Multiple Vertebral Fractures

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ABSTRACT

Background: Multiple vertebral fractures (MVF) are the result of high-energy trauma. These can be contiguous (CMVF) when there is a fracture of two or more vertebral bodies in an adjacent way and non-contiguous (NCMVF) when there are lesions of various levels separated by at least one vertebra without injury. **Objective:** To evaluate clinical features and kinematics, establish distribution, evaluate association with extra-vertebral injuries, detail complications. **Materials and Methods:** A multicenter, prospective, and observational study. Patients with MVF. **Results:** Sixty-six patients presented 196 vertebral lesions, without neurological deficit in 55; 26 were women and 40 were men, with an average age of 39 years old. Kinematics: 32 car accidents, 27 falls from height, 5 direct traumas and 2 sports traumas. Topography: 2 C0-C3, 4 C3-C7, 8 C7TT1, 61 T1-T10, 91 T10-L2, 28 L2-L5 and 1 sacrum. Combination: 21 thoracolumbar-thoracolumbar and 8 thoracic-thoracic. There were 32 contiguous injuries, 19 non-contiguous injuries, and 15 mixed-pattern injuries. Twenty-six patients presented 47 extra-verterbral injuries (20 multiple trauma, 12 thoracic trauma). 36 patients received non-surgical treatment and 30 patients underwent surgery. **Conclusion:** The presence of MVF in spinal cord trauma is frequent, most do not show neurological involvement and are consequences of motor vehicle accidents. The most affected sector was between T2 to L5, the most frequent combination was thoracolumbar-thoracolumbar, followed by thoracic-thoracic; the most frequent were extra-vertebral injuries, mainly head and chest trauma. Complications: one patient had increased kyphosis; one, surgical site infection; and one patient died.

Key words: Spine; trauma; vertebral injuries; associated injuries; kinematics; injury pattern.

Level of Evidence: IV

Fracturas vertebrales múltiples

RESUMEN

Introducción: Las fracturas vertebrales múltiples son el resultado de traumatismos de alta energía. Se clasifican en contiguas cuando hay fractura de dos o más cuerpos vertebrales en forma adyacente y no contiguas cuando hay lesiones de varios niveles separadas por, al menos, una vértebra sin lesión. **Objetivos:** Evaluar la clínica y la cinemática de las fracturas vertebrales múltiples, establecer su distribución, evaluar la asociación con lesiones extravertebrales y detallar las complicaciones. **Materiales y Métodos:** Estudio multicéntrico, prospectivo y observacional de pacientes con fracturas vertebrales múltiples. **Resultados:** 66 pacientes (26 mujeres y 40 hombres; promedio de edad 39 años) con 196 lesiones vertebrales, 55 no tenían déficit neurológico. Cinemática: 32 accidentes automovilísticos, 27 caídas de altura, 5 traumas directos y 2 traumas deportivos. Topografía: dos C0-C3, cuatro C3-C7, ocho C7-T1, 61 T1-T10, 91 T10-L2, 28 L2-L5 y una sacro. Combinación: 21 toracolumbar-toracolumbar y 8 torácica-torácica. Treinta y dos fracturas eran contiguas; 19, no contiguas y 15 tenían un patrón mixto. Veintiséis pacientes presentaron 47 lesiones extravertebrales (20 politraumatismos), 12 traumas torácicos. Treinta y seis pacientes recibieron tratamiento conservador y 30 fueron operados. **Conclusiones:** La presencia de FVM es frecuente y son consecuencia de accidentes automovilísticos, la mayoría de los pacientes no tiene compromiso neurológico. El sector más afectado fue entre T2 y L5, la combinación más frecuente fue toracolumbar-toracolumbar, seguida de torácica-torácica. Las lesiones extravertebrales más frecuentes fueron traumatismos de cráneo y de tórax.

Palabras clave: Columna; trauma; lesiones vertebrales; lesiones asociadas; cinemática: patrón de lesión.

Nivel de Evidencia: IV

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INTRODUCTION

More than one concomitant traumatic vertebral fracture may occur. Since the 1970s, studies have been published with numerous patients, describing patterns of association of vertebral fractures.[1] They are usually due to a fall from height or a traffic accident[2] and, depending on the number of uninjured vertebrae between the affected bodies, they are usually classified into contiguous and non-contiguous injuries. Up to 20% of patients with a vertebral fracture may suffer a concomitant non-contiguous injury;[3] therefore, it is imperative to evaluate the entire spine to avoid omission of diagnosis or late diagnosis in the event of the appearance of a traumatic vertebral fracture. The presence of multiple vertebral fractures can modify the therapeutic decision, mainly if the injuries are not contiguous.[4]

The objectives of this study on multiple vertebral fractures were to analyze the incidence rate, evaluate the clinical aspects and kinematics, establish the distribution, distinguish the treatment options, evaluate the association with extra-vertebral injuries, and detail the complications.

