Trauma Mon. 2018 May; 23(3):e59809. doi: 10.5812/traumamon.59809.
Published online 2017 August 19. **Research Article**

Cervical and Upper Limb Peripheral Nerve Injuries in Adults: Electrodiagnostic Studies and Symptoms

Bina Eftekharsadat,[1] Arash Babaei-Ghazani,[2,*] Bahram Samadirad,[3] and Vida Mamaghany[3]

[1]Physical Medicine and Rehabilitation Research Center, Tabriz University of Medical Sciences, Tabriz, Iran
[2]Neuromusculoskeletal Research Center, Physical Medicine and Rehabilitation Department, Iran University of Medical Sciences, Tehran, Iran
[3]Legal Medicine Research Center, Legal Medicine Organization, Tehran, Iran

[*]*Corresponding author*: Arash Babaei-Ghazani, Department of Physical Medicine and Rehabilitation, Firozgar Hospital, Valiasr square, Iran University of Medical Sciences, Tehran, Iran. E-mail: arashbabaie@gmail.com

Received 2016 December 24; **Revised** 2017 April 13; **Accepted** 2017 June 10.

Abstract

Background: Peripheral nerve injury (PNI), due to upper extremity and cervical trauma can impair hand function, as well as affect quality of life.
Objectives: In this study we aimed to evaluate clinical symptoms and electrodiagnostic findings in traumatic upper extremity PNI.
Methods: A total of 106 traumatic patients with upper extremity peripheral nerve injuries were recruited and completed a physical examination. In addition, an electrodiagnostic study was performed to investigate detailed pattern of nerve lesions.
Results: Of 106 patients, 88 were males with a mean age of 36.6 ± 14.91. Thirty-three patients had an involvement in the forearm area and 20 of them had an injury of the shoulder girdle. Twenty-one had ulnar nerve injury, 8 had median, and 8 had radial nerve involvement. Furthermore, the ulnar nerve was the most common nerve injury among other nerve involvements. Only 10 patients had plexopathy and 10 other had radiculopathy.
Conclusions: Ulnar nerve lesions were highly prevalent in upper limb trauma followed with brachial plexopathy and radiculopathy. The forearm and shoulder girdle are more susceptible to nerve injury.

Keywords: Trauma, Nervous System, Upper Extremity, Electrodiagnostic Study

1. Background

Peripheral nerve injuries (PNI) are extremely common in many types of upper limb trauma, which occurs in 2% - 3% of cases (1-3). PNI can cause extreme dysfunction in the hand for the patient disrupting their professional and leisure activities. PNI pose various challenges to patients, ranging from mild discomfort to life-long impairment. It may be accompanied by neurological deficits. These injuries may lead to irreversible disabilities in patients, such as sensory loss, deficient motor function, pain problems in terms of cold intolerance and hyperesthesia that can ultimately impair hand function, and affect quality of life at work and in society (4-6).

Certain peripheral nerves are at an increased risk of injury due to their anatomic location (1). The most affected nerves in the upper limb are ulnar, median, radial, and digital nerves (7-9). Mild injuries may cure without intervention, however, severe injuries may lead to lifelong disabilities if they are not diagnosed and treated appropriately (2, 3, 10, 11).

Patients with upper extremity PNI need long time hospital admission and rehabilitation cares; therefore early diagnosis and treatment of these patients is important (12). Defining the exact injured nerve could also help in its better treatment. It is shown that median nerve injury compared to other nerves has better recovery time (13).

Special tests can be used to support or confirm a nerve injury including electromyography (EMG), nerve conduction studies (NCS), or electrical muscle stimulation in different disease (9, 14, 15). Electromyography (EMG) is the most important diagnostic method for evaluating PNIs. These studies help in precise localization of the lesion and also in assessing the severity of the lesion, thus facilitating the treatment options (16). Early identification of PNI is important, because untreated PNI may be the source of serious disabilities in later life.

2. Objectives

In this study, we aimed to evaluate the distribution of upper extremity PNI in traumatic patients in northwest

Iran.

3. Methods

Between April 2012 and April 2013, all patients with upper extremity trauma visiting Forensics Organization were included. All traumatic patients were examined and those with any clinical doubt of upper or cervical peripheral nerve were included. Patients with iatrogenic etiology of injury were excluded. This study was approved by the ethics committee of Tabriz University of Medical Sciences, and informed consent was obtained from all study participants.

Patients' demographic information, their past trauma history, recent trauma characteristics, and physical examination findings were recorded. All patients were referred to a physical medicine and rehabilitation clinic for diagnostic investigations. Physical medicine and rehabