

Analysis of Patients with Vertebral Gunshot Injuries According to Return to Work

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ABSTRACT

Introduction: Firearm spinal injuries account for 13-17% of all traumatic spinal injuries, with varying clinical manifestations. The goal of this study was to examine the demographic and clinical-therapeutic characteristics of patients who suffered spinal injuries as a consequence of gunshots in the context of workplace incidents, based on how soon they could return to work. **Materials and Methods:** An analytic, observational, and retrospective study of patients with spinal injuries caused by firearms in workplace incidents between January 2012 and March 2022 was conducted. Variables associated with the incident, initial assessment, spinal injury, treatment, progression, and return to work were recorded. **Results:** Twenty-two individuals were evaluated (15 men and 7 women; mean age 32.5 years). 54% were law enforcement officers, yet 82% of the accidents happened on the job. 90% had associated injuries. Twelve (55%) required surgery, while ten (45%) required conservative treatment. 81% had complications. Twelve patients (54%) returned to work, one-third were requalified, and nine needed sick leave. Patients on permanent sick leave had a statistically significant relationship with chest topography ($p = 0.005$), severe neurological damage ($p = 0.004$), transfixing or penetrating injuries ($p = 0.005$), the need for chronic psychiatric treatment ($p = 0.012$), and more days of temporary incapacity for work ($p = 0.001$). **Conclusion:** In our series, permanent sick leave was associated with thoracic, transfixing, or penetrating injuries, severe neurological compromise, and the need for chronic clinical-pharmacological psychiatric treatment.

Keywords: Gunshot vertebral injuries; spine; return to work.

Level of Evidence: IV

Análisis de pacientes con lesiones vertebrales por proyectil de arma de fuego según el retorno laboral

RESUMEN

Introducción: Las lesiones vertebrales por arma de fuego representan el 13-17% de las lesiones vertebrales traumáticas con presentación clínica variable. El objetivo de este estudio fue comparar las características demográficas y clínico-terapéuticas de pacientes que sufrieron lesiones vertebrales por arma de fuego en el contexto de accidentes laborales, según la posibilidad de retorno laboral. **Materiales y Métodos:** Estudio analítico, observacional y retrospectivo de pacientes con lesión vertebral por arma de fuego en accidentes de trabajo, entre enero de 2012 y marzo de 2022. Se registraron variables sociodemográficas y relacionadas con el siniestro, la atención inicial, la lesión vertebral, el tratamiento, la evolución y el retorno laboral. **Resultados:** Se evaluó a 22 pacientes (15 hombres y 7 mujeres; media de la edad 32.5 años). El 54% eran trabajadores de fuerzas de seguridad; no obstante, el 82% de los accidentes se había producido *in itinere*. El 90% tenía lesiones asociadas. Doce (55%) requirieron cirugía y 10 (45%), tratamiento conservador. El 81% sufrió complicaciones. Doce (54%) regresaron al trabajo, un tercio fue recalificado y 9 requirieron la baja laboral. Se halló una asociación estadística entre pacientes con baja laboral permanente y topografía torácica ($p = 0,005$), daño neurológico severo ($p = 0,004$), incidencia transfixiante o penetrante ($p = 0,005$), requerimiento de tratamiento psiquiátrico crónico ($p = 0,012$) y más días de incapacidad laboral temporaria ($p = 0,001$). **Conclusión:** La baja laboral permanente se asoció con lesiones torácicas, transfixiantes o penetrantes, compromiso neurológico severo y requerimiento de tratamiento psiquiátrico clínico-farmacológico crónico.

Palabras clave: Heridas por proyectil de arma de fuego; columna vertebral; retorno laboral.

Nivel de Evidencia: IV

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INTRODUCTION

Spinal injuries caused by firearm projectiles have a wide range of presentations, from stable and paucisymptomatic vertebral fractures to potentially fatal lesions caused by neurological, vascular, or clinical involvement.^{1,2} It is estimated that they represent 13-17% of traumatic spinal injuries; however, the incidence varies by country.³

They frequently occur in young adult patients, so their morbidity has a great social and economic impact, possibly related to potential sequelae that include chronic pain, neurological deficits, infections, and cerebrospinal fluid fistula, among others.^{4,5}

The velocity of the projectile, the associated involvement of the abdominal viscera, the stability of the injury, the incidence of the projectile, and the involvement of the spinal canal are all factors to consider when classifying this type of spinal injury.^{6,7} In our field, it is worth noting the NOPAL classification, an acronym in Spanish that summarizes the five components that this classification evaluates: neurological compromise (N), bone stability (O), incidence of projectile impact (P), associated injuries (A), and location of the spinal injury (L).⁷