MATERIALS AND METHODS

A multicenter, prospective, observational, cross-sectional cohort study was conducted that included patients who had suffered trauma with more than one vertebral fracture. The exclusion criteria were: pathological fractures, previous surgery, and osteoporosis. Sex, age, neurological status, kinematics, spinal injury and extra-vertebral injury, and complementary studies were recorded. Vertebral fractures were classified according to the AOSpine classification.[5-7]

For the statistical analysis, the IBM SPPS 20®program was used. The chi-squared and Student's tests were applied for the dependent variables.

RESULTS

We included 66 (23.49%) of 281 patients with vertebral fractures (196 vertebral injuries) who were admitted to 15 centers in different parts of Latin America, between July 1, 2018, and June 30, 2020. The group consisted of 26 women and 40 men, with an average age of 39 years (range 15-82). The most frequent neurological level of injury was ASIA E in 55 cases; in five patients it was not possible to determine it due to an altered state of consciousness or hemodynamic alterations (NX of AO classification) (Figure 1).

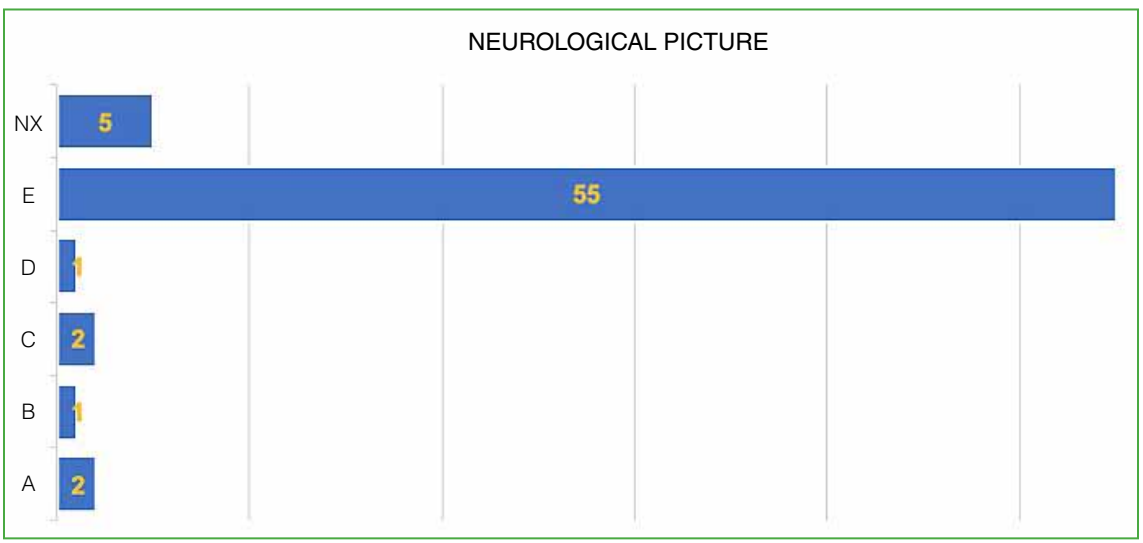

Figure 1. Distribution according to the neurological picture. NX = nonassessable. A-E = Neurological classification of spinal cord injury according to the score of the *American Spinal Injury Association* (ASIA).

The most indicated complementary examinations were computed tomography and magnetic resonance imaging, the latter evidenced A1 lesions unnoticed by tomography on 15 occasions.

Thirty-two patients had been in a car accident; 27 had suffered falls from height; five, direct trauma; and two, sports trauma.

According to the topographical distribution, two injuries were located in the upper cervical spine; four, in the lower cervical spine (C3-C7), eight were cervicothoracic (C7-T1), 61 were thoracic (T2-T9); 91 were thoracolumbar (T10-L2); 28 were lumbar (L3-L5), and one was sacral. The combination of thoracolumbar-thoracolumbar injuries (the main injury and the associated injuries are in the thoracolumbar segment) was detected in 21 cases whereas thoracic-thoracic injuries (both the main injury and the associated injuries are in the thoracic segment) were found in eight cases (Figure 2).

