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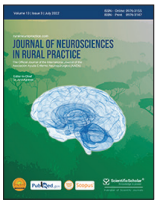

Original Article

Integrated spine trauma team protocol: Combined neurosurgical and orthopedic experience for the management of traumatic spinal injuries

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ABSTRACT

Objectives: During the last decades, spine surgery has grown exponentially. In spite of that, it remains a surgical specialty without a well-defined own certification. It is usually carried out, separately, by neurosurgeons and orthopedic surgeons, even if there is an overlapping of competence and skills.

Materials and Methods: In our hospital, from January 2019, a systematic protocol called integrated spine trauma team protocol (ISTTP) was implemented to improve the management of traumatic spinal injuries in a multidisciplinary way. It is characterized by a specific algorithm from diagnosis to post-operative care. According to the new protocol, orthopedic spinal surgeons and neurosurgeons work together as an integrated spine trauma team. The authors analyzed, retrospectively, the results obtained by comparing patients treated before and after the application of the ISTTP.

Results: The new protocol allowed a statistically significant reduction in waiting time before surgery and complication rate. Moreover, early discharge of patients was recorded. To the best of our knowledge, this is the first study that described a specific algorithm for a standardized multidisciplinary management of the spinal trauma with combined orthopedic and neurosurgeon expertise.

Conclusion: Our preliminary results suggest that the application of our ISTTP leads to better results for treating traumatic spinal injury (TSI).

Keywords: Trauma, Spinal injuries, Team, Neurosurgical, Orthopedic

INTRODUCTION

Recently spine surgery showed an exponential growth due to developments in diagnostic imaging, greater diffusion of minimally invasive procedures, and better comprehension of biomechanics. Nevertheless, it is not a well-defined own certified specialty because it is usually carried out by neurosurgeons or orthopedic surgeons. Moreover, the self-perception of skill is comparable among both specialists.[1] A multidisciplinary team (MDT) is defined as the cooperation between different professional figures with specific skills with the aim of improving treatment efficiency and patient management. Published studies suggest that collaboration in the MDT improves the transmission of experience, sharing of evidences, and decisions. Several studies[2-4] have examined the influence of MDT on patient results, valuation, and management. The results indicated a better outcome and a lower rate of complications. Recently, some experiences of MDT in spine surgery have been reported.[5,6] Some institutions in the USA have set up a "spine team" for managing spinal deformities.[6,7] However, to the best of our knowledge, there are yet no reported "spine trauma team" with combined orthopedic and neurosurgeons dedicated to traumatic spinal injury (TSI). Moreover, no specific multidisciplinary care pathways have been developed for spinal trauma. This article aims at introducing key concepts relating to teamwork in this area. Collaboration requires shared authority and responsibility. From January 2019 onwards, in our trauma center in the metropolitan area of Milan, a systematic protocol for the TSI, the so-called integrated spine trauma team protocol (ISTTP) was established to improve the management of these injuries. In this study, we describe the organizational flowchart and report our preliminary results.

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MATERIALS AND METHODS

ISTTP

In January 2019, the ISTTP was authorized by the Institutional Review Board and the comprehensive management with all surgical procedures for TSI was carried out by our STT. The institutional STT consists of orthopedic spine surgeons and neurosurgeons with specific skills for TSI, ensuring full-time care with a combined team.

A daily meeting is organized to discuss cases and to plan the surgical treatments. The main guidelines underlying the ISTTP underwent an evaluation with Check List Agree II[8] translated by the Italian Group for Evidence-Based Medicine and were reported in [Table 1]. Considering that the clinical outcome can be strongly affected by variability of surgical techniques and medical management, these procedures were standardized and a specific care pathway for TSI was designed. To achieve this goal, meetings were conducted to obtain consensus between the members of the STT and all other medical specialties [Figure 1].

The trauma team assesses a patient with suspected TSI. If the patient is hemodynamically stable, a C0-T4 computed tomography (CT) scan and thoracolumbar X-rays are performed. If the patient is hemodynamically unstable, a whole-body CT scan is performed. In the case of diagnosed TSI, the STT is activated for patient management. A second detailed neurological evaluation is carried out at the end of the primary survey according to the American spinal injury association impairment scale (AIS).

Urgent magnetic resonance imaging criteria consist in progressive neurological deficit, suspected spine ligamentous lesions, and no neurologically evaluable patient.

