Post-Traumatic Vertebral Injuries

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ABSTRACT

Introduction: Spinal injuries are common among young adult men. Recognizing kinematics can help reduce the number of late diagnoses, especially if there are consciousness disorders. Vertebral fractures can be single or multiple, and they are often associated with extravertebral injuries. **Objectives:** To examine the distribution of the lesion based on the mechanism of production, to characterize the neurological condition, to evaluate the lesion pattern and its relationship with extravertebral lesions, and to analyze the treatment. **Materials and Methods:** This was a multicenter, prospective study of patients admitted with post-trauma vertebral injuries between July 1, 2018 and June 30, 2020. Age, gender, kinematics, neurological condition, affected sector, pattern of injury, and associated extravertebral injuries were all examined. **Results:** There were 281 patients (60% men) evaluated, with 400 vertebral and 118 extravertebral lesions. The causes were as follows: polytrauma in 62 cases, falls from great heights in 147 patients, and traffic accidents in 98. ASIA E was the most frequently observed neurological picture (8 cases), which was not determined at admission. The T2-L5 sector was the most affected, mostly by compression injuries. Head and chest trauma were the most common extravertebral injuries; there was one case of SCIWORA and one early death. **Conclusions:** The most commonly affected spinal sectors were thoracolumbar, thoracic, and lumbar; the injuries are typically caused by falls from great heights and, in general, are isolated, with no neurological injuries. The treatment is determined by the stability and neurological condition.

Keywords: Spine; trauma; fracture; kinematics; vertebral fracture; spinal injury.

Level of Evidence: IV

Lesiones vertebrales postraumáticas

RESUMEN

Introducción: Las lesiones raquídeas son frecuentes en hombres adultos jóvenes. Reconocer la cinemática ayuda a disminuir la tasa de diagnósticos tardíos, principalmente si hay trastornos de la conciencia. Las fracturas vertebrales pueden ser únicas o múltiples, y asociarse con lesiones extravertebrales. Los objetivos de este estudio fueron analizar la distribución de la lesión según el mecanismo de producción, caracterizar el cuadro neurológico, evaluar el patrón de lesión y la asociación con lesiones extravertebrales, y analizar el tratamiento. **Materiales y Métodos:** Estudio multicéntrico, prospectivo de pacientes con lesiones vertebrales postrauma, que ingresaron entre el 1 de julio de 2018 y el 30 de junio de 2020. Se analizaron los siguientes parámetros: edad, sexo, cinemática, cuadro neurológico, sector afectado, patrón de lesión, lesiones extravertebrales asociadas. **Resultados:** Se evaluó a 281 pacientes (60% hombres) con 400 lesiones vertebrales y 118 extravertebrales que, en 62 casos, conformaban un cuadro de politraumatismo; 147 con trauma por caída de altura y 98, por accidente de tránsito. El cuadro neurológico más observado fue ASIA E (8 casos), no determinado al ingreso. El sector T2-L5 fue el más afectado, en su mayoría, por lesiones por compresión. Las lesiones extravertebrales más frecuentes fueron el trauma de cráneo y de tórax; hubo un caso de SCIWORA y un

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óbito temprano. **Conclusiones:** Los sectores raquídeos más afectados fueron: el toracolumbar, el torácico y lumbar; las lesiones suelen deberse a caídas de altura y suelen ser únicas, sin un cuadro neurológico. El tratamiento se decide según la estabilidad y el cuadro neurológico.
Palabras clave: Columna; trauma; fractura; cinemática; fractura vertebral; lesión vertebral.
Nivel de Evidencia: IV

INTRODUCTION

Spinal cord injuries are a major cause of morbidity and mortality among young people, accounting for 60% of injuries in people <40 years of age. The risk of suffering from this type of injury is higher in the male sex.[1,2]

The reported incidence of spinal cord injuries in the general population is 64 people per 100,000 inhabitants. However, it is distributed disproportionately throughout the world, and the incidence is higher in developing countries than in more developed nations, due to changes in the automotive industry. Severe injuries to the spine, particularly to the upper cervical region, are often fatal, while those involving the spinal cord often result in permanent disability.[3,4]

Recognizing the kinematics of a spinal trauma can help determine the type of injury suffered by the patient upon admission. The first lumbar vertebra (L1) is the most frequently injured vertebral level, followed by the adjacent thoracic vertebra (T12), in motorcycle accidents.[3] In addition, motorcyclists are more likely to sustain a serious spinal injury when they hit an object directly than if they hit the ground directly during an accident.[3]

In epidemiologic studies, accidental falls have been shown to be the most common cause of spinal fractures, while motor vehicle injuries rank second.[2]

Accurate evaluation and classification of spinal fractures are very important for making appropriate treatment decisions. To facilitate this, in addition to the AOSpine thoracolumbar classification system, Verheyden et al. took into account morphological modifiers such as vertebral alignment, spinal canal stenosis, vertebral body comminution, and intervertebral disc injury.[5]

Associated injuries, such as head trauma or thoracic injuries, can significantly influence the prognosis of spinal cord injuries.[1]

The objectives of this study were to analyze the distribution of the injuries according to the mechanism of production, to characterize the neurological condition, to evaluate the injury pattern and the association with extravertebral injuries, and to analyze the treatment guidelines.

