Study of peripheral nerve injury in trauma patients

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Abstract

Objective: *To determine the prevalence, location, mechanism and characteristics of peripheral nerve injury (PNI) in trauma patients.* **Material and Methods:** *Retrospective study of medical records with trauma-associated PNI diagnoses over the 2008-2012 period. The collected information included: gender, age, occupation, anatomic location, affected nerve, mechanism of injury, degree of injury, intervention costs and hospital length of stay.* **Results:** *The prevalence of PNI is 1.12%. Sixty-one percent of peripheral nerve injuries were located in the upper limb, with a higher incidence at the brachial plexus (35%) and ulnar nerve (18%); and the main mechanism was stab wound (19%).* **Discussion:** *PNI occur commonly in working age persons, 51% of injuries were of the neurotmesis type, hospital length of stay was 2.51 ± 1.29 days and average cost was MXN 12,474.00 ± 5,595.69 (USD 1,007.54 ± 452.21) for single nerve injuries.* (Gac Med Mex. 2014;150:519-23)

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Introduction

Trauma-associated peripheral nerve injury (PNI) has a prevalence of 1.3-2.8%[1,2]. These injuries usually occur at working ages, which results in economical losses associated with time of recovery, and even result in permanent disability. These patients suffer muscular weakness, loss of the sense of touch and an increased probability of developing neurotrophic ulcers[3]. When the degree of PNI warrants it, surgical repair is the treatment alternative that produces 80% of functional recovery[4]. In the U.S.A., 50 000 PNI repairs are performed annually, with a cost of USD 7 billion per year[3].

The PNI location is typically related with occupation and lifestyle, whereas the mechanism is associated with the social and warfare situation of each country or region. The mechanism, in turn, is related with the degree of injury, which determines the type of treatment and thus the cost and time of recovery of the patient.

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In U.S.A. and Canada, the primary cause of PNI is motor vehicle accidents (26-46%)[2,5,6]; conversely, in other countries, stab wounds is the main mechanism (61%)[1]. Currently, there is an increase in violence within Mexican society, a fact that is probably related with organized crime[7,8]. For this reason, we believe that this situation may reflect on the prevalence, location and mechanism of PNI.

In the literature reviewed, no studies were found on trauma-associated PNI involving the Northeastern Mexico population. The objective of this study was to determine the prevalence, location, mechanism and characteristics of PNI in trauma patients.

Material and methods

A cross-sectional, retrospective, descriptive study was conducted based on clinical records. All cases with PNI caused by trauma treated in the *Hospital Universitario Dr. José Eleuterio Gonzalez* over the period encompassed from January 1st 2008 to June 1st 2012 were included. For the search of clinical records, the International Classification of Diseases (ICD) S00-S99.9 and T00-T14.9 codes were used. Incomplete medical

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Table 1. Population demographics according to age group

Parameter	Pediatric*	Adult	Total
Number	42 (31.34%)	92 (68.66%)	134
Age (mean and SD)	7.08 ± 5.83	36.35 ± 14.63	27 ± 15
Female/Male	20/22	23/69	43/91

*1-18 years.

records or patients diagnosed with PNI caused by other condition were excluded. From each record, the following data were obtained: gender, age, occupation (according to the 2011 National System of Occupation Classification)[9], anatomic location, injured nerve (organized as single and multiple), mechanism of injury, degree of injury (according to Seddon's classification)[10], intervention costs (exchange rate according to the *"Banco de México"* institution for January 17th 2014)[11] and hospital length of stay, which were the study variables. A data base was constructed using the Microsoft Office Excel 2007 program, and variables were processed using descriptive statistics (percentages and frequencies) and central tendency measures (mean and standard deviation).

Results

During the five-year period (2008-2012), 11,998 trauma-patients were treated, out of which 134 were diagnosed with PNI, which represents a prevalence of 1.12%. Sixty-eight percent belonged to the male and 32% to the female gender. Overall, average age was 27 years (± 18.5). Population demographics according to age group are shown in table 1.

Fifty-eight percent of the patients were minors (19%), unemployed (16%), students (11.5%) and housewives (11.5%), whereas the remaining 42% had a formal job at the time of their injury. Patient distribution according to working status and type of activities is shown in table 2.

Upper limb was the location where most PNIs were reported (61%), followed by lower limb (15%) and the face (14%). Injury distribution acorrding to location and injured nerves is shown in table 3. Multiple injuries (two nerves) occurred in 10 patients (6%), 7 of them with ulnar (cubital) and median nerve injury, and 3 with radial nerve injury combined with facial, ulnar and tibial nerve injuries, respectively.

Stab wounds (19%) were the most common PNI mechanism. Motor vehicle accidents were the third most frequent (16%), even after direct trauma (17%). PNIs due to fracture (12%), gunshot wound (11%), obstetric trauma (10%), crush (7%), fall (4%), laceration (2%) and dislocation (2%) account for the rest of the peripheral nerve injury mechanisms in this study.

