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Traumatic spinal cord and peripheral nerve injuries: correlation of trauma type with subsequent disability

Ahsen Kaya[1*], Ender Senol[1], Engin Bayrakci[2] and Hayrettin Altindag[3]

Abstract

Background Traumatic spinal cord and peripheral nerve injuries may lead to neurological deficits and fatal consequences. This study aimed to evaluate the characteristics of traumatic spinal cord and peripheral nerve injuries, examine the relationship between the type of injury and the affected nerves, and discuss appropriate prevention measures.

Results Of these, 236 were males and 63 were females, and the mean age was 35.56 ± 15.10 years. Traffic accidents (56.9%) were the most common etiological factor. This study included 288 peripheral nerve injuries and 82 spinal cord injuries. The fibular nerve ($n = 49$) and cervical spinal cord ($n = 35$) were the most frequently injured areas. Permanent functional and sensorial losses associated with traumatic nerve injuries were observed in 239 (79.9%) cases, of which 171 exhibited loss of muscle strength, 114 presented with neuro-sensorial symptoms, 37 had urinary/faecal incontinence, and 1 demonstrated erectile dysfunction. And, the incidence of permanent loss of function was significantly higher following traffic accidents ($\chi^2 = 50.095$, Adj. $p < 0.001$).

Conclusions Peripheral and spinal nerve injuries play a crucial role in forensic investigations, providing valuable insights into the circumstances surrounding a crime or injury. Their significance extends to both criminal and civil proceedings, influencing legal strategies, determinations of liability, and the quantification of damages. In this study, especially traffic accidents were significantly associated with nerve injuries leading to permanent loss of function, and the type of trauma was associated with the nerves injured. Therefore, this study will contribute to criminal and civil proceedings.

Keywords Injury, Spinal cord, Peripheral nerve, Traffic accident

Background

Traumatic nerve injuries often have notable psychological and physical impacts and are associated with high mortality and morbidity rates globally (Walter & Zweckberger 2018). They may be classified into central and peripheral nervous system injuries, with the former being further classified into those affecting the brain and spinal cord injuries (SCIs). Peripheral nervous system injuries may have fatal consequences by causing respiratory and cardiac arrest, or result in temporary or permanent disabilities (Moshi et al. 2017). A comprehensive review found that the annual incidence rate of SCI was 8906 cases per one million individuals (in Spain and the United States), and it was most commonly observed in males aged 30 years and under. Moreover, it frequently affected the cervical region and was typically caused by traffic accidents (although these findings varied by country and region) (Singh et al. 2014). According to the World Health Organisation, more than 90% of traumatic

*Correspondence:
Ahsen Kaya
ahsen.kaya@ege.edu.tr
[1] Faculty of Medicine, Department of Forensic Medicine, Ege University, Izmir, Turkey
[2] Trabzon Kanuni Education and Research Hospital, Trabzon, Turkey
[3] Urfa Forensic Medicine Branch Directorate, Urfa, Turkey

SCIs were caused by traffic accidents (Biering-Sørensen et al. 2011).

Peripheral nerve injuries (PNIs) are often associated with increased morbidity and neurological deficits (Eser et al. 2009), with previous studies reporting prevalence rates ranging between 1%–5% in Turkey, Iran, Central Europe, Canada, USA, and Mexico (Eser et al. 2009; Huckhagel et al. 2018a, b; Saadat et al. 2011; Noble et al. 1998; Taylor et al. 2008; Miranda and Torres 2016; Castillo-Galvan et al. 2014). The most common etiological factors were traffic accidents; stabbing; firearm injuries; crushing, compression, and strain injuries; occupational accidents; sports injuries; and blast injuries (Kouyoumdjian et al. 2017). PNIs frequently affected the ulnar nerve in the upper extremities and the sciatic and deep peroneal nerves in the lower extremities (Eser et al. 2009; Kouyoumdjian et al. 2017; Babaei-Ghazani et al. 2017).

Prevention of traumatic nerve injuries is important for improving quality of life of the patient and economical loss of the society. So, this study aimed to evaluate the characteristics of traumatic spinal cord and PNIs, examine the relationship between the type of trauma and the nerves injured, and discuss possible preventive measures.