MATERIALS AND METHODS

A multicenter, prospective case series study involving patients admitted with traumatic spinal injuries between July 1, 2018, and June 30, 2020, was carried out. The study was approved by the ethics committee of the main hospital.

The following variables were analyzed: age, sex, seasonal variability, neurological condition on admission, kinematics, affected sector, vertebral injuries and initial treatment, and extravertebral injuries.

The exclusion criteria were: age <15 years, pathological or low-energy vertebral fracture, history of spinal surgery.

The ASIA (American Spinal Injury Association) scale was used to assess the neurological condition, and the AOSpine system was used to classify the injury's morphology and neurological status.[6-8]

In order to analyze the kinematics, four general groups were determined: 1) traffic accident, 2) fall from height, 3) sports trauma and 4) direct trauma.

Initially, injuries were grouped by sector: 1, high cervical (C0-C2); 2, low cervical (C3-C7); 3, cervicothoracic (C7-T1); 4, thoracic (T2-T9); 5, thoracolumbar (T10-L2); 6, lumbar (L3-L5) and 7, sacrum. In addition, cases of a single or multiple vertebral injury pattern were analyzed.

Extravertebral injuries were grouped into: 1, head trauma; 2, facial trauma; 3, thoracic trauma; 4, upper limb; 5, abdomen; 6, pelvis and 7, lower limb. Tables such as SCIWORA (*Spinal Cord Injury without Radiologic Abnormality*) and deaths in the first 72 hours were recorded.

The aforementioned variables were analyzed with the EpiInfo® V7 program.

RESULTS

In this study, 17 Latin American centers participated: 10 from Argentina, four from Paraguay, one from Chile, one from the Dominican Republic and one from Uruguay.

281 patients were included, 113 women and 168 men, with an average age of 45.63 years (range 15-90), who had 400 spinal injuries. 54.8% were Argentines, 35.2% were Chileans, 8.54% were Paraguayans, 1.07% were Dominicans, and 0.36% were Uruguayans. In the variables examined, no statistically significant differences were discovered.

The age group 45 to 60 years was the most affected (86 cases), but this was not statistically significant (Figure 1). The highest amount of admissions was recorded between November and February of both years of the study (Figure 2).

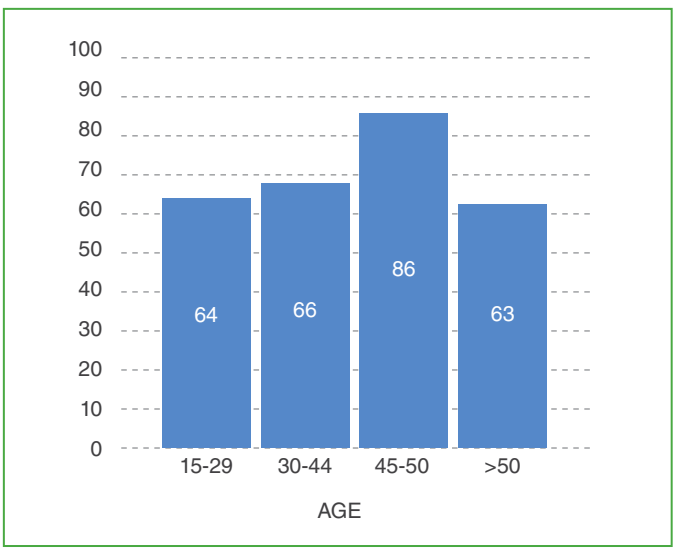

Figure 1. Distribution by age of trauma patients.