Furthermore, injuries in the civilian population have been separated from those in the military population in the literature.^{4,8} Injuries in the military population involve impacts from high-energy weapons (>2000 feet/second) that cause significant indirect injuries due to the effect of shock waves or cavitation. On the contrary, in the civilian population, they are usually from low-energy firearms, and tissue damage occurs mainly as a consequence of the impact of the projectile mass.^{4,6,8}

The goal of this study was to examine the demographic and clinical-therapeutic characteristics of patients who sustained spinal injuries from a firearm projectile in the context of occupational accidents based on their ability to return to work.

MATERIALS AND METHODS

An analytical, observational and retrospective study was carried out on a series of patients with spinal injuries due to a gunshot wound in the context of a work accident, who were treated at an occupational disease referral center between January 2012 and March 2022.

The inclusion criteria were: patients of both sexes and >18 years of age with spinal injury due to a gunshot wound while the exclusion criteria were a follow-up <6 months and incomplete clinical and imaging records.

Data were obtained from the institution's medical records and image archives on the following study variables: 1) sociodemographic (age, sex, work, type of work accident); 2) related to the accident and initial care: place of initial care, delay from trauma to initial care at our institution, neurological status according to the *ASIA Impairment Scale* (AIS),⁹ hemodynamic status, and Glasgow scale; 3) related to the spinal injury: number of projectiles, type/velocity of the projectile, entry and exit orifices, involvement of abdominal viscera, associated injuries, involved vertebrae, mechanical instability; projectile incidence according to the NOPAL classification,⁷ and treatment (conservative, surgical); 4) related to the evolution and return to work: hospital days, days in the intensive care unit, days on mechanical ventilation, neurological status in the last follow-up according to the AIS, job requalification, temporary work incapacity, complications, need for chronic psychiatric treatment (contemplating those patients with regular psychiatric care and who received medication for acute post-traumatic stress).

In terms of mechanical instability, there is no agreement in the literature on how to define instability in spinal injuries induced by a firearm projectile; similarly, applying the same criteria as for blunt force trauma fractures is problematic.^{10,11} For this reason, in the imaging analysis, fractures showing signs of displacement, ligament involvement, bilateral involvement of pedicles, or articular facets were considered unstable ([Figure 1](#)).¹¹

