma, Spinal surgery, Thoracolumbar Injury Classification and Severity Score, Magerl/AO Spine Classification, American Spinal Injury Association

Introduction

The Thoracolumbar Injury Classification and Severity Score or ‘TLICS’ system has been proposed to improve injury classification and guide surgical decision-making. The system is composed of three major descriptive categories: (1) injury morphology (2) integrity of the posterior ligamentous complex, and (3) neurological status. The

final score is calculated by summation of the individual scores of each of these three major categories.¹ One of its unique advantages is the inclusion of the neurological status as a descriptor of thoracolumbar trauma. Neurological status is one of the most critical determinants of surgical decision treatment, which has not been incorporated in other classifications systems used worldwide.^{2–4}

Acceptable reliability and validity of the system have been described, with a more favorable profile when compared to other thoracolumbar classification systems.^{5–7} The TLICS system has been advocated to be a valuable

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tool for clinical care and education, although, as far as we know, there have been only a limited number of clinical studies on the TLICS system published to date.⁸ Additionally, these investigations have been on a small number of patients and/or treating surgeons.

Given the potential benefits of this new system, continued assessment of the TLICS efficacy in a clinical context is needed. Specifically, the impact of the TLICS system on a health system with multiple treating surgeons has not been quantified to date. The purpose of this study is to evaluate the impact of the TLICS system on the care of patients at a tertiary medical center.

Materials and methods

We retrospectively analyzed patients treated for thoracic and/or lumbar spine trauma from 2000 through 2010 at the Department of Orthopaedic Surgery, University of Utah School of Medicine, Salt Lake City, UT, USA. Patients were identified through a prospective, database of all patients (age >12 years) presenting to our trauma center ($n = 20\,595$). From this group, patients were identified by ICD-9 codes for thoracic and/or lumbar injuries or spinal cord injury. Inclusion criteria included adult patients (age ≥ 18), thoracic or lumbar injuries, complete radiology imaging for TLICS evaluation, and complete clinical data. Exclusion criteria included pathologic fractures (osteoporosis, infection, and cancer), transverse process and isolated spinous process fractures, and those with chronic or age-indeterminate thoracic and/or lumbar trauma. Patients were grouped according to the period of their treatment: before (2000–2006) or after (2007–2010) utilization of the TLICS at the institution. Patients were further categorized according to initial treatment: surgical or non-surgical (conservative).

The TLICS system, described in 2005, was further implemented into clinical practice at the institution through a series of educational sessions including a grand rounds lecture by one of the founding authors of the system (ARV), as well as at weekly, multidisciplinary spine conferences and surgical indications conferences by another author (AAP) with prior clinical and research experience with the TLICS system.

Demographic data including age and gender were recorded. Baseline injury details were recorded, including trauma etiology, injury level, and neurological status. Injuries were described as thoracic (T1–T10), thoracolumbar (T11–L2), or lumbar (L3–L5). Using available radiographic studies, patient injuries were classified by two reviewers (AFJ, AAP) according to the Magerl/AO Spine Classification and the TLICS system at the most severely injured level. The neurological status was classified using the American Spinal Injury Association (ASIA)

system – the ASIA Impairment Scale (AIS).⁹ Surgical details included operative approach, number of operative levels, and treatment complications were also assessed.

Outcomes of treatment were identified as well as complications (neurological deficit, conversion to operative treatment, and surgical complications). Failure of conservative treatment was definite if a patient required surgery or had neurological worsening during the follow-up period. Patients with failure of initial conservative treatment were maintained in the conservative treatment sub-groups for analysis.

Successful treatment, in the conservative group, was determined when the patient maintained or improved his/her neurological status and did not require surgery. Success in the surgical group was determined when the patient maintained or improved his/her neurological status.

Analysis of TLICS scores between groups was performed using an unpaired *t*-test; comparisons of treatment (surgical vs. conservative) between groups were analyzed using a two-tailed Fisher's exact test. Statistical significance was determined at $P < 0.05$. Institutional review board committee approval was obtained prior to initiation of the study (IRB 43071). There were no external funding sources for this study.

Results

We identified and evaluated 1339 patients, identified by ICD-9 codes for thoracic and lumbar injuries or spinal cord injury. However, 881 patients were excluded due to the pathologic nature of the fracture, i.e. secondary to tumor or infection, an age indeterminate injury, fractures not located in the thoracic or lumbar spine, including isolated spinous process or transverse process fractures and incomplete radiological data. Four hundred and fifty-eight patients ultimately met all inclusion and exclusion criteria.