Neurotmesis was the most commonly occurring degree of PNI (51%), followed by axonotmesis (29%) and neurapraxia (20%). Importantly, stab wound-associated PNIs produced mainly neurotmesis (26.47%); crush LNPs, axonotmesis (16%); and fractures, neurapraxia (22.22%).

Table 2. Patient distribution according to working status and type of activity

Working status	Type of activity	n	%
Formal employment: 42%	Basic and support activities	17	14.2
	Agricultural and livestock farming and forestry workers	11	9.24
	Professionals and technicians	6	5.04
	Traders	6	5.04
	Surveilance services workers	6	5.04
	Car/bus drivers	4	3.4
Other: 58%	Minors	23	19
	Unemployed	18	16
	Students	15	11.5
	Housewives	15	11.5

Table 3. Injury distribution according to location and injured nerves

Location	Nerve	n	Percentage	Total percentage
Upper limb	Brachial plexus	35	24%	61%
	Ulnar	18	13%	
	Median	15	10%	
	Radial	14	10%	
	Digital	5	3%	
	Axillary	1	1%	
Lower limb	Plantar	7	5%	15%
	Sciatic	6	4%	
	Tibial	3	2%	
	Saphenous	2	1%	
	Fibular	1	1%	
	Femoral	1	1%	
	Sural	1	1%	
Face	Facial	14	10%	14%
	Trigeminal	5	3%	
	Ophthalmic	1	1%	
Neck	Cervical root	9	6%	6%
Thorax	Intercostal	6	4%	4%

Note: includes multiple injuries individually.

Patient distribution according to injury mechanism and degree is shown in figure 1.

On average, the cost of intervention for a single PNI was MXN 12,474 ± 5,595 (USD 1,008.21 ± 452.21) and hospital length of stay was 2.5 ± 1.29 days. Table 4 shows hospital length of stay in days (mean ± SD) and intervention costs in Mexican pesos (mean ± SD) by PNI location, whereas table 5 shows hospital length of

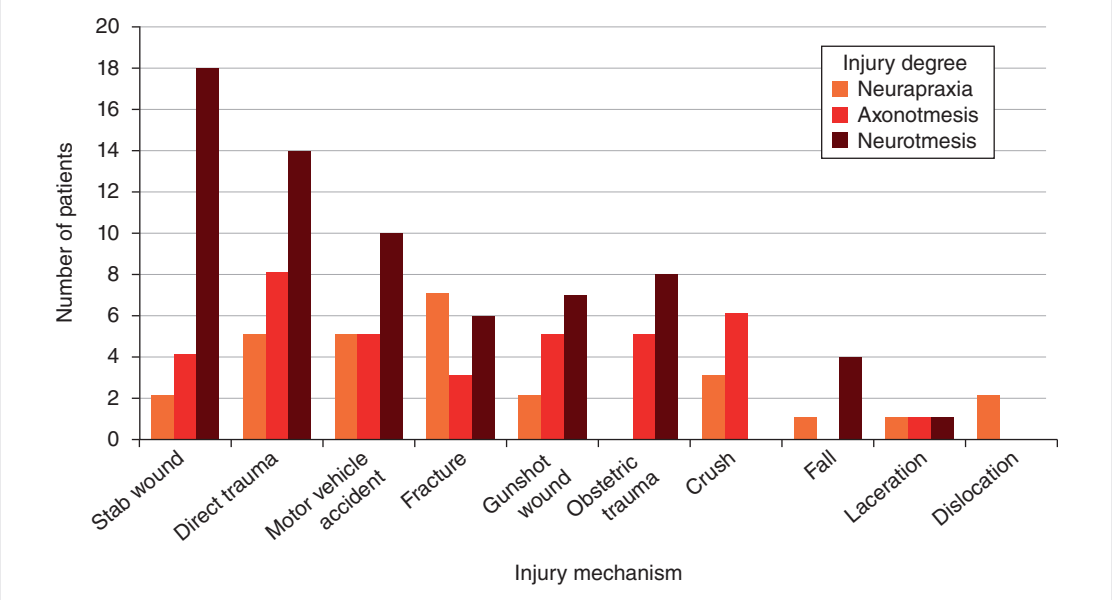

Figure 1. *Patient distribution according to injury mechanism and degree.*

Table 4. Hospital length of stay in days (mean ± SD) and intervention costs (Mexican pesos, mean ± SD) according to PNI location

Parameter	Time in days (mean ± SD)	Costs in Mexican currency (mean ± SD)
Upper limb	2.31 ± 0.99	$ 13,325.96 ± 5,437.47
Lower limb	2.73 ± 1.62	$ 9,459.25 ± 4,477.19
Face	2.83 ± 1.80	$ 8,799.67 ± 6,841.06
Neck	2.67 ± 1.63	$ 10,603.00 ± 7,094.06
Thorax	4 ± 0	$ 16,206.00 ± 10,897.93
Multiple	2.29 ± 1.11	$ 15,888.50 ± 994.39

stay in days (mean ± SD) and intervention costs in Mexican pesos (mean ± SD) as related to PNI degree.