In the TSI, surgical treatment is performed with the following timing:

- Cervical displacement, any AIS: Urgent early (<12 h)
- Any levels with any worsening AIS: Urgent early (<12 h)
- Any level with B, C, D AIS: Urgent (<24–36 h)
- Any level with stable A, E AIS: Planned (<72–96 h).

To meet the time-sensitive requirements for spinal cord decompression, the ISTTP included the basis for urgent surgery in spinal cord injuries (SCI). In any TSI with B, C, D AIS, or neurological worsening with radiological findings of spinal cord compression a posterior surgery with decompression is performed. All cervical displacements have to be treated with urgent reduction and fixation.

Rehabilitation in spinal unit or intensive care unit (ICU) is started as soon as possible with the aim of discharging the patient a few days after the surgical procedure.

Study population

This study is a retrospective review of consecutive patient's series with any AIS and level TSI surgically treated from January 2017 to December 2020. Pathological vertebral fractures and multiple levels of TSI were excluded from the study. Demographic, clinical, and radiological data were collected. The TSI was classified according to the AO-spine Classification System.[9] Included patients were separated into two groups according to the start of the ISTTP: Group A patients were treated from January 2017 to December 2018 and Group B from January 2019 to December 2020. All patients had a follow-up (FU) for a minimum of 12 months. The two groups were compared with the analysis of five

Table 1: Guidelines for ISTTP.

Guidelines	Purpose of the guidelines used
Guidelines for the management of acute cervical spine and spinal cord injuries: Update (2013)	Assessment of functional outcomes, diagnosis of atlanto-occipital dislocation, cervical subaxial injury classification, diagnosis of vertebral artery injuries, radiographic assessment
Spinal injury: Assessment and initial management - Nice (2016)	Clinical assessment and management at the emergency department, acute stage imaging
A clinical practice guideline for the management of patients with acute spinal cord injury: recommendations on the use of methylprednisolone sodium succinate (2017)	To clarify the appropriate use of methylprednisolone sodium succinate in patients with acute spinal cord injury
A clinical practice guideline for the management of patients with acute spinal cord injury: recommendations on the role of baseline magnetic resonance imaging in clinical decision-making and outcome prediction (2017)	To outline the role of magnetic resonance imaging in clinical decision making in patients with traumatic spinal cord injury
A clinical practice guideline for the management of patients with acute spinal cord injury and central cord syndrome: recommendations on the timing (24 h vs. >24 h) of decompressive surgery (2017)	To standardize the timing of surgical decompression in patients with traumatic spinal cord injury and central cord syndrome
Spinal cord injury research evidence (International spinal cord society) (2020)	To document and classify changes in autonomic neurological function following spinal cord injury

ISTTP: Integrated spine trauma team protocol

critical indicators: (1) Surgical timing (ST) in hours from admission to surgery, (2) intra, peri, and post-operative complications, (3) hospitalization time (HT) in days, (4) mortality, and (5) AIS score improvement.

Statistical analysis

Statistical analysis was performed by Statistical Package for the Social Sciences 28.0. The following descriptive variables were recorded: Average, range, standard deviation, and distribution frequency. Comparisons between the two groups were found using the two-tailed *t*-test and Fisher test. Significance was established for values of $P < 0.05$.

RESULTS

In 4 years, 235 patients with TSI undergoing surgical treatment were enrolled. They were divided in two groups: 102 patients in Group A with 23 cases of SCI and 133 in Group B with 29 cases of SCI. In Group A, there were 62 males and 40 females with a mean age of 42.7 years (range 16–84 years). In Group B, there were 69 males and 64 females with a mean age of 51.9 years (range 14–81 years). Demographic data and characteristics of TSI (level and type) are reported in [Table 2] and in [Table 3], respectively. [Table 4] lists the types of surgical approaches used. No statistically significant differences between the two groups were observed.