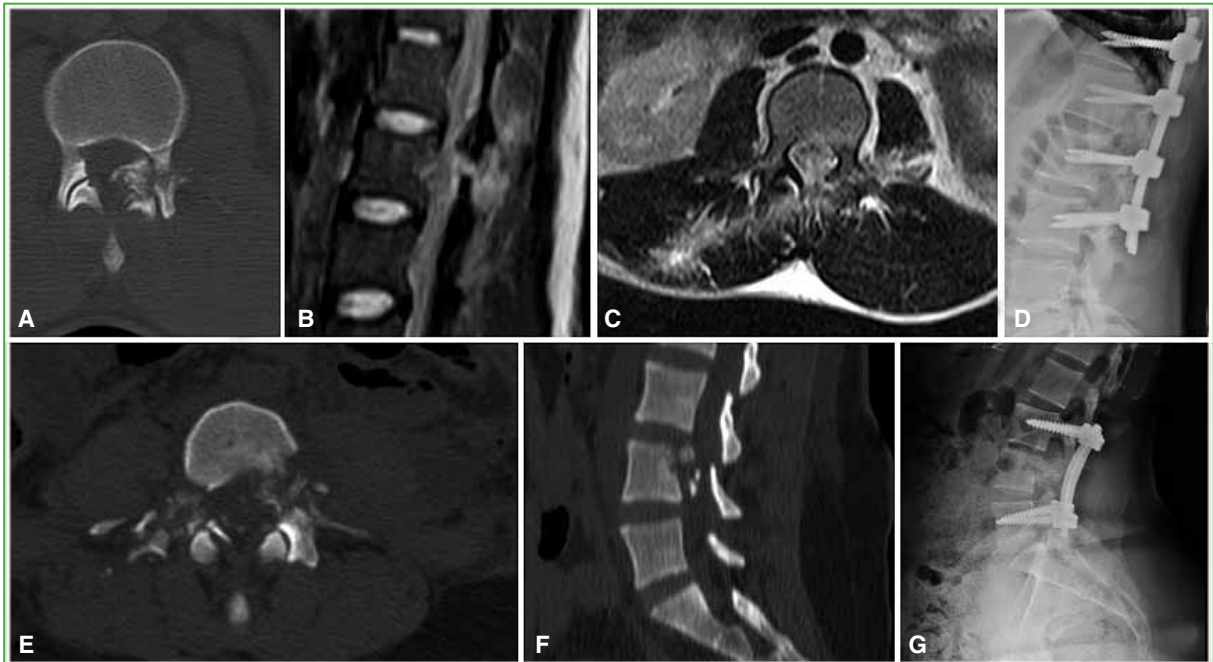


Figure 1. Spinal fractures interpreted as mechanically unstable. **A-D.** Facet fracture and injury to the posterior ligamentous complex. **E-G.** Bilateral fracture of the pedicles and left facet.

Statistical Analysis

Categorical variables were expressed as numbers and percentages, and were analyzed using the chi-squared test or Fisher's test. The interval variables are described with mean and median, according to their distribution and their measures of dispersion, standard deviation (SD), and minimum-maximum interval. For the comparison of continuous variables, the Student's t test or the Mann-Whitney U test was used, according to the distribution expressed. A p-value <0.05 was considered statistically significant. For the analysis, the SPSS Statics 25 program was used.

RESULTS

Twenty-two patients with spinal injuries due to firearm projectiles treated at our center during the study period were included. The mean age was 32.5 (SD ± 9), 15 (68.2%) patients were men and 7 (31.8%) were women. **Figure 2** shows the topography of the vertebral wounds, in which the thoracic spine predominated (41%). Three patients (13%) had a high cervical spine injury.

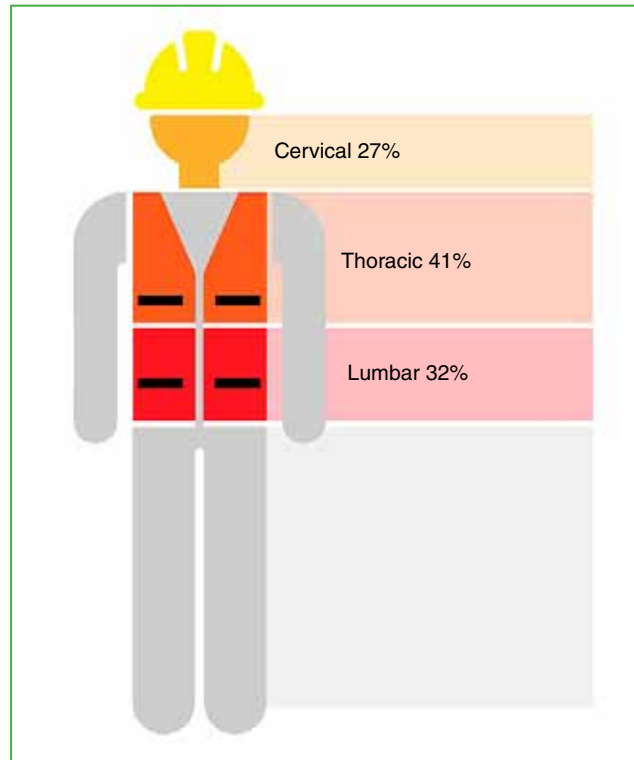


Figure 2. Topography of spinal injuries caused by firearm projectiles in our series.

When describing the sample considering the trauma as an occupational accident, it should be noted that all the patients were referred from other centers ($n = 22$) where they received initial trauma care and all were referred from public institutions. The median delay from trauma to care at our institution was 12.5 hours (min-max = 1-198). 54% ($n = 12$) were law enforcement workers (police); however, 82% ($n = 18$) of the cases were *commuting* accidents and 20 patients suffered an injury from a firearm projectile unrelated to their work activity (assault, $n = 19$; suicide attempt, = 1) (Figure 3).

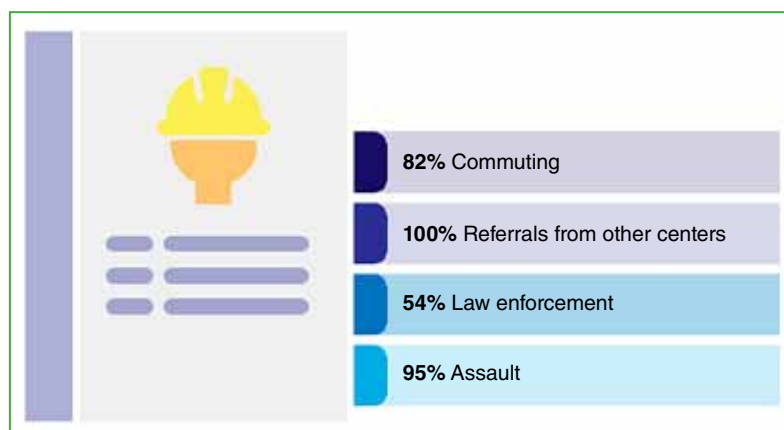


Figure 3. Characteristics of spinal injuries caused by a firearm projectile as a work accident.