Discussion

The reported PNI prevalence varies depending on the country where the study is conducted, the number of hospital centers included, years and range, as well as on the social context prevailing in the region[12,13]. While some studies report a prevalence ranging from 1.3[1] to 2.8%[2], the present one found a prevalence of 1.12%. This difference might be explained by underreporting associated with probable capture errors, as well as possible lack of training of the personnel on IDC codes filling. Table 6 shows the differences in the prevalence of PNI.

Age influences on recovery following a PNI[14]. In most studies, average age is located within the fourth decade of life and male gender is predominant, as shown in the trials by Noble (34.6 years, 83% males)[2] and Eser (31.8 years, 79% males)[15]. In the latter, average age in adults is 36.35 years and, in pediatric patients, 7.08 years. In adults, male gender was most affected (3:1), whereas in children there is no distribution predominance by gender. This suggests that the roles of gender, lifestyle and occupation influence on how PNIs occur in adults.

Table 5. Hospital length of stay in days (mean ± SD) and intervention costs (Mexican pesos, mean ± SD) according to PNI degree

PNI degree	Time in days (mean ± SD)	Costs in Mexican currency (mean ± SD)
Neurapraxia	3.14 ± 1.61	$ 9,005 ± 898.47
Axonotmesis	2.44 ± 1.42	$ 11,864 ± 7,034.44
Neurotmesis	2.37 ± 1.07	$ 13,536 ± 4,417.04

Peripheral nerve injury is related with occupation and lifestyle. In this studio, the occupations most vulnerable to suffer a PNI correspond to people working in basic and support activities and to agricultural and livestock farming and forestry workers. According to lifestyle, minors and unemployed persons are predominant. This is probably due to risk activities carried out in these occupations. In minors and unemployed persons, these are likely to be somehow related with violence.

Upper limb is the location where most PNIs are reported[1,2,5,15,16]. In the study by Noble (1998), radial nerve was the most prevalent. In this study, most injuries are located in upper limbs, primarily affecting the brachial plexus and the ulnar nerve.

Peripheral nerve injuries include penetrating, compression, traction and ischemic mechanisms, as well as other less common mechanisms such as thermal, electric shock, radiation, percussion and vibration[12]. Motor vehicle accidents are at first place in works conducted in Toronto, Canada (52%)[2]; Sao Paulo, Brazil (43%)[5]; and Ankara, Turkey (26.9%)[15]. In other countries, stab wound is the main cause of PNI (61%)[1]. In this study, the most common injury mechanism was stab wound (19%), with motor vehicle accidents being the cause of 16%. Forty-seven percent of the injury mechanisms (stab wound, direct trauma and gunshot wound) are related with violence, which in turn is associated with increased violence in Mexican society[7,8].

Neurapraxia and axonotmesis injury degrees have the potential for recovery and most of these cases do not require surgical intervention; conversely, neurotmesis requires surgical intervention for recovery[10,12,17]. The axonotmesis injury degree (53-45%) is predominant in the works by Noble (1998)[22] and Kouyoumdjan (2006)[5], respectively. In our study, 51% of the

Table 6. Differences in PNI prevalence

Reference	Place of Study	Number of centers	Range	Number of trauma patients	Number of patients with PNI	Prevalence
Noble et al. (1998)	Ontario, Canada	1	10 years (1986-1996)	5,777	162	2.8%
Saadat et al. (2011)	Teheran, Iran	8	4 years (1999-2004)	16,753	219	1.3%
Our study	Monterrey, Mexico	1	5 years (2008-2012)	11,998	134	1.2%

lesions are neurotmesis and 29%, axonotmesis. Nerve injury degree is related with injury mechanism; the higher incidence of neurotmesis is probably due to primary injury mechanisms being stab wound and direct trauma.

Peripheral nerve injury entails economic losses due to the time of recovery and possible functional disability. In the work carried out by Saadat (2011)[1], average hospitalization time is 6.0 ± 2.02 days. Conversely, in our study, hospital length of stay was 2.51 ± 1.29, maybe because the most common degree of injury in this study was neurotmesis, which requires prompt surgical repair.

The cost of PNI varies according to the location and degree of the injury. A thoracic injury is more expensive when compared with a lower limb PNI; the cost of a neurotmesis-degree injury is higher than that for a neurapaxia injury, which is probably due to the management and intervention of the PNI.

In conclusion, PNI has a prevalence of 1.12% and is related with workers engaged in basic and support activities, minors and unemployed persons. Upper limbs represent the most frequent location of PNI, with brachial plexus and ulnar nerve injuries being the most common. Violence is the main cause associated with peripheral nerve injury in this study. Stab wounds produced primarily neurotmesis-degree injuries, whereas direct traumas are related with axonotmesis and fractures with neurapraxis. It is important to conduct a study assessing the costs associated with disability, loss of function and other sequels in order to know the real economic impact on the patient's life.

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