Methods

Study design

This retrospective study collected the cases with traumatic spinal cord and peripheral nerve injuries and examined the backgrounds and etiologies by examining all relevant medical records issued by … University Faculty of Medicine, Department of Forensic Medicine for five years between 2014 and 2018.

The medical information of the patients was obtained from the medical records sent to us by the judicial authorities during the preparation of the forensic report.

Population

We studied 299 cases diagnosed with traumatic SCIs or PNIs. All cranial nerve and brain injuries were excluded from this study.

The patient's age group (0–9, 10–19, 20–29, 30–39, 40–49, 50–59, 60–69, and ≥ 70 years), sex, region of injury (right and left upper and lower limbs, spinal cord level), affected nerves, presence of other associated injuries, and permanent losses were evaluated. Permanency was defined as the presence of degeneration in electromyography (EMG) and/or losses diagnosed by neurologists with clinical signs, EMG findings and/or radiological images at least 18 months after the trauma.

Data management and analysis

The data were presented as frequencies and percentages, and the IBM SPSS Statistics software v22.0 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.) was used for all statistical analyses. A *p*-value less than 0.05 was considered statistically significant. Benjamini–Hochberg correction was applied to all *p* values and adjusted (adj.) *p* values were shown in the study.

The Chi-square test (or Monte Carlo adj. *p*-values) was used to assess associations between qualitative variables (Mehta and Patel 2011), and the adjusted residuals were used to determine which cells were responsible for significant Chi-square results in r × c tables (Everitt 1992). The data were normally distributed, fulfilling the independence null hypothesis of the Chi-square test, and were reported as z-scores. A positive z-score greater than 1.96 indicated that the observed frequency in that cell exceeded the expected frequency.

Results

Of the 299 cases included in this study, 236 (78.9%) were male and 63 (21.1%) were female. The mean age was 35.56 ± 15.10 years (range 1–74 years), and the distribution of cases in each age groups was compared by sex was seen to significantly differ (Adj. $p = 0.004$; Table 1).

Table 1 The distribution of cases by sex and age group

Sex *Adj. p-value = 0.004*[†]		Age Group								Total
		0–9	*10–19*	*20–29*	*30–39*	*40–49*	*50–59*	*60–69*	*≥ 70*	
Female	***n (%)***	3 *(50.0)*	13 *(31.0)*	5 *(7.2)*	11 *(16.7)*	15 *(24.6)*	7 *(19.4)*	6 *(42.9)*	3 *(60.0)*	63 *(21.1)*
	Adjusted residual	1.8	1.7	**− 3.2**[a]	− 1.0	.8	− .3	**2.0**[a]	**2.2**[a]	
Male	***n (%)***	3 *(50.0)*	29 *(69.0)*	64 *(92.8)*	55 *(83.3)*	46 *(75.4)*	29 *(80.6)*	8 *(57.1)*	2 *(40.0)*	236 *(78.9)*
	Adjusted residual	− 1.8	− 1.7	**3.2**[a]	1.0	− .8	.3	**− 2.0**[a]	**− 2.2**[a]	
Total	***n (%)***	6 *(100.0)*	42 *(100.0)*	69 *(100.0)*	66 *(100.0)*	61 *(100.0)*	36 *(100.0)*	14 *(100.0)*	5 *(100.0)*	299 *(100.0)*

[†] Pearson Chi-Square test results, Adj. *p*-value

[a] Significant adjusted residual

Of the 299 cases included in this study, 217 (72.6%) patients had PNIs, 81 (27.1%) had SCIs, and 1 (0.3%) patient had both SCI and PNI. Amongst those diagnosed with PNIs, 136 (62.4%) and 82 (37.6%) cases exhibited injuries of the upper and lower extremities, respectively, and the most commonly observed etiological factor was traffic accidents ($n=170$, 56.9%). The associations between the type of trauma and the affected nerves (peripheral/spinal cord) and anatomical regions have been shown in Table 2. Falls ($n=2$), iatrogenic ($n=7$), crush ($n=6$), crush and incisive injuries ($n=6$), and falls from height ($n=4$), and the patient had both PNI and SCI ($n=1$) have not been shown in Table 2. Also, about affected anatomical regions ($n=7$), both left and right lower limbs ($n=1$); right upper and lower limbs ($n=1$); right upper and left lower limbs ($n=1$); left upper and lower limbs ($n=2$); left upper and right lower limbs ($n=1$); right upper limb and spinal column ($n=1$) have not been indicated in Table 2.