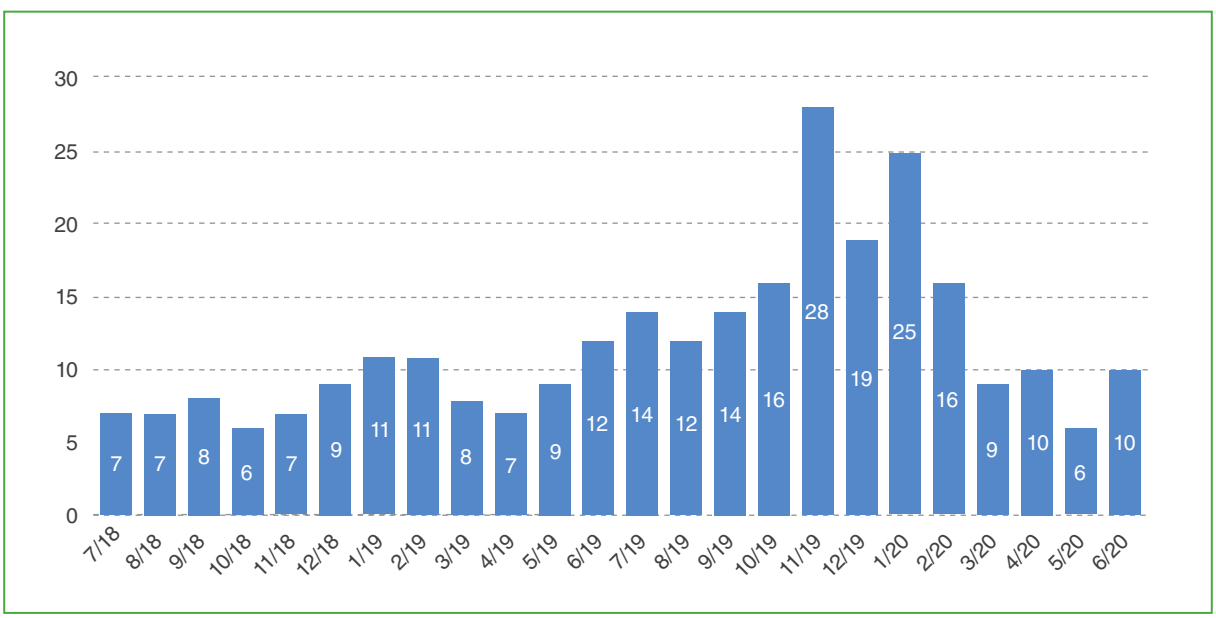

Figure 2. Number of admissions per month from July 2018 to June 2020.

The most frequent neurological condition was ASIA E in 244 patients, followed by a complete injury (12 cases); in eight patients, baseline neurological status could not be determined due to disturbances of consciousness or hemodynamic compromise (Figure 3).

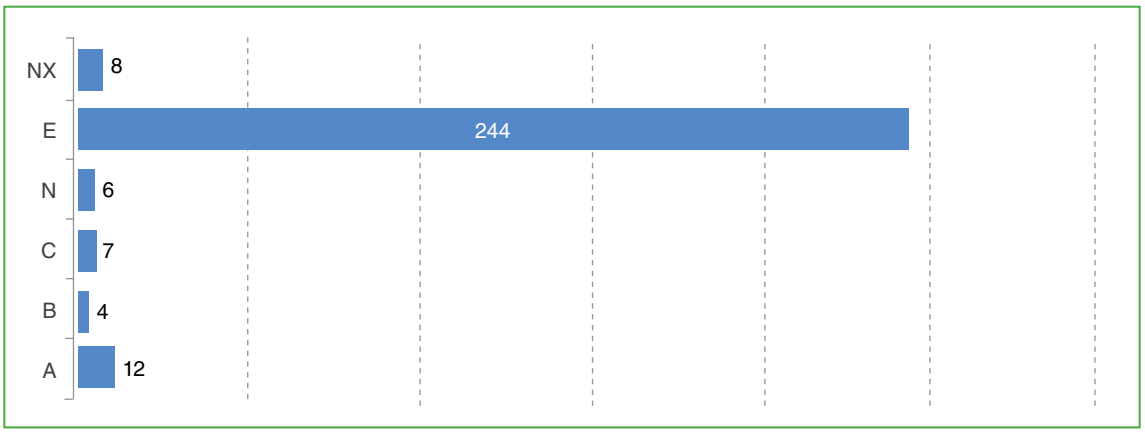

Figure 3. Neurological chart of 281 patients upon admission.

The most frequent kinematic causes were falls from a height (147 injuries) and traffic accidents (98 injuries); and both compromised, to a large extent, the thoracolumbar sector (Figure 4), which was the most affected (266 lesions), followed by the thoracic (76 cases) and lumbar (40 cases), which made up a global sector of 372 injuries (Figure 5).