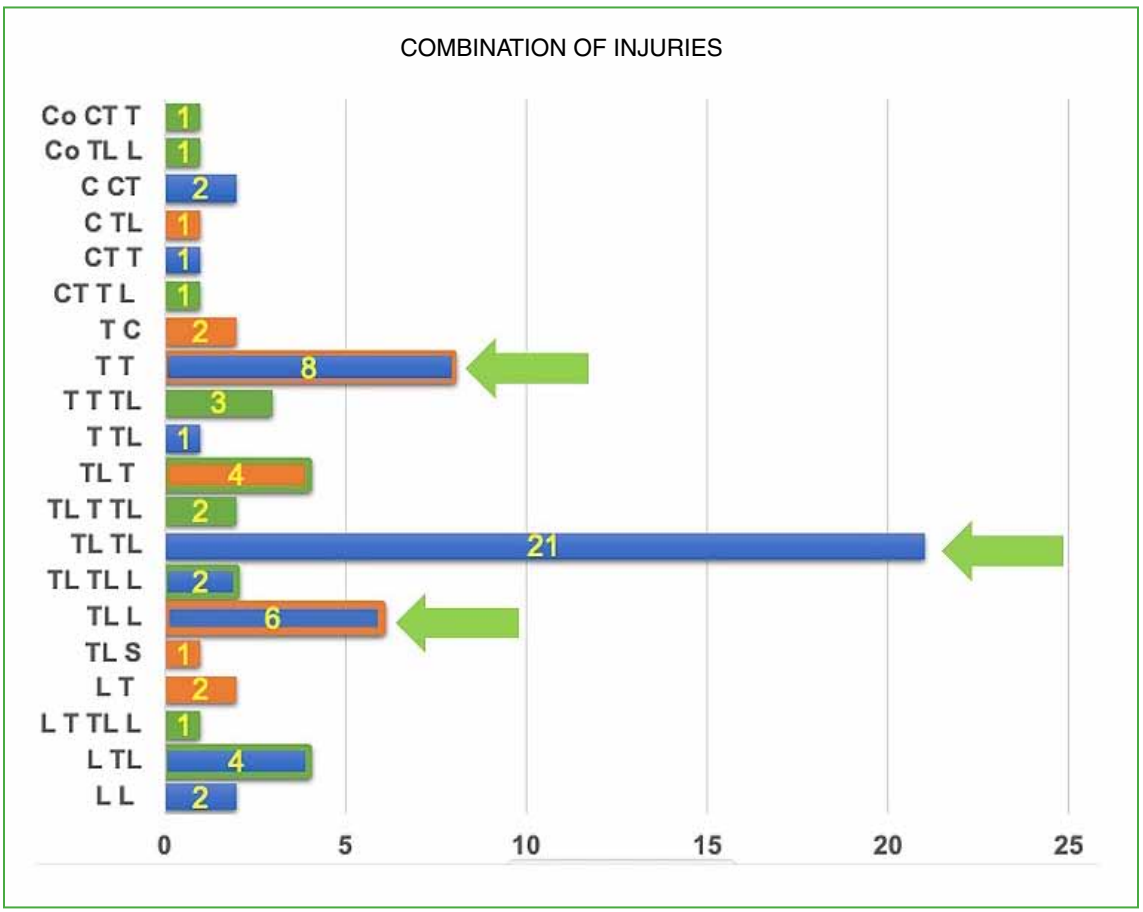

Figure 2. Distribution of injuries according to the vertebral segment. They are distinguished by color: blue for contiguous injuries, orange for non-contiguous injuries, and green for the mixed pattern.

The associated injuries were contiguous (32 cases), non-contiguous (19 cases), or had a mixed pattern (contiguous/non-contiguous) (15 cases) (Figures 3 and 4).