A total of 288 PNIs were observed in this study, with 49 patients exhibiting > 1, 31 exhibiting > 2, 15 exhibiting > 3, and 3 exhibiting > 4 injuries. Of these, 153 (53.1%) injuries were caused by traffic accidents. Among the peripheral nerves, the common fibular nerve ($n=49$) was most commonly affected. And, its injuries were significantly higher in motorcycle accidents compared to other types of traumas (Adj. $p<0.05$).

Of the 82 SCIs included in this study, 58 (70.7%) were caused by traffic accidents. The incidences of cervical and radial nerve injuries were significantly higher among in-vehicle traffic accidents (Adj. $p<0.05$), and the distribution of injured nerves by the type of injury has been shown in Table 3.

Fractures/dislocations accompanied by nerve damages were observed in 191 (63.9%) cases, of which 60 cases exhibited > 1 fracture/dislocation. A total of 251 fractures/dislocations were observed in this study, and the three most commonly fractured bones were the vertebra ($n=75$, 29.0%), humerus ($n=31$, 12.0%), and tibia ($n=25$, 9.9%). Fractures of the humerus were most commonly associated with radial ($n=18$) and ulnar ($n=16$) nerve injuries, while the 22 tibial fractures were most frequently accompanied by common fibular nerve injuries. The majority of these were caused by traffic accidents [17 out-vehicle (10 motorcycle accidents and 7 pedestrians) and 5 in-vehicle traffic accidents]. The distribution of injuries that were accompanied by nerve trauma has been shown in Table 4.

Permanent functional and sensorial losses associated with traumatic nerve injuries were observed in 239 (79.9%) cases, of which 171 exhibited loss of muscle strength, 114 presented with neuro-sensorial symptoms, 37 had urinary/faecal incontinence, and 1 demonstrated erectile dysfunction. Some cases exhibited more than one loss. Neuro-sensorial findings such as neuropathic pain, radiculopathy, and anaesthesia/hypoesthesia, and functional losses associated with diminished muscle strength including paraplegia ($n=30$), tetraplegia ($n=8$), hemiparesis ($n=8$), tetraparesis ($n=6$), monoparesis ($n=3$), and paraparesis ($n=1$) were observed.

The incidence of permanent losses associated with nerve injuries were notably higher in traffic accidents ($\chi^2=50.095$, Adj. $p<0.001$). In contrast, the incidence of permanent losses was significantly lower after occupational accidents, firearm injuries ($\chi^2=7.398$, Adj. p-value$=0.038$; $\chi^2=7.917$, Adj. p-value$=0.032$,

Table 2 The associations between the type of trauma and the affected nerves (peripheral/spinal cord) and anatomical regions

			Type of trauma					Total n *(%)*
			Traffic	*Occupational*	*Firearm*	*Stabbing*	*Incisive*	
Nerves	***PNIs***	**n *(%)***	112 (65.9)	14 *(50.0)*	20 *(87.0)*	36 *(100.0)*	16 *(100.0)*	198 *(72.5)*
	SCIs	**n *(%)***	58 *(34.1)*	14 *(50.0)*	3 *(13.0)*	-	-	75 *(27.5)*
	Total	**n *(%)***	170 *(100.0)*	28 *(100.0)*	23 *(100.0)*	36 *(100.0)*	16 *(100.0)*	273 *(100.0)*
	Adj. p-value		**0.004[a]**	**0.009[a]**	0.138[a]	**< 0.001[a]**	**0.024[a]**	**< 0.001[†]**
Anatomical regions	***Right upper limb***	**n *(%)***	33 *(19.7)*	2 *(7.1)*	3 *(13.6)*	14 *(40.0)*	11 *(68.8)*	63 *(23.5)*
	Left upper limb	**n *(%)***	32 *(19.2)*	5 *(17.9)*	6 *(27.3)*	15 *(42.9)*	5 *(31.2)*	63 *(23.5)*
	Right lower limb	**n *(%)***	21 *(12.6)*	4 *(14.3)*	4 *(18.2)*	2 *(5.7)*	-	31 *(11.6)*
	Left lower limb	**n *(%)***	23 *(13.8)*	3 *(10.7)*	6 *(27.3)*	4 *(11.4)*	-	36 *(13.4)*
	Spinal column	**n *(%)***	58 *(34.7)*	14 *(50.0)*	3 *(13.6)*	-	-	75 *(28.0)*
	Total	**n *(%)***	167 *(100.0)*	28 *(100.0)*	22 *(100.0)*	35 *(100.0)*	16 *(100.0)*	268 *(100.0)*
	Adj. p-value		**0.032[a]**	**0.066[†]**	0.132[†]	**< 0.001[†]**	**< 0.001[†]**	**< 0.001[†]**