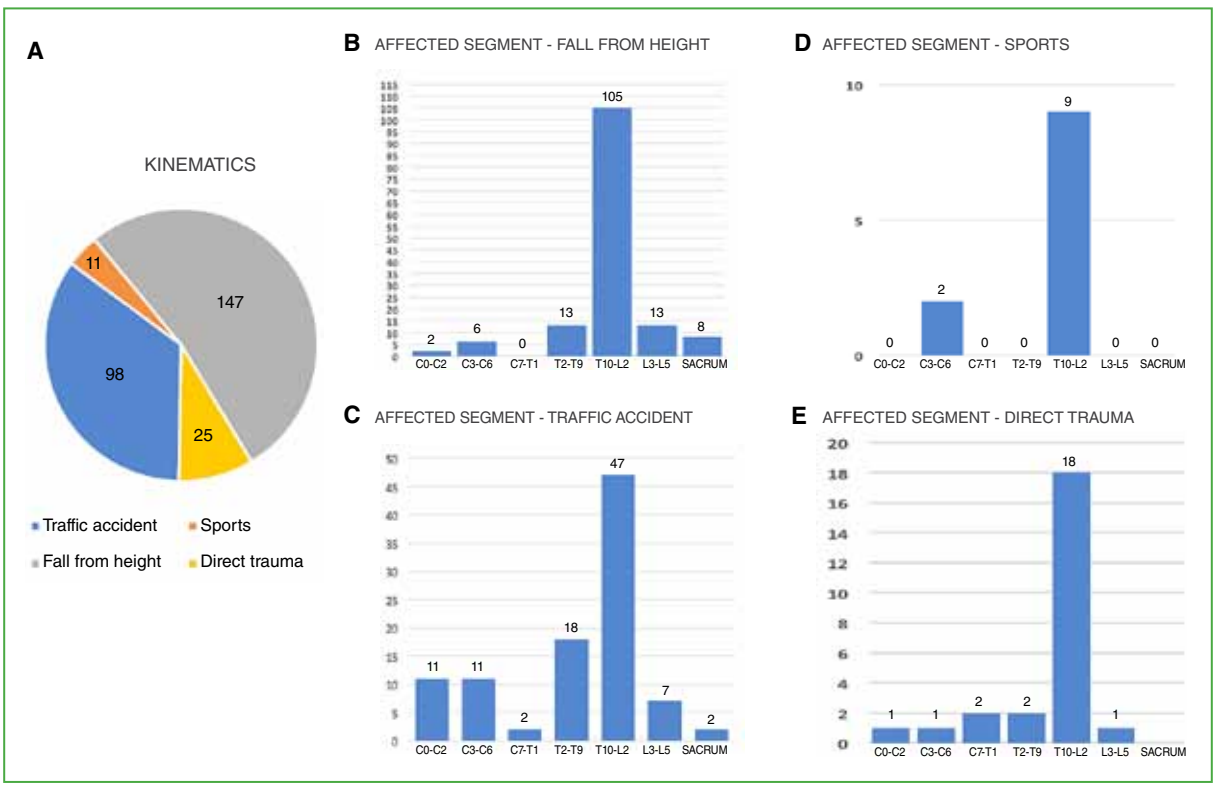

Figure 4. Relationship between the mechanism of action and vertebral lesions. **A.** Kinematic distribution. Distribution of injuries caused by traffic accidents (**B**), falls from a height (**C**), sports trauma (**D**) and direct trauma (**E**).

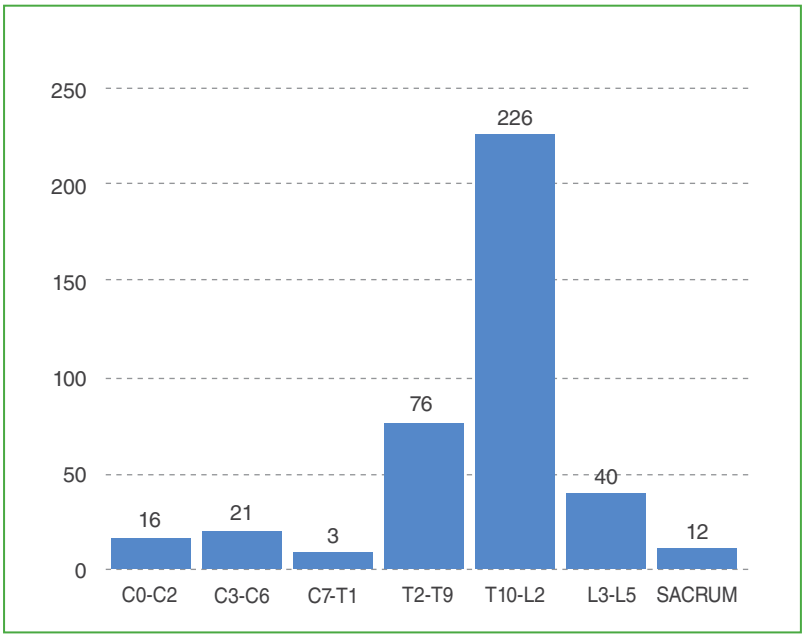

Figure 5. Distribution of vertebral lesions.