These 458 patients were then grouped according to the period of time they were treated. From 2000 through 2006, 214 (46.7%) patients were treated, 148 conservatively and 66 surgically. From 2007 through 2010, 244 (53.2%) patients were treated, with 162 patients treated conservatively and 82 treated surgically (Table 1).

Motor vehicle collisions were the main cause of injury in the whole group (217 patients, 47%), followed by fall

Table 1 Distribution of patients according to period of time and initial treatment

	2000–2006	2007–2010
Conservative	148	162
Surgical	66	82
Total	214	244

Table 2 Distribution of the patients according to injury location and initial treatment

	2000–2006		2007–2010	
	Conservative group	Surgical group	Conservative group	Surgical group
Thoracic (T1–T10)	14	5	17	6
Thoraco-lumbar (T11–L2)	96	50	108	64
Lumbar (L3–L5)	38	11	37	12
Total	148	66	162	82

from a height (106 patients, 23%). Patients' distribution according to injury location is presented in Table 2.

Group 1 – Patients treated between 2000 and 2006

Conservative treatment – 148 patients

Of the 148 in this group, 110 were male (74.3%) and 38 (25.6%) were female, with an average age of 39.4 years (range: 18–89 years). All patients, except one (AIS C, with full recovery), were neurologically intact (AIS E) (99.3%). The TLICS score (Table 3) ranged from 1 to 7 (SD = 0.99; median = 1; mean = 1.57); 145 patients (97.2%) had an AO type A injury (85 compression fractures and 60 burst fractures). Initial treatment provided matched the TLICS recommendation (TLICS ≤ 4) in 145 (97.9%) patients (Table 3). Three patients with distractive injuries (TLICS = 7; AO type B with concomitant PLC disruption), were initially misdiagnosed; all three patients had severe pain and deformity with

attempted conservative treatment and were ultimately treated surgically.

Overall, seven patients (4.7%) required surgery after initial conservative treatment (Table 4). These included the three patients with undiagnosed PLC injuries and four patients with burst fractures: one with a severe radiculopathy refractory to clinical treatment (TLICS 4), two with severe axial back pain but no neurological deficit (TLICS 2), and one with worsening of radiographic kyphosis without pain on upright radiographs before hospital discharge (TLICS 2). Among the patients with burst fractures converted to surgery, only the patient with severe radiculopathy had substantial improvement of his clinical symptoms. None of the two patients who underwent surgery for axial back pain had a significant clinical improvement.

Among all patients in this group, no treatment-related complications were noted and no patients had deterioration of neurological function. Retrospective follow-up

Table 3 Distribution of ASIA grade, AO classification, and TLICS score according to time and treatment provided

	Conservative	Surgical
2000–2006	148	66
ASIA Grade	99% ASIA E	67% ASIA E 33% ASIA A-D
AO Classification	98% Type A	67% Type A 26% Type B 7% Type C
TLICS Score	1–7 (SD 0.99; median 1; mean 1.57)	2–10 (SD 2.9; median 2; mean 4.14)
2007–2010	162	82
ASIA Grade	100% ASIA E	74% ASIA E 26% ASIA A-D
AO Classification	99% Type A	73% Type A 31% Type B 6% Type C
TLICS Score	1–4 (SD 0.64; median 1; mean 1.48)	2–10 (SD 2.65; median 4; mean 4.4)

Table 4 Conservative treatment: outcomes and complications

	2000–2006	2007–2010
Total number of patients	148	162
Successful treatment (no neurological worsening nor late surgery)	141 (95.3%)	160 (98.7%)
Failed conservative treatment (pain, deformity)	7	2
Missed distractive injuries	3	0

was obtained in 95 patients (64.1%) who underwent non-surgical treatment (mean of 5.8 months).

Surgical treatment – 66 patients

Of the 66 patients in this group, 48 (72.7%) were male and 18 (27.2%) were female, with a mean age of 34.4 years (range: 18–79 years). In this group, 44 patients were AIS E (66.6%) and 22 (33.3%) had some neurological injury (7 were AIS A and 15 were AIS B-D). The TLICS score (Table 3) ranged from 2 to 10 (SD = 2.9; median = 2; mean = 4.14); 48 patients (72.7%) had AO type A fractures (burst fractures), 15 (31.2%) had type B, and 3 (6%), type C fractures.

Initial treatment provided matched the TLICS recommendation (TLICS ≥ 4) in 26 patients (39.4%). All patients (60.6%) with discordance between treatment provided and TLICS recommendation sustained burst fractures without neurological deficit (TLICS = 2).

No patients had deterioration of neurological function. At final follow-up, all the patients that presented as AIS A remained AIS A, one patient that presented as AIS B improved to AIS C, two patients that presented as AIS C and four patients that presented as AIS D improved to AIS E.