[†] Monte Carlo (2-sided) Adj. *p*-value

[a] Pearson Chi-Square test results, Adj. *p*-value

Table 3 The distribution of injured nerves by the type of trauma

Nerves		*Motorcycle accidents*	*Out-vehicle traffic accidents*[*]	*In-vehicle traffic accidents*	*Falls from heights*	*Crush injuries*	*Falls*	*Pull and strain injuries*	*Firearm injuries*	*Incisive injuries*	*Stab injuries*	*Crush and incisive injuries*	*Iatrogenic injuries*	Total		x^2	Adj. *p*-value
														n	*%*		
Peripheral Nerves (*n* = 288, 100.0%)	***Common fibular***	15	5	9	3	2	-	-	6	-	3	1	5	*49*	*17.0*	-	*0.002*[b]
	Ulnar	8	5	11	1	-	-	-	2	8	5	4	-	*44*	*15.3*	-	*0.023*[b]
	Radial	3	6	16	-	-	1	-	4	1	5	3	-	*39*	*13.6*	-	*0.118*[b]
	Digital	2	1	1	-	4	-	-	3	4	17	3	-	*35*	*12.2*	-	*< 0.001*[b]
	Median	6	6	4	-	-	-	-	1	4	4	3	-	*28*	*9.7*	-	*0.072*[b]
	Tibial	7	3	5	1	1	-	-	4	-	2	-	4	*27*	*9.4*	-	*0.032*[b]
	Brachial plexus	7	5	4	-	1	-	1	3	-	-	-	-	*21*	*7.3*	*14.252*	*0.139*[a]
	Sural	3	2	2	-	-	-	-	1	-	2	-	3	*13*	*4.5*	-	*0.076*[b]
	Sciatic	1	2	1	-	-	-	-	1	-	1	-	1	*7*	*2.4*	*7.842*	*0.567*[a]
	Superficial fibular	2	1	1	-	1	-	-	-	-	-	-	-	*5*	*1.7*	*7.317*	*0.604*[a]
	N. cut. antebrachii med	-	-	-	-	-	-	-	-	-	4	-	-	*4*	*1.4*	-	-
	Axillary	-	-	2	-	-	-	-	1	-	-	-	-	*3*	*1.1*	-	-
	Deep fibular	1	1	1	-	-	-	-	-	-	-	-	-	*3*	*1.1*	-	-
	Saphenous	2	-	-	-	-	-	-	-	-	1	-	-	*3*	*1.1*	-	-
	Femoral	-	-	-	-	-	-	-	1	-	1	-	-	*2*	*0.7*	-	-
	N. glut. sup	-	-	1	-	-	-	-	-	-	-	-	-	*1*	*0.3*	-	-
	N. cut. fem. ant	-	-	-	-	-	-	-	-	-	1	-	-	*1*	*0.3*	-	-
	Lumbosacral plexus	-	-	-	-	-	-	-	1	-	-	-	-	*1*	*0.3*	-	-
	Lat. Fem. Cut	-	-	-	1	-	-	-	-	-	-	-	-	*1*	*0.3*	-	-
	Not specified	1	-	-	-	-	-	-	-	-	-	-	-	*1*	*0.3*	-	-
Spinal Cord (*n* = 82, 100.0%)	***Cervical***	4	4	22	3	1	-	-	1	-	-	-	-	*35*	*42.7*	*30.807*	*< 0.001*[a]
	Thoracic	1	3	9	7	3	-	-	1	-	-	-	1	*25*	*30.5*	*33.672*	*< 0.001*[a]
	Lumbar	2	1	9	3	-	1	-	2	-	-	-	-	*18*	*21.9*	*13.954*	*0.132*[a]
	Thoracic + Lumbar	-	-	2	1	-	-	-	-	-	-	-	-	*3*	*3.7*	-	-
	Cervical + Lumbar	1	-	-	-	-	-	-	-	-	-	-	-	*1*	*1.2*	-	-

[a] Pearson Chi-Square, Adj. *p*-value

[b] Monte Carlo (2-sided) Adj. *p*-value

[*] Out-vehicle traffic accidents except for motorcycle accidents

respectively). No statistically significant differences in other injury types ($p > 0.05$) were observed.