A total of 217 patients had single spinal injuries, 56.74% due to falls from a height. Sixty-four had multiple spinal injuries (p 0.0576) and the most frequent association was thoracolumbar-thoracolumbar (16 cases) and thoracic-thoracic (8 cases) (Figure 6); 48.48% occurred due to traffic accidents and 40.91% due to falls from a height.

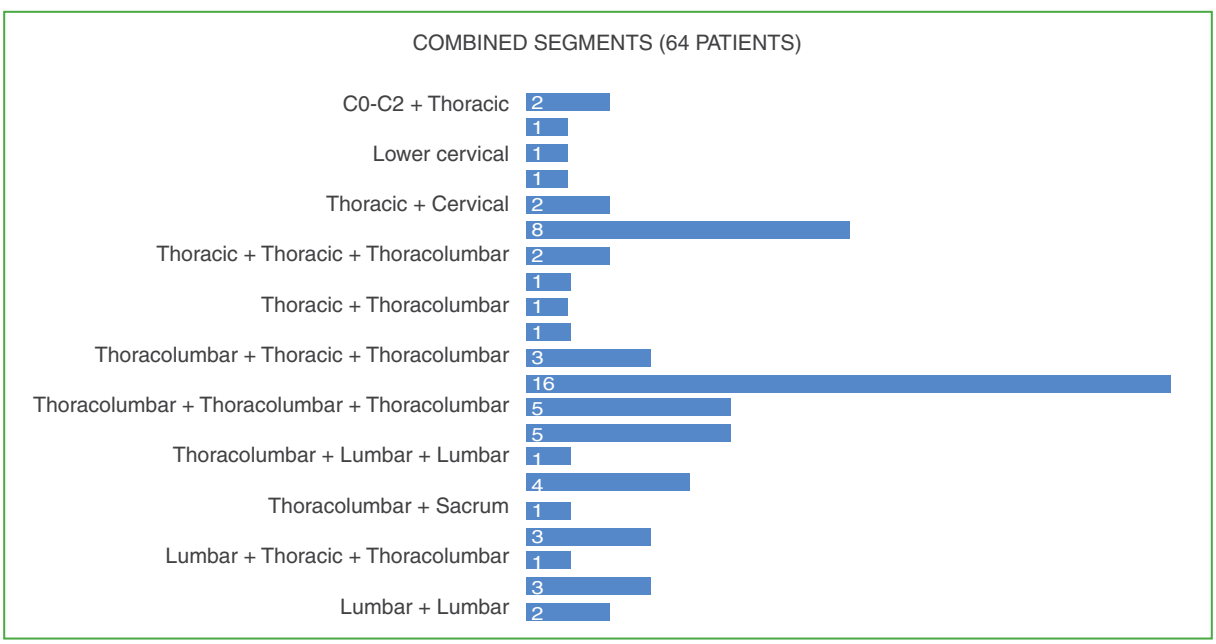

Figure 6. Association pattern of multiple vertebral lesions.

When analyzing the thoracic, thoracolumbar, and lumbar regions grouped together (T2-L5), type A1 injuries were the most frequent, followed by burst fractures. In patients with type B fractures and compression fractures of the vertebral body, the most frequent type of secondary injury was also the A1 fracture.

Conservative treatment was prescribed for 129 patients with stable injuries, while 122 underwent surgery due to unstable injuries or neurological deficits (Figure 7).