The morbidity associated with trauma in the patients in our sample was high: 15 (68%) had a neurological injury, 20 (90%) had associated injuries, nine (40%) had a Glasgow scale <8 on admission, seven (30%) had hollow abdominal viscera perforation, and four (18%) had hemodynamic instability. Specific associated injuries were: fractures (n = 10; 45%), single or multiple abdominal viscera injury (n = 9; 41%), hemothorax (n = 8; 36%), gastrointestinal hollow viscera perforation (n = 7; 27%), lung injury (n = 6; 27%), vascular injury (n = 5; 23%), peripheral neurological injury (n = 3; 14%), maxillofacial trauma (n = 3; 14%), diaphragmatic injury (n = 2; 9%), penetrating skull trauma (n = 1; 5%), tracheal injury (n = 1; 5%).

All cases were the result of attacks by low-velocity projectiles. The entry site was the thorax in 45% (n = 10) of the patients, followed by head and neck (n = 7; 32%). A projectile exit wound was not recorded in 12 cases (54%). The incidence of the projectile was predominantly non-penetrating (n = 7; 32%) or transfixing (n = 6; 27%); followed by penetrating-tangential in five cases (23%) and penetrating in four (18%). In five (23%) patients, the projectile (n = 4) or its fragments (n = 1) were found lodged in the spinal canal. The spinal lesion was considered unstable in six (27%) cases. The description of the sample is summarized in [Table 1](#).

According to the treatment of the spinal lesion, 12 (55%) patients underwent surgery and 10 (45%) received conservative treatment. Two patients with cervical spine injuries wore a halo vest. The median number of total surgeries per patient (including those not related to the spinal injury) was three (min-max = 0-8). The median hospital stay was 26 days (min-max = 7-123), and the median number of days in the intensive care unit was 20 (min-max = 0-63); nine patients required mechanical ventilation, with a median 3 ventilation days (min-max = 1-48).

81% (n = 17) suffered complications. The majority (n = 16; 73%) received chronic treatment with drugs and psychiatric care in inpatient and outpatient settings due to stress associated with trauma (acute stress reaction), the other most frequent complications were neuropathic pain (12 patients, 54%) and infectious diseases (9 patients, 41%). In three (13.5%) cases, the infections were directly related to the gunshot wound: one (4.5%) retroperitoneal abscess secondary to gastrointestinal perforation, one (4.5%) empyema secondary to traumatic hemothorax, and one (4.5%) mediastinitis due to esophageal perforation. The rest were urinary tract infections (n = 5; 22.7%); pneumonia associated with mechanical ventilation (n = 2; 9%), bacteremia (n = 1; 4.5%) and soft tissue infection (n = 1; 4.5%). Almost half of the patients (n = 10; 45%) were readmitted for treatment of a complication related to the accident.

Table 1. Sample description

Variables		Results	
Age, mean (SD)		32.5	(9)
Sex, n (%)	Male	15	(68.2)
	Female	7	(31.8)
Topography, n (%)	High cervical	3	(13.6)
	Subaxial cervical	3	(13.6)
	Thoracic	9	(40.9)
	Lumbar	7	(31.8)
Neurological lesion, n (%)	No	7	(31.8)
	Spinal cord injury	10	(45.5)
	Cauda equina	2	(9.1)
	Root lesion	3	(13.6)
Initial AIS, n (%)	A	6	(27.3)
	C	5	(22.7)
	D	1	(4.5)
	E.	10	(45.5)
Glasgow Scale <8, n (%)		9	(40.9)
Hemodynamic instability, n (%)		4	(18.2)
Projectile type, n (%)		Low speed	22 (100)
Projectile(s) (number), median (min-max)		1	(1-3)
Entry orifice, n (%)	Head and neck	7	(31.8)
	Chest	10	(45.5)
	Abdomen and pelvis	5	(22.7)
Exit orifice, n (%)	Head and neck	2	(9.1)
	Abdomen and pelvis	8	(36.4)
	Without exit orifice	12	(54.5)
Projectile incidence (NOPAL classification)	Transfixing	6	(27.3)
	Penetrating	4	(18.2)
	Penetrating-tangential	5	(22.7)
	Non-penetrating	7	(31.8)
Gastrointestinal perforation		7	(31.8)
Associated injuries		20	(90.9)
Mechanical instability		6	(27.3)
Projectile or fragments in spinal canal.		5	(22.7)

AIS = ASIA Impairment Scale; SD = standard deviation; min-max = minimum-maximum.