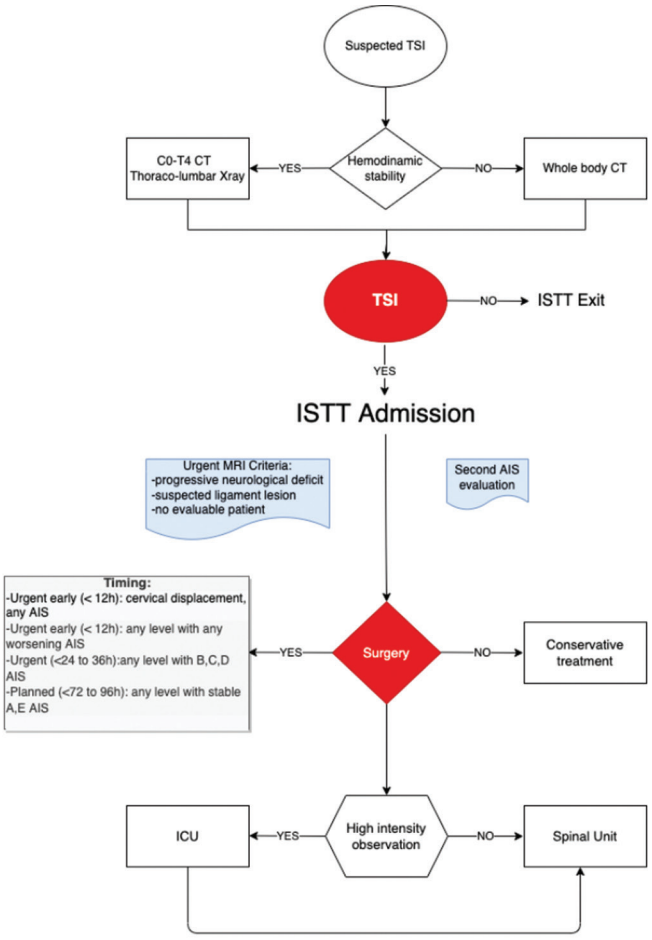

Figure 1: TSIs care pathway flow chart. TSI: Traumatic spinal injuries, CT: Computer tomography, ISTT (protocol): Integrated spine trauma team, AIS: American spinal injury association impairment scale, MRI: Magnetic resonance imaging, ICU: Intensive care unit.

Table 2: Demographics data.

	Group A	Group B	*P*-value
Number of patients	102	134	
Mean age (years old)	42.7	51.9	>0.005
Male	62	69	>0.005
Female	40	65	>0.005
Body mass index (average)	24.1	23.4	>0.005

Table 3: Level and type of traumatic spinal injuries.

	Group A	Group B
Cervical		
Type A	5	3
Type B	7	3
Type C	9	13
Total	21	19
Thoracic		
Type A3	20	20
Type A4	12	25
Type B	6	12
Type C	2	13
Total	40	70
Lumbar		
Type A3	13	22
Type A4	21	18
Type B	2	0
Type C	5	4
Total	41	44

Table 4: Surgical approaches in Group A and Group B.

	Group A	Group B	*P*-value
Cervical			
Anterior % (*n*)	38.09 (8)	36.84 (7)	
Posterior % (*n*)	42.85 (9)	36.84 (7)	0.84
Combined % (*n*)	19.94 (4)	26.31 (5)	
Thoracic			
Antero-lateral % (*n*)	7.5 (3)	9.94 (7)	
Posterior % (*n*)	62.5 (25)	56.8 (40)	0.83
Combined % (*n*)	30 (12)	32.66 (23)	
Lumbar			
Antero-lateral % (*n*)	7.29 (3)	9.08 (4)	
Posterior % (*n*)	68.03 (28)	70.37 (31)	0.88
Combined % (*n*)	24.3 (10)	20.45 (9)	

The mean value of ST in Group A was 144.54 h versus 73.51 h in Group B ($P < 0.005$). In Group A, the overall complication rate was 12.7% with six cases of superficial wound infection treated with antibiotic therapy and three cases of deep wound infection that required surgical treatment. Four patients needed revision surgery, one for a mispositioned transpedicular screw and three for mechanical failure. In Group B, the complication rate was lower (6.8%) with eight wound infections of which six non-surgically treated and a single case of mechanical failure.

These indicator outcomes highlighted a significant difference between the two comparison groups ($P < 0.05$). Regarding the HT and the mortality, no significant difference was recorded ($P = 0.065$ and $P = 0.061$ respectively). However, patients in Group B had a lower HT: 26.15 days versus 30.15. A significant improvement in the neurological status was observed in group B ($P < 0.05$). The data are reported in [Table 5].