Discussion

Traumatic nerve injuries can not only affect the patient's quality of life but also have social and economic consequences for both the individual as well as society due to the permanent functional and sensorial damages they may cause.

This study of traumatic nerve injuries included 299 cases that was predominantly male and had a mean age of 35.56 ± 15.10 years. This distribution was in agreement with previous literature (Moshi et al. 2017; Huckhagel et al. 2018b; Noble et al. 1998; Miranda and Torres 2016; Kouyoumdjian et al. 2017; Babaei-Ghazani et al. 2017).

Comparison of the age groups and sexes showed a statistically significant difference, with the proportion of males in the 20–29 year age group being significantly higher than the proportion of females. Previous studies have also reported a higher incidence of PNIs among young adult males (Miranda and Torres 2016; Kouyoumdjian et al. 2017). A global study examining SCIs found that the most commonly affected age group was 15–30 years (Singh et al. 2014), and this was attributed to young adult males being more active than females in business and social life (Singh et al. 2014; Miranda and Torres 2016; Kouyoumdjian et al. 2017).

In the present study, 56.9% of injuries were caused by traffic accidents and this was significantly higher than the incidence of other injuries. In contrast, Saadat et al. stated that the most common etiological factor for nerve injuries was stabbing, followed by traffic accidents (Saadat et al. 2011). Miranda et al. reported a higher incidence of trauma caused by firearms among patients diagnosed with PNIs and this could be attributed to the higher crime rates in the region where the study was carried out (Miranda and Torres 2016). These differences between studies may have resulted from variations in living conditions, culture, and geography in the countries where the studies were conducted.

While some studies found that traffic accidents played a significant etiological role in PNIs (Eser et al. 2009; Huckhagel et al. 2018a; Kouyoumdjian et al. 2017). Singh et al. reported similar findings among SCIs (44.5%–61.6%) except in a few regions (Singh et al. 2014). Traffic accidents (38.6%) were also found to be the most common cause of SCIs in the United States since 2015, as per a datasheet published by the National Spinal Cord Injury Statistical Centre in 2020 which found that 70.7% of SCIs and 53.1% of PNIs were caused by traffic accidents (United States National Spinal Cord Injury Statistical Centre 2020).

These findings emphasise the impact of traffic accidents on mortality and morbidity today. The global increase in vehicular traffic and the lack of awareness and sensitivity about traffic rules have made related accidents a crucial public health problem, highlighting the need for provision of adequate training regarding traffic rules and the creation of social awareness from an early age. Also, there is much more to be done than simply more training. Today, we are driving ever more sophisticated vehicles, in greater numbers, on roads originally designed many years ago. Therefore, encouraging public transportation to reduce vehicular traffic and building satisfactory roads will also be effective in reducing mortality and morbidity due to traffic accidents.

Approximately ¾ of the cases included in this study exhibited PNIs, of which 62.4% affected the upper extremities. Eser et al. 2009; Saadet et al. 2011; Kouyoumdjian et al. 2017 reported that the incidence rates of upper extremity involvement were 77%, 83.9%, and 72.6%, respectively, and these were slightly higher than the rates observed in the current study. In general, greater usage of the upper extremities makes them more susceptible to injuries in comparison to the lower extremities.

Nearly half (42.7%) of the SCIs were seen to affect the cervical region, and this was in agreement with a previous review of the global incidence and prevalence of traumatic SCIs which found that the most frequently injured anatomical region was the cervical cord (43.9%–61.5% (Singh et al. 2014). A Tanzanian study also found similar results, with approximately 39.9% of cases exhibiting injuries of the cervical region (Moshi et al. 2017). The relatively unprotected spinal cord in the neck region makes it more susceptible to injuries, particularly during acceleration-deceleration, and this is supported by the significantly higher incidence of cervical region traumas associated with in-vehicle traffic accidents after high acceleration and deceleration.