Fifteen surgical complications were identified. Three patients required removal of the instrumentation due to pain or implant protrusion. In two cases, both initially treated anteriorly alone, posterior instrumentation and arthrodesis was later required due to pseudarthrosis. Two patients required surgical debridement due to wound infection. Two patients had urinary infection. One patient had a deep venous thrombosis, two patients had pneumothorax and one patient had a myocardial infarction. One patient with a burst fracture and no neurological deficit died on postoperative-day 3 due to a pulmonary embolism. Retrospective follow-up was obtained in 53 patients (80%) in this group (mean of 13 months).

Group 2 – Patients treated between 2007 and 2010

Conservative group – 162 patients

Of the 162 patients in this group, 112 were male (69.1%) and 50 (30.8%) were female, with a mean age of 42.3 years (range: 18–89 years). All patients were AIS E and 160 (98.7%) had an AO type A (95 compression and 65 burst fractures). Two patients were classified as having anterior distractive injuries without PLC disruption (an increase in the disk space in the thoracic spine) without neurological deficits. Both of them were treated conservatively with success. The TLICS score (Table 3) ranged from 1 to 4 in this group (SD = 0.64; median = 1; mean = 1.48). Initial treatment provided matched TLICS

recommendations in 100% of patients. Two patients with burst fractures and no neurological deficit (TLICS 2) required surgery – one for vertebral body collapse on upright radiographs before hospital discharge and the other for back pain (Table 4). The patient maintained some back pain in the follow-up reported.

No treatment-related complications were noted and no patients had deterioration of neurological function. Retrospective follow-up was obtained in 117 (72.2%) patients that underwent non-surgical treatment (mean of 5.3 months).

Surgical group – 82 patients

Of the 82 patients in this group, 58 (70.7%) were male and 24 (29.2) were female, with a mean age of 36.1 years (range: 18–65 years). Sixty-one (74.3%) patients were AIS E and 21 (25.6%) were AIS A-D. The injuries included 55 (67%) type A fractures (all burst fractures), 21 type B (25.6%) fractures, and 6 (7.3%) type C fractures. The TLICS score (Table 2) ranged from 2 to 10 (SD = 2.65; median = 4; mean = 4.4) (Table 3), with 39 (47.5%) patients having burst fractures without neurological deficit (TLICS 2). Treatment provided matched TLICS recommendations (TLICS ≥ 4) in 43 (52.4%) patients. Similar to the surgical group of 2000–2006, all patients (47.5%) with discordance between treatment provided and TLICS recommendation sustained burst fractures without neurological deficit (TLICS = 2).

At the final follow-up, all the patients who presented as AIS A remained AIS A, two patients that presented as AIS B improved to AIS C, one patient that presented as AIS C and four patients that presented as AIS D improved to AIS E. No neurological deterioration occurred.

Nine surgical complications were identified. Three patients required removal of the instrumentation due to pain or implant protrusion. In one case, initially treated anteriorly alone, posterior instrumentation and arthrodesis was later required due to pseudarthrosis. Two patients required surgical debridement due to wound infection. One patient had urinary infection. One patient had a deep venous thrombosis and one patient required revision of the instrumentation. No patients died in this group. Retrospective follow-up was obtained in 74 patients (90%) in this group (mean of 14.8 months).

Comparison – 2000–2006 and 2007–2010

No differences in patient age, AIS, AO classification or TLICS scores were noted between the two groups. There was a trend towards greater success in conservative care in the group treated after introduction of the TLICS system: 2000–2006 group (seven failures in 148 cases) compared to the 2007–2010 group (two failures in 162 cases)

Table 5 Treatment of Burst Fractures Without Neurological Deficits (TLICS = 2) before and after TLICS system*

	Conservative	Surgical	Total
2000–2006	60	40	100
2007–2010	65	39	104
Total	125	79	204

*No statistical difference ($P = 0.77$) between surgical and conservative treatment and period of treatment.

($P = 0.09$), but it did not reach statistical significance. Among patients with stable burst fractures (TLICS = 2) (Table 5), no significant differences ($P = 0.7743$) in the rate of surgical or conservative treatment were noted from 2000 through 2006 and 2007–2010. Lastly, in Table 6, we have presented the characteristics of the patients with burst fractures without neurological deficits who underwent late surgery.