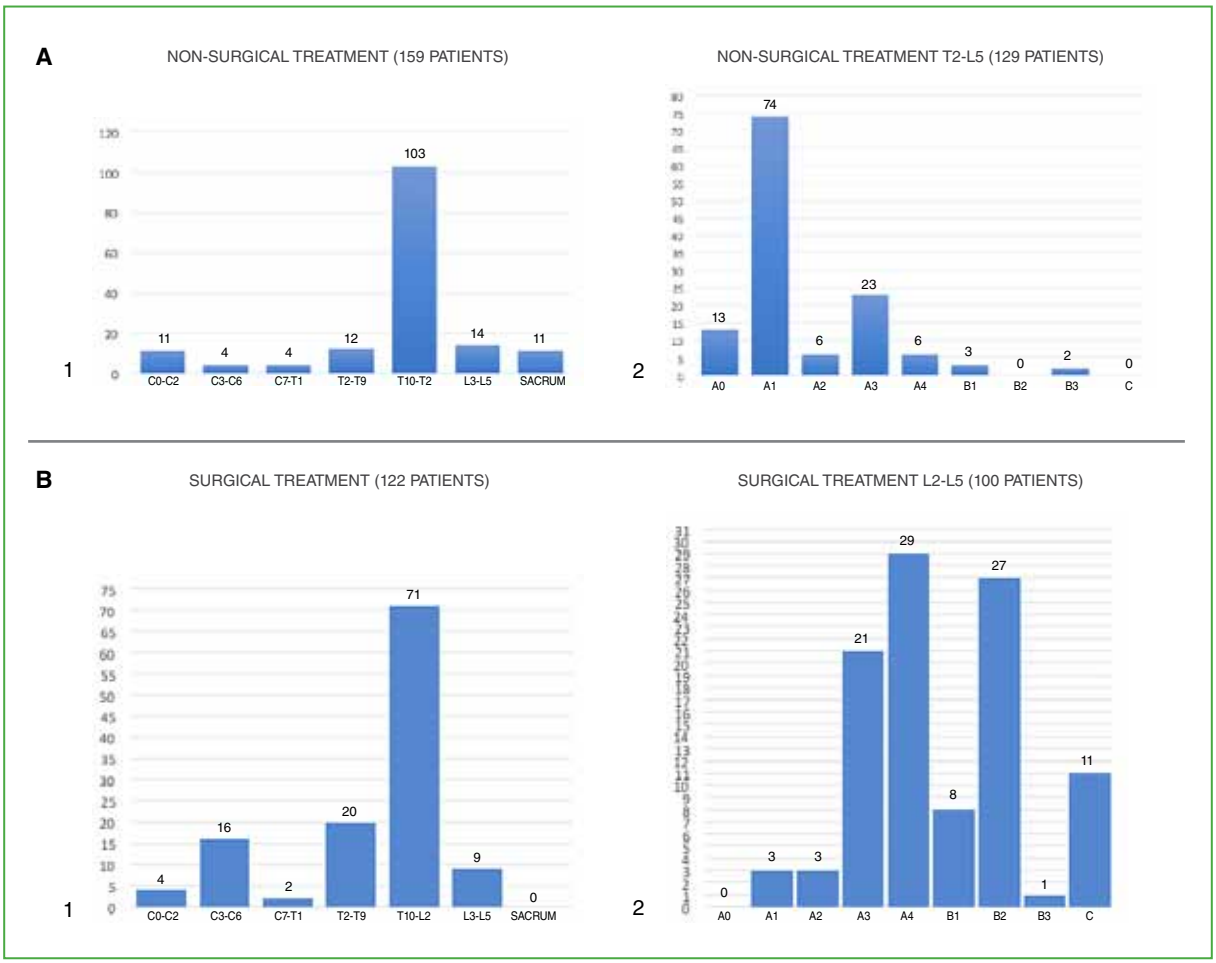

Figure 7. Therapeutic decision and type of injury. **A.** Non-surgical treatment. **B.** Surgical treatment **1.** Distribution of lesions in both treatments. **2.** Type of lesion in the T2-L5 region.

Eighty-two patients presented with 118 extravertebral injuries associated with vertebral injuries, with 61 exhibiting polytrauma symptoms. The most common injuries were head trauma (26 cases) and thorax (22 cases); once again, T2 to L5 trauma was associated with the highest percentage of these injuries (Figure 8).

44.19% of patients who suffered associated injuries were involved in traffic accidents, and 41.86% were involved in a fall from a height (p 0.06), but if only cases with a polytrauma diagnosis are considered, 50.82% were involved in traffic accidents (p 0.016).

Having two or more simultaneous spinal injuries was associated with the presence of associated injuries. However, this relationship was not statistically significant (Fisher 2-tailed p = 0.3; OR = 1.8).

One case of SCIWORA was detected and one death occurred in the first 72 hours.

Short-term adverse events were: increased kyphosis in one patient after the first radiographic control, which led to changing the therapeutic decision, and two cases of surgical site infection.