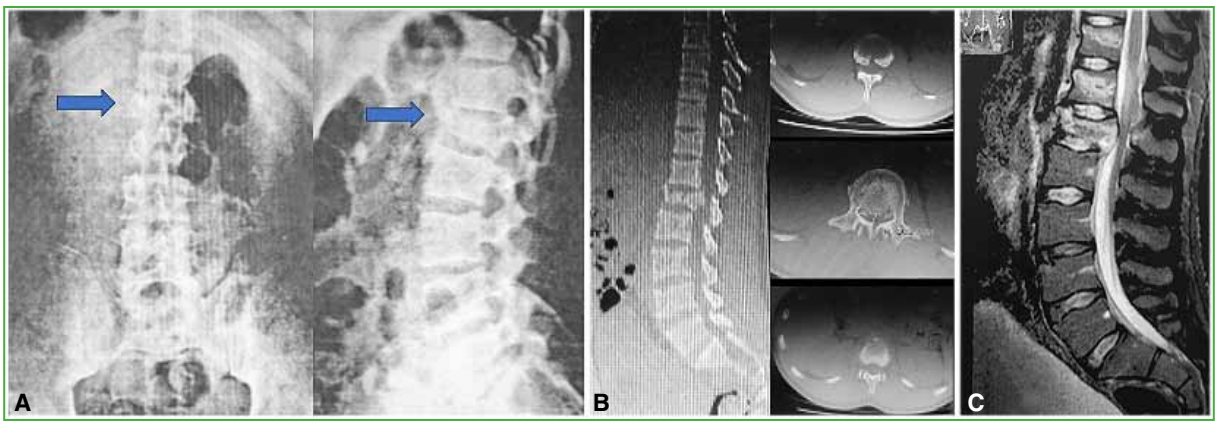

Figure 3. Patient 27. A 15-year-old male suffered an accident on a low-displacement motorcycle while driving without a helmet. He was thrown 3 meters into the air. He had no neurological deficit. **A.** Anteroposterior and lateral radiographs of the lumbar spine showing an L1 burst fracture. **B.** CT scan of the lumbar spine, sagittal and axial planes, showing the vertebral injury classified as L1A4. **C.** Magnetic resonance imaging of the lumbar spine showing the association of two contiguous supra-adjacent injuries (T11 and T12), modifying the classification to L1A4 (T11A1 and T12 A1).

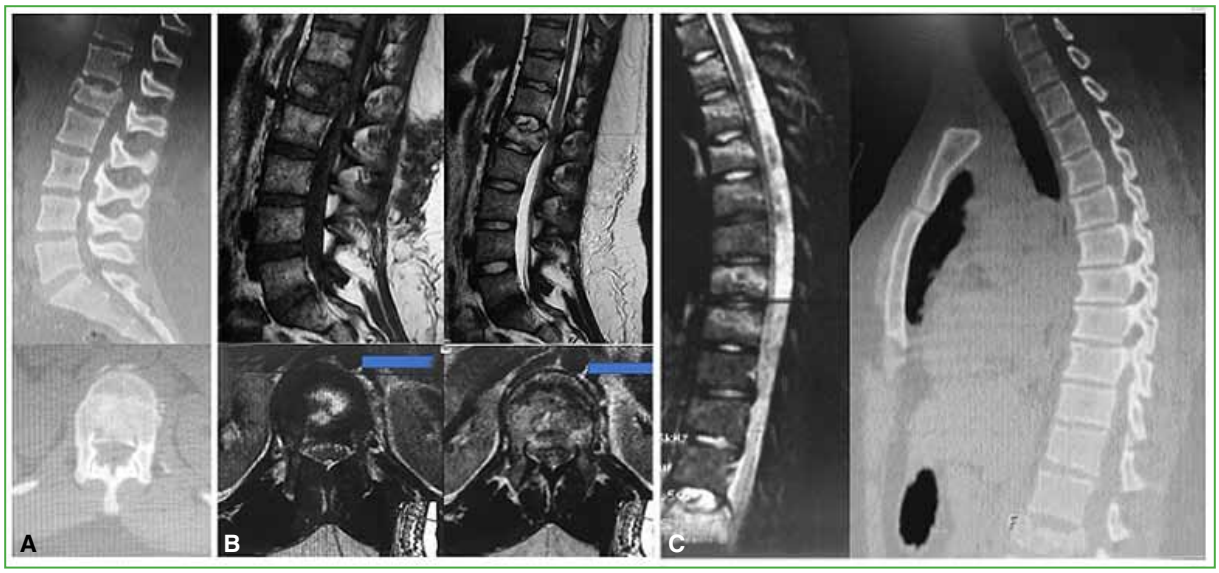

Figure 4. A 16-year-old teenager suffered a sports accident during pre-competitive horse-riding training. Polytrauma with associated skull trauma and facial trauma, without neurological deficit. **A.** CT scan of the lumbar spine, sagittal and axial planes, showing an L1A3 fracture. **B.** Magnetic resonance imaging of the lumbar spine, sagittal plane in T1w and T2w sequences, and axial planes in T2w sequence that confirm the injury. **C.** Magnetic resonance imaging and computed tomography of the thoracic spine, sagittal slices showing the association of non-contiguous/contiguous injuries (mixed pattern) of A1 lesions of T3, T4, T5, T6, T8, T9, with an intact sternum.