Among the PNIs, common fibular nerve injuries exhibited the highest incidence and were significantly associated with motorcycle accidents. This was in agreement with Huckhagel et al. who evaluated nerve injuries in the lower extremities of 60,422 cases and observed similar results (Huchagel et al. 2018b). This could be attributed to the relatively lower level of protection offered by motorcycles in comparison to cars. Moreover, although motorcycle users are obliged to wear helmets as per the 'Highway Traffic Regulations' in Turkey, the usage of other protective equipment has not been made mandatory as yet (Highway Traffic Regulation, 1997). This, in turn, increases the risk of injuries to nerves of the lower extremities, particularly those that are superficially located such as the common fibular nerve, during

Table 4 The distribution of injuries that were accompanied by nerve trauma

Accompanied injuries	n	%
Fracture/dislocation	144	48.2
Muscle/tendon	42	14.0
Vascular & Muscle/Tendon	26	8.7
Non/Skin Lesions/Soft tissue traumas	23	7.7
Crush[a]	22	7.4
Fracture/dislocation & Muscle/Tendon	15	5.0
Fracture/dislocation & Vascular	11	3.7
Traumatic disc herniation	7	2.3
Vascular	4	1.3
Fracture/dislocation & Traumatic disc herniation	3	1.0
Direct injury of spinal cord[b]	2	0.7
Total	**299**	**100.0**

[a] There were also fractures in 18 of the crush injuries

[b] Central cord syndrome ($n=1$), Spinal cord injury due to spinal anesthesia ($n=1$)

motorcycle accidents. These findings emphasise the need for use of complete protective equipment by motorcycle users in order to prevent permanent nerve damage.

The second most common PNIs were those affecting the ulnar nerve, and these were significantly associated with all kinds of traffic accidents and stabbing and incisive injuries. This was in agreement with Kouyoumdjian et al. who also found that the ulnar nerve was commonly injured either individually or in combination with other nerves (Kouyoumdjian et al. 2017).

The radial nerve was the third most commonly injured nerve, and the incidence of such injuries was significantly associated with in-vehicle traffic accidents. This was followed by digital nerve injuries which were significantly associated with stabbing trauma associated with self-defence and home accidents.

Tsai et al. found that humeral fractures were most commonly associated with traffic accidents (63.2%), and 11% of cases exhibited associated radial nerve damage (Tsai et al. 2009). Previous studies have also reported higher incidence of ulnar and radial nerve injuries, particularly in association with humerus fractures and traffic accidents, and this could be attributed to their anatomical location (Huchagel et al. 2018a; Macêdo Ricci et al. 2015). Similarly, humerus fractures were seen to be commonly associated with PNIs (radial nerve injury $n=18$, ulnar nerve injury $n=16$) in the current study, suggesting the need for examination of these nerves to rule out possible damage following humeral fractures in traffic accidents.

In the current study, the most commonly observed fractures were those affecting the vertebral bone ($n=75$, 29.0%), and these were seen to occur in 92.6% of cases ($n=81$) diagnosed with SCIs. This suggests that SCIs commonly accompany high-energy trauma resulting in fractures of the vertebral column. However, a retrospective study examining traumatic spinal fractures caused by traffic accidents over a period of 11 years in China observed SCIs in nearly half of the cases (42.7%), and the incidence rate was seen to decrease with increasing age (53.1% in the ≤ 19-year-old age group and 24.6% in the ≥ 60 age group) (Wang et al. 2016). This suggests that although spinal fractures played an important etiological role in SCIs, they were not the only factor involved.

In the current study, the third most common bone fractures were those affecting the tibia ($n=25$, 9.9%), and these were most frequently caused by traffic accidents ($n=22$) and were associated with common fibular nerve injuries. Tibial fractures were frequently associated without-vehicle traffic accidents ($n=17$, 77.3%), particularly motorcycle accidents ($n=10$). Huchagel et al. 2018b; in their study evaluating 60,422 cases with leg injuries found that the fibular nerves were affected in 55% of tibial fractures, and the most common etiological factors were motorcycle (31.2%) and car accidents (30.7%). A Pakistani study also reported similar results, with more than half (55.8%) of motorcycle accidents being associated with tibial fractures (Tahir Lakho et al. 2019). The findings of the current study were consistent with the literature, emphasising the importance of protective equipment for both motorcycle drivers and passengers.