41% (n = 9) required referral to rehabilitation centers (tertiary care). Twelve (45%) patients suffered some degree of neurological sequelae (AIS A n = 6; AIS C n = 3 and AIS D n = 3) and eight (36%) suffered from neurogenic bladder (Table 2).

Table 2. Treatment and evolution

Variables		Results	
Treatment of the spinal lesion, n (%)	Conservative	10	(45.5)
	Surgical	12	(54.5)
Surgical delay in hours, median (min-max)		307	(12-1272)
Total surgeries, median (min.-max.)		3	(0-8)
Complications, n (%)		17	(81)
Days in intensive care, median (min.-max.)		20	(0-63)
Mechanical ventilation, n (%)		9	(41)
Days on mechanical ventilation, median (min-max)		3	(1-48)
Days of hospitalization, median (min.-max.)		26	(7-123)
Psychiatric treatment, n (%)		16	(72,7)
Tertiary care admission		9	(41)
Readmissions, median (min.-max.)		0	(0-10)

min-max = minimum-maximum.

Regarding the impact on work activity, 12 (54%) patients returned to work and a third of them (n = 4) had to be reclassified. The median of temporary incapacity for work was 572 days (min.-max. 72-3614), with a great dispersion as a consequence of the fact that nine (n = 41) patients required permanent sick leave with outpatient follow-up due to the severity of the sequelae (Table 3).

Table 3. Return to work (days)

Variables		Results	
Return to work (days)		12	(54.5)
TWI (days), median (min-max)		575	(72-3614)
Reclassification, n (%)	No	8	(36.4)
	Yes	4	(18.2)
	Ambulatory with sick leave	9	(40.9)
	Without specialty discharge	1	(4.5)

TWI = temporary work incapacity; min-max = minimum-maximum.

Patients with definitive discharge from spinal injury (n = 21; 95%) were grouped based on return to work for their comparison (return to work n = 12; permanent sick leave n = 9). In our sample, patients with permanent sick leave were associated, in a statistically significant way, with chest topography (p = 0.005), severe neurological damage according to the AIS (AIS A, B or C) (p = 0.004), transfixing or penetrating wound (p = 0.005), chronic psychiatric treatment (p = 0.012) and days of temporary incapacity for work (p = 0.001) (Table 4).

Table 4. Comparison according to return to work.

	Return to work (days)		p
	Yes = 12	No = 9*	
Age, mean (SD)	32 (11)	34 (6)	0.589
Sex, n (%)			
Male	8 (67)	6 (67)	1.000
Female	4 (33)	3 (33)	
Topography, n (%)			
Cervical	5 (42)	1 (11)	0.296
Thoracic	2 (16)	7 (78)	0.005
Lumbar	5 (42)	1 (11)	0.125
Neurological lesion, n (%)	6 (50)	8 (89)	0.061
AIS (A/B/C vs. D/E), n (%)			
A/B/C	3 (25)	8 (89)	0.004
D/E	9 (75)	1 (11)	
Glasgow Scale <8, n (%)	5 (42)	4 (44)	0.899
Hemodynamic instability, n (%)	1 (8)	3 (33)	0.149
Associated injuries, n (%)	11 (92)	9 (100)	0.375
Mechanical instability, n (%)	2 (17)	4 (44)	0.163
Projectile in the spinal canal, n (%)	1 (8)	3 (33)	0.149
Projectile incidence, n (%)			
Transfixing/penetrating	2 (17)	7 (78)	0.005
Penetrating-tangential or non-penetrating	10 (83)	2 (22)	
Gastrointestinal perforation	4 (33)	3 (33)	1.000
Total surgeries, mean (SD)	3 (2.5)	4 (2.1)	0.402
Complications, n (%)	8 (67)	9 (100)	0.089
Days in intensive care, median (min.-max.)	11 (0-40)	24 (2-63)	0.129
Mechanical ventilation, n (%)	5 (42)	4 (44)	0.899
Days of hospitalization, median (min.-max.)	25 (7-130)	44 (18-97)	0.382
Psychiatric treatment, n (%)	6 (50)	9 (100)	0.012
Readmission, n (%)	4 (33)	5 (55)	0.309
TWI, median (min-max)	349 (72-1707)	1507 (459-3614)	0.001

*For the purposes of comparison, a patient without return to work was excluded because he was not discharged at the last follow-up. SD = standard deviation; AIS = *ASIA Impairment Scale*; TWI = temporary work incapacity.