In this analyzed group, the correlation of kinematics and the pattern of multiple vertebral injuries showed a direct relationship (x^2 0.186) between car accidents and the possibility of suffering more than one spinal injury.

In the T2-L5 sector, the main injury was: A1 in 21 cases, followed by B2 in nine patients and the associated lesion was: A1 (26 cases) and A0 (14 cases).

Regarding treatment, 36 patients were indicated conservative management (rest, immobilization, and analgesia), the injuries of T2 to L5 were mainly A1; in one case, an increase in kyphosis was observed in the first control, so the indication had to be modified to surgical treatment. 30 patients underwent surgery for posterior instrumented stabilization and neurological release, if necessary, and the most frequent lesion was B2 in 10 cases. One patient suffered an infection of the surgical site that required cleaning and specific antibiotics, with good results.

Twenty-six patients (39.39%) presented 47 extra-vertebral injuries, 20 of them with polytrauma related to 12 traffic accidents and 7 falls from height; the most frequent injuries were chest trauma (12 cases) and head trauma (9 cases); one patient died.

DISCUSSION

High-energy traffic accidents and falls from height represent the most frequent causes of traumatic multiple vertebral fractures. Another less common cause is the direct impact of a heavy object, such as the fall of a tree trunk.[8] Some sports, such as snowboarding[9] and skiing, tend to generate a higher risk than others, due to the combination of the bending position and high jumps at a high speed.

Circus practices, such as aerial silks, performed without using protective mechanisms, can be associated with multiple vertebral fractures.[10]

These fractures are usually classified as contiguous and non-contiguous, based on the number of uninjured vertebrae between the affected bodies. This concept varies in the literature. According to Wittenberg et al.,[11] contiguous multiple vertebral fracture is a type of injury involving more than two consecutive fractured vertebral segments, while non-contiguous fracture refers to fractures separated by normal vertebral segments. According to Takami et al.,[8] two fractures are non-contiguous when two healthy segments are involved between them.

Late diagnosis plays an important role, as up to 23% of concomitant fractures are not diagnosed at the time of injury.[8] According to different reports, this rate varies from 15% to 81%,[8] and the incidence is higher in polytraumatized patients who are admitted unconscious, with the risk of neurological damage and consequent residual deformity. This suggests the need to evaluate the entire spine, especially the junctions, because they are transition sites from rigid structures to structures of greater mobility. Also, magnetic resonance imaging is essential to evaluate vertebral injuries, as it allows to differentiate acute injuries from chronic ones.[12]

The association of non-contiguous fractures was described in the classic study by Calenoff et al.,[1] in which three patterns stand out: type A, cervical fracture with secondary injury in the thoracolumbar or lumbar junction; type B, fracture from T2 to T4 with secondary injury to the cervical spine; and type C, fracture between T12 and L2, with secondary injury from L4 to L5.

Gupta and Marsi[13] reported that 55% of patients with multiple injuries presented incomplete neurological damage and that injuries of more than two levels were commonly associated with paraplegia. Therefore, it is appropriate to relate the number of fractured levels to the incidence rate and severity of neurological involvement.[14] In their series, Collado Arce et al.[15] reported that 70% of patients with multiple fractures had a neurological injury.

Multiple vertebral fractures are usually associated with injuries to other organs and the incidence rate reaches up to 50%.[15] This evidences the association between high-energy trauma and the severity of the injuries caused, and that this type of case requires high-complexity multidisciplinary management since the patient's admission.[16,17]

Another topic to consider is the relationship between non-contiguous fractures that are unstable and that require early surgical treatment to avoid complications and begin early rehabilitation.[8]

CONCLUSIONS

The presence of simultaneous multiple vertebral fractures in patients suffering from spinal cord trauma is frequent (20%) and most have no neurological involvement; these fractures are frequently caused by car accidents. The most affected sector was between T2 and L5, the most frequent combination was thoracolumbar-thoracolumbar, followed by thoracic-thoracic. 39.39% had associated extra-vertebral injuries, mainly head and chest trauma, due to motorcycle accidents and falls of >6 m in height.

Conflict of interests: The authors declare they do not have any conflict of interests.

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