DISCUSSION

In recent years, spine surgery has increased in popularity. However, there is no well-defined specialty and surgery is generally performed by neurosurgeons or orthopedics individually.[5,6] As technology has advanced, surgical choices have become much more complex. Resource utilization can be influenced by a number of different factors related to the surgeon's preferences and experience. Neurosurgeons and orthopedic spinal surgeons have different experiences and expertise.[10] The first is traditionally more skilled in microsurgery and decompression of nervous structures, while the second is generally skilled in biomechanics with expertise in spine reconstruction and fixation.

There is a wide overlapping of interest and competence in the field of spinal trauma and management of SCI. Management of spinal trauma is a complex and rapidly evolving field. The surgical treatment in TSI is characterized by challenging procedures often associated with high rates of intraoperative and perioperative morbidity (wound infection, neurological injury, and mechanical failure).[11,12]

Literature well describes that standardized systematic protocols and multidisciplinary approaches across surgical disciplines can reduce complication rates.[13-15] In Europe, the number of new combined spine units with neurosurgeons and orthopedics has increased mostly because of the need to provide adequate care for a large variety of spinal diseases and procedures.[1]

Furthermore, there are no studies on the effect of systematic collaboration between orthopedic surgeons and neurosurgeons in the management of TSI. The authors describe the first Italian experience of an integrated spine team in the field of trauma, with a protocol that standardizes a pathway from diagnosis to surgery. According to our ISTTP, every procedure is performed using a neurosurgical and orthopedic combined team. The main goal of the ISTTP was to improve the management of TSI relating to ST, complications, HT, mortality, and AIS score.

It is well described that early spinal fixation is related to a substantial reduction in ICU length of stay, occurrence of pneumonia, and pain caused by spinal instability. ST is essential for an early mobilization of the patients and to provide an adequate critical care, pulmonary recovery, physical therapy, and rehabilitation.[16-20] Moreover, the progressive effect on neurologic result has been broadly demonstrated.[21,22] Rotter *et al.* in their review of the effects of pathways on a clinical practice described a significant reduction in the complication rate associated with their introduction.[23]

Deckey *et al.*[7] in their study of 34 young patients affected by L5-S1 high-grade spondylolisthesis and treated by a combined orthopedic and neurosurgeon team reported a reduction in the occurrence of nerve injury and other complications compared with historically reported data.

Sethi *et al.*[6] showed that a systematic multidisciplinary approach (Seattle Spine Team Protocol) can improve quality and safety in complex spine surgery, specifically in the management of adult deformity. They described a significant reduction of the mortality rate and perioperative complications such as cardiovascular events, implant failures, and wound infection.

The report of our findings suggests that risk mitigation and quality improvement strategies yielded a statistically significant decrease in surgical complications in the first 12 months after surgery. The study reported reductions in the rate of deep wound infections, mechanical failures, and revision surgery.

HT is the most employed clinical and economic outcome measure to analyze the effectiveness of the new care pathway and most studies report a positive impact also considering hospital charges.[23]

Our study shows a lower HT and mortality in the ISTTP group without statistical significance. It is worth noting

Table 5: Five critical indicators.

	Group A	Group B	*P*-value
ST (hours)	144.54 (12–480)	73.51 (2–320)	<0.005
Complication rate	12.7%	6.8%	<0.005
HT (days)	30.15 (3–90)	26.15 (2–85)	0.065
Mortality rate	4.9%	3%	0.061
AIS score improvement rate	17.3%	25.8%	<0.005

ST: Surgical time, HT: Hospitalization time, AIS: American spinal injury association impairment

that HT is also influenced by the institutional context and reflects hospital practices. Results from this report suggest that ISTTP is related with favorable findings (reduced ST, complications and mortality rate, significant improvement of the neurological status) without increasing HT. The main limitations are the monocentric retrospective design, the small size, and the short FU.

CONCLUSION

To achieve safe and high-quality spine care in the TSI, a multidisciplinary STT must function in a highly integrated manner from the diagnosis to the surgical treatment. We believe that optimizing perioperative spine trauma surgery processes can improve the outcome and minimize the risk of complications. In the authors' opinion, this study can help the improvement of health-care quality and practice with a particular focus on the management of the TSI.

We must continue to refine our ISTTP, further studies will be necessary to confirm our preliminary results to support the strategic relevance of STT in the management of these injuries.

Declaration of patient consent

The authors certify that they have obtained all appropriate consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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