DISCUSSION

Latin America is the continent with the highest homicide rate according to international records.¹² Our country is no stranger to this reality. In Argentina, there were 2,416 fatalities from intentional homicides in 2020, with a rate of 5.3 victims per 100,000 inhabitants, which represents the third leading cause of violent death in our environment after suicide and road traffic accidents. 38.5% of the deaths are concentrated in the province of Buenos Aires, the most violent in the country. 50% of homicides are by gunshots.¹³

Spinal fractures caused by gunshots represent 13-17% of traumatic spinal injuries and, in the case of the civilian population, they occur more frequently in young men of working age, with a significant socioeconomic impact.^{6-8,10,11} The demographic characteristics of our sample coincide with those recorded in the literature, with a predominance of male victims (68%) and a mean age of 32.5 years.

Our study retrospectively evaluated a specific subgroup of patients who suffered penetrating injuries from a firearm in the context of an occupational accident, and who were treated under the coverage of the occupational risk insurance system. It should be noted that, although 54% of the injured worked in jobs with the use of weapons, most of the accidents were *in itinere* (82%), that is, outside the workplace and as a consequence of violent attacks when commuting from home to work, and vice versa.

Due to the characteristics of the health system in our country, primary trauma care in all cases was carried out by public system providers and patients were referred to our institution for definitive treatment with an unavoidable delay (median 12.5 h). However, a large dispersion of this variable was recorded, ranging from 1 to 198 hours.

In line with other publications, spinal injuries were predominantly thoracic (41%) and 90% of patients had associated injuries with a predominance of fractures in other bones, injuries to solid and hollow abdominal viscera, and hemothorax.^{6,10} There is consensus in the literature on the early initiation of broad-spectrum antibiotic treatment in patients with fractures induced by a firearm projectile, particularly when perforation of the gastrointestinal viscera is present.^{6,10} In our series, two patients suffered infectious complications associated with perforation of the colon and esophagus, regardless of the initial antibiotic prophylaxis. 27% had a perforation of hollow abdominal viscera, a rate similar to that reported in the literature (23.7%).⁶

Surgical treatment is still controversial. The indications in most published studies include decompression of patients with incomplete or progressive neurological deficits, removal of projectile or bone splinters at the cauda equina level, stabilization of unstable lesions, and approach to dural fistulas.^{6-8,10,11} In our series, 54% had a neurological injury, with a predominance of spinal cord injuries (45%) and stable fractures (73%). In five patients, the projectile or its fragments were lodged in the spinal canal.

The magnitude of the morbidity of the patients included in our study is reflected in the distribution of patients with permanent sick leave (41%; n = 9). The comparison of groups based on return to work allowed us to attain a higher level of characterization of this subgroup, estimating a strong relationship with thoracic spine transfixing or penetrating injuries, as well as severe neurological injury (AIS A, B, or C). It is also worth noting that these patients had a much higher requirement for clinical-pharmacological psychiatric treatment. All required hospitalization in rehabilitation or tertiary care centers and with a statistically significant difference in the days of temporary incapacity for work. Under the work risk insurance system, this created a subset of patients that required a high consumption of health resources.

The weakness of our study is its retrospective nature with a small sample of cases treated in a single center, which prevents drawing generalizable conclusions. However, it represents the description of a specific subgroup of patients with gunshot wounds in the context of occupational accidents. This population is not well explored in the literature, which confers hierarchy and interest to the research.

CONCLUSIONS

In our study, patients with spinal injuries caused by firearm projectiles in the setting of occupational accidents had significant morbidity linked with the initial trauma, as well as related injuries and frequent complications. Thoracic fractures and mechanically stable injuries predominated. Permanent sick leave was associated with thoracic, transfixing or penetrating injuries, with severe neurological compromise and the requirement of chronic clinical-pharmacological psychiatric treatment.

Conflict of interest: Ricciardi GA is section editor of the Journal of the Asociación Argentina de Ortopedia y Traumatología. No other conflicts of interest to declare.

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