Discussion

The TLICS system was created to aid in the diagnosis and decision-making of the management of thoracic and lumbar spinal trauma. The critical factors in this decision are quantified – injury morphology, status of the posterior ligamentous complex, and neurological status. However, until now, assessment of the clinical impact of the TLICS system has been limited to small case series or to publications by the describing authors.⁸

Our study demonstrates that the TLICS system and score accurately matched conservative treatment in 97.9% of patients treated from 2000 through 2006 and 98.8% of patients treated from 2007 through 2010. Successful conservative treatment trended towards a significant increase ($P = 0.09$) after implementation of the TLICS system. Seven (78%) of nine patients failing conservative treatment occurred prior to implementation of the TLICS system. This suggests that use of the TLICS may identify unstable injuries that would otherwise be missed and directs these situations towards surgical care. As a corollary, it suggests that the conservative treatment of unstable injuries (TLICS > 4) will likely fail due to kyphosis, deformity, and pain.

Although considered a stable injury pattern, a small number of patients with burst fractures and no

neurological deficit in each group were ultimately converted to surgical treatment: six for back pain and one for a persistent radiculopathy. While the indication for surgery in the patient with neurological symptoms was clear, most of the patients with back pain did not demonstrate significant improvement after surgery.

After introduction of the TLICS system, a small, but not statistically significant, decrease was seen in the surgical treatment of stable burst fractures (TLICS = 2) and an increase was noted in the percentage of surgical patients that matched the TLICS recommendations (TLICS ≥ 4), from 37.4% (22 from 66 surgically treated patients) to 52.4% (43 from 82 surgically treated patients). This variability suggests a non-uniform acceptance and utilization of the TLICS system at our institution despite the numerous educational efforts to implement the system into practice. This is also representative of continued controversies in the treatment of thoracolumbar burst fractures. Two prospective, randomized studies, both with small numbers of patients, have been reported to date.^{10,11} Wood *et al.*¹⁰ in a study of 47 patients, demonstrated that surgical treatment of stable burst fractures did not improve clinical outcomes and increased the risk of complications for the patient. Siebenga *et al.*¹¹ however, in a study of 34 patients, reported better long-term results for pain and function with surgical treatment.

The small number of patients in these studies limits the generalization of our findings. Both of the aforementioned reports, in addition to our large group of patients, demonstrated safety with conservative treatment and a greater complication rate with surgical management for stable burst fractures. As neurological preservation is a critical goal in the acute management of patients, collectively, these data support the initial conservative treatment of stable burst fractures with the use of an external orthosis. The criteria for conversion to surgical treatment remain unclear, especially when we considered axial back pain as a potential cause of failure in the conservative treatment. Chronic pain is a complex subject in spinal trauma, not accessed in our study, which requires long-term follow-up and functional status questionnaires evaluation. Prospective application of the TLICS system, with

Table 6 Characteristics of the 5 patients with Burst Fractures Without Neurological Deficits (TLICS 2) who underwent late surgery

1	L1	2002	Surgery 4 months later due to pain and some worsening on kyphosis
2	L1	2004	30° of kyphosis on stand radiographs without pain – acute phase before hospital discharge
3	L1	2005	Pain and worsening of kyphosis (10° to 30°) during the follow up (three months) – patient had a leg amputated – still with severe back pain
4	L3	2007	Surgery 4 days later due to vertebral collapse in upright position
5	L1	2008	Surgery one week later for back pain. Still with some moderate back pain

consistently defined injuries, will better elucidate the potential differences between surgical and conservative treatment.

Despite the large number of patients identified, this study is limited by its retrospective nature and the limited clinical follow-up. Retrospective application of the TLICS system, while demonstrating validity and safety, does not definitively prove its efficacy. The study assumes that the TLICS, which was first described in 2005,⁴ was fully implemented by 2007 across our health system by all treating surgeons. The TLICS system was implemented at our institution through a grand rounds event by a founding author of the system (ARV) in 2006. Another author (AAP), who trained with and had prior research experience with the TLICS system, joined the institution in September 2006 and further implemented the system through weekly, multidisciplinary conferences and spine indications conferences. While this supports our decision to use 2007 to form the study cohorts, the uniformity of TLICS application across all surgeons was not assessed. As such, the study may be biased towards under-reporting an impact of the TLICS system. Despite this, valuable information about the tendency of change in the treatment of thoracolumbar spine trauma could still be identified.

Conclusion

We conclude that the TLICS is a promising classification system that may better identify unstable injuries, thereby reducing failures of conservative treatment. However, the management of stable burst fractures remains inconsistent with no significant changes after implementation of the TLICS system. Given that this injury pattern comprised a large portion of surgically treated patients, the impact of the TLICS system on surgical care remains unknown. In future, larger studies addressing the TLICS in a prospective manner are

necessary to define the prognostic value of the TLICS system on patient outcomes.

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