Nerve injuries may be associated with permanent loss of motor, autonomic, or sensory functions, resulting in chronic neuropathic pain, hypoesthesia, hyperalgesia, and cold sensitivity (Perrin and Noristani 2019; Osborne et al. 2018). The patients included in the current study reported experiencing neuropathic pain, radiculopathy, and anaesthesia/hypoesthesia, in addition to severe motor functional losses such as paresis, plegia, and incontinence. Permanent loss of function was more commonly associated with traffic accidents and this was statistically significant. This suggests that nerve healing may be associated with the mechanism and type of injury.

Conclusions

The forensic significance of peripheral and spinal nerve injury cases can be substantial in both criminal and civil proceedings. In criminal proceedings: peripheral and spinal nerve injuries may serve as crucial evidence of violence or assault. The nature and extent of nerve injuries can help establish the force applied and the severity of the attack. Additionally, they can aid in identifying the type of weapon used and may contribute to understanding the dynamics of the crime. Also, forensic experts specializing in neurology or pathology can provide valuable testimony regarding the nature and origin of nerve injuries, helping the court understand the potential intent behind the actions. In terms of civil proceedings: nerve injuries can be central to determining liability. Understanding how and when the injury occurred is crucial for establishing negligence or fault. Also, shown in this study, PNIs and SCIs can result in long-term or permanent damages, leading to significant physical and emotional consequences. Accurately quantifying these damages are essential for determining compensation amounts. Behinds, the forensic assessment of nerve injuries may involve considerations of ongoing medical care, rehabilitation, and associated costs. This information is vital for estimating the financial impact on the injured party. Moreover, the presence and severity of nerve injuries can influence the pleas and negotiations. Defendants may consider plea bargains based on the strength of evidence related to nerve injuries. In civil cases, knowledge of the forensic significance of nerve injuries can impact settlement negotiations. Both parties may consider the potential outcomes at trial, leading to more informed settlement discussions. Therefore, this study will contribute to criminal and civil proceedings.

The current study found that young adult males were at a higher risk of traumatic nerve injuries. Moreover, healthcare professionals should take into consideration the relationship between the type of trauma and the nerves injured, traffic accidents often resulting in permanent functional losses. These findings emphasise the importance of raising political and social consciousness regarding trauma prevention and road traffic safety.

Common fibular nerve injuries were significantly associated with motorcycle accidents, highlighting the importance of using protective equipment. And, the significantly higher incidence of cervical and radial nerve injuries following in-vehicle traffic accidents draws attention to the ergonomic design of such vehicles which may help to prevent or reduce such trauma.

Permanent loss of sensory, motor, or autonomic functions was observed in more than half of the cases included in this study. Therefore, the adoption of protective measures by groups at higher risk of certain types of injury may be effective in preventing permanent disabilities and the associated social and economic consequences for both individuals and populations.

This study has limitations. Mostly because of the long period of judicial processed in our country, the data presented in this study are at least 5 years ago. Since this retrospective study was based on medical files review, the evaluation was made by taking into consideration of the existing documents. So, electromyography reports cannot be obtained in all PNIs. Besides, because of reviewing only living individuals' files, we may not present the characteristics of some spinal cord injury cases who will have been fatal (cervical cord transection, for example) at the scene of an accident. Also, in traffic accidents, we could not assess whether the cases are passengers or drivers which may affect the type of injury. Additionally, the details of the treatment of the cases for their nerve injuries were not examined in this study, and so the effect of the treatments applied on functional losses has not been evaluated. For these reasons, there is a need for prospective studies that will enable these issues to be evaluated in detail.

Abbreviations

SPSS Statistical Package for the Social Sciences
SCIs Spinal Cord Injuries
PNIs Peripheral Nerve Injuries

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Authors' contributions

All authors have substantial contributions to the acquisition, analysis, or interpretation of data for the study. AK: Conceptualization, Methodology, Writing-Reviewing and Editing, Supervision, Visualization. ES: Conceptualization, Methodology, Supervision. EB: Investigation, Data curation, Writing-Original draft preparation. HA: Investigation, Data curation, Writing-Original draft preparation. All authors read and approved the final version of the submitted manuscript.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the Medical Research Ethics Committee of Ege University, Faculty of Medicine (Decision no: 19-2 T/29).

Consent for publication

Applicable.

Competing interests

The authors declare that they have no competing interests.

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