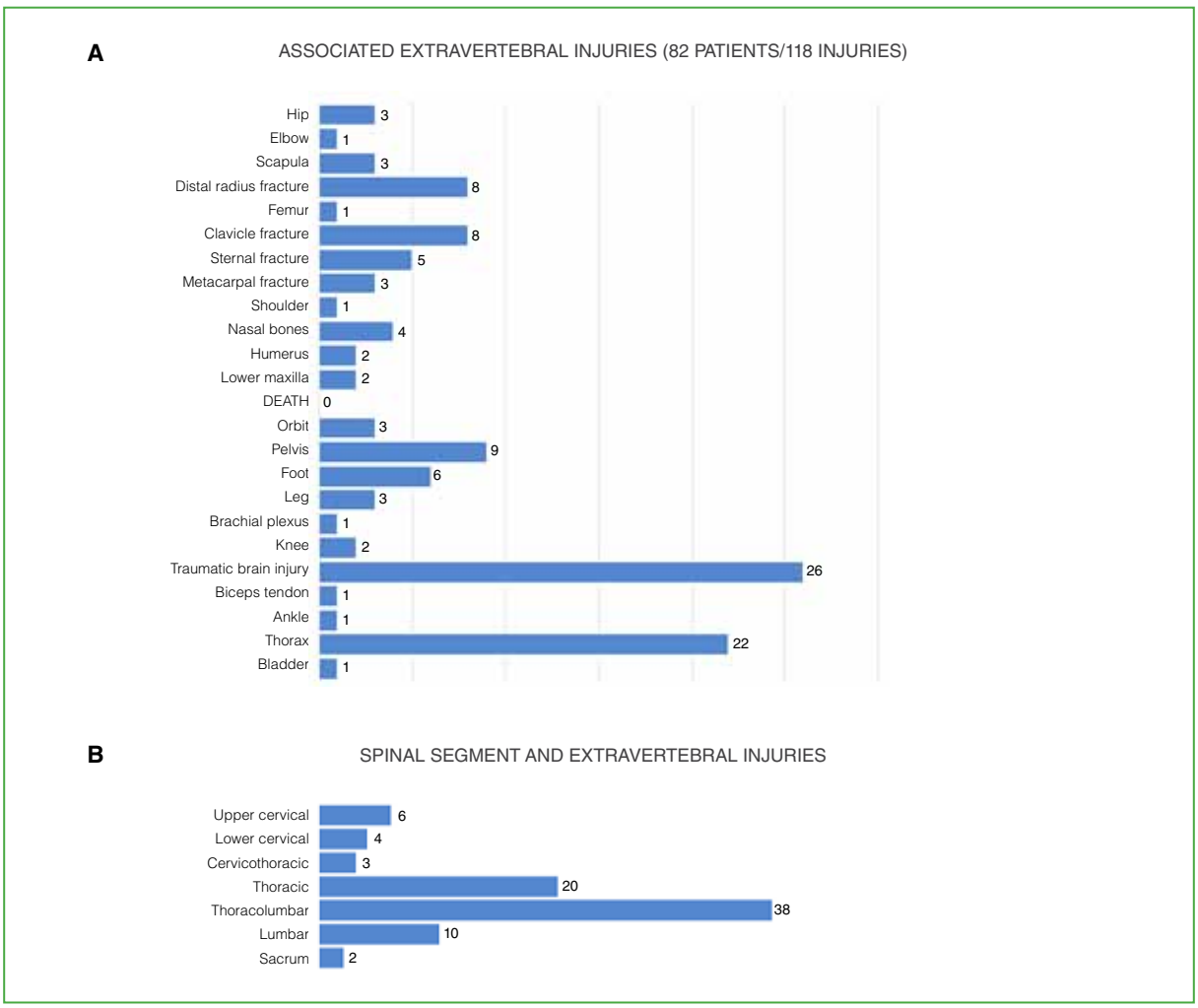

Figure 8. Relationship between vertebral and extravertebral lesions. **A.** Distribution of extravertebral lesions. **B.** Vertebral sector associated with extravertebral injuries.

DISCUSSION

Traumatic injury is the leading cause of death and morbidity in the adult population. 60% of spinal cord injuries occur in people <40 years of age, and they are more frequent in men.[9-11]

These injuries can be aggravated by the risk of neurological deficit in the short and long term.[12] In our study, 49% had no associated injuries on admission, and 32% of them had a mild or moderate neurological status (Frankel D and E). It is important to recognize spinal cord injuries, including SCIWORA, in adults, as they can result from high- or low-energy trauma and be missed on radiographs.

Magnetic resonance imaging is the diagnostic study of choice. In these patients, the probability of neurological recovery is related, in the first instance, to the initial injury, the diameter of the canal, the age, the extension of the lesion and the severity of the neurological symptoms.[13] Therefore, surgery is not the gold standard treatment.[14]

Understanding the factors that contribute to spinal injuries is critical to preventing them.[1] In this series, 13 patients rode motorcycles or quadricycles of different displacements, and none wore a helmet. Kuo et al. highlight the protective effect of helmets, the mortality rate is significantly lower among motorcyclists who wear a helmet.[15]

The injuries that caused the most neurological compromise (Frankel A) occurred in the cervical sector (90%), with only the thoracolumbar and lumbar sectors being compromised in 10% of the cases. When describing the

topography of vertebral injuries based on the mechanism of injury, the cervical spine was the most common location in patients involved in traffic accidents. The thoracolumbar spine was the predominant topography of those who had a fall from a great height. This agrees with the study by Zileli et al. who described that the most frequent mechanism of cervical spine trauma is traffic accidents (39.5%), followed by falls (38%). However, there are differences between the various regions, for example, falls are the most common mechanism in low-income countries (54%) and sports-related injuries are rare in these countries (2.1%).[16]

Seat belts and airbags reduce thoracic and lumbar injuries, but they are frequently associated with cervical injuries.[17] Only 29% of patients who suffered cervical spine trauma as a result of a traffic accident wore a seat belt.

When treating these patients, it is important to evaluate the entire spine and look for associated injuries.[18] In our study, patients with vertebral fractures in the presence of associated non-vertebral injuries were classified as polytraumatized. This is consistent with the findings of Driessen et al., who report that a percentage of spinal trauma is associated with polytrauma.[19] The current definition of polytrauma refers to patients who have multiple injuries and are at high risk of death. The definition includes lesions with an AIS score ≥3 in two or more body regions combined with the presence of one or more physiologic risk factors, such as age, Glasgow Coma Scale, hypotension, acidosis, and coagulopathy.[19] One of the diseases that should be suspected when a patient with polytrauma is admitted is ankylosing spondylitis, as it is a risk factor for spinal fractures. In a retrospective multicenter study of a case series with six patients who suffered a fall from a height, it was observed that these types of patients have a higher risk of suffering a thoracolumbar fracture due to low-energy trauma.[20]

Other injuries that were associated with spinal cord trauma in this study were chest and head injuries. This coincides with what has been published in the current literature, an incidence between 20% and 57%.[12] 25-50% of patients with traumatic spinal cord injuries have an associated brain injury. It is extremely important to recognize associated injuries during the primary review of patients with spinal trauma, since associated non-vertebral injuries can significantly influence the prognosis of these patients.[1,21,22] According to recent studies, the mechanism of injury is an independent determinant of death after trauma. In other series, the mortality rate was higher in patients who suffered traffic accidents than falls from height.[2]

There is a relationship between spinal injuries and sports.[23,24] In our series, the percentage of patients with a history of sports trauma as a mechanism of spinal cord injury was lower compared to those who suffered falls from a height, traffic accidents, and direct trauma. These injuries usually occur due to inexperience and poor knowledge of the inherent dangers of the sport, inadequate training and practice facilities, and lack of supervision, protective equipment and strict refereeing.[20,23] Cantu et al. reported that teaching game skills and improving medical care both on and off the field of play reduced permanent spinal cord injuries in American football by 270%.[25]

The use of safety elements, such as a belt, a helmet, and a harness when working at heights, is a fundamental measure for the prevention of spinal injuries.[1] Traffic accidents caused the majority of spinal injuries in a study by Bazán et al.[10] Road accidents have a multifactorial etiology; however, driver behavior is one of the most important factors. Other influencing factors are: vehicle safety and improvements in road infrastructure. Minimum vehicle safety standards and the implementation of breathalyzer tests for drivers have reduced the number of fatalities from traffic accidents.[1]

The correct assessment of the morphology of a spinal fracture depends on an accurate diagnosis[14] based on the new AOSpine Thoracolumbar Classification System and morphological modifiers implemented by the German Orthopedics and Trauma Society in 2017.[5] This classification helps to understand the degree of instability and to determine the various therapeutic alternatives.[5] Although these modifiers were not exposed in our study, they are taken into account when deciding on treatment in clinical practice.

CONCLUSIONS

In general, the thoracolumbar sector is the most affected by a traumatic injury, followed by the thoracic and lumbar. The most frequent mechanism of action is a fall from height, followed by traffic accidents; the thoracolumbar sector is the most compromised regardless of the kinematics.

The majority of vertebral injuries are isolated compression injuries; cases of multiple vertebral injuries are frequently associated with extravertebral injuries and, in a large percentage of cases, comprise a picture of polytrauma.

The prevalent neurological condition is the pattern without neurological injury; there are cases that cannot be classified when the patient is admitted and this increases the risk of diagnostic error.

Conservative treatments were indicated for patients with stable bone lesions and surgery was reserved for those with bone or osteoligamentary lesions or neurological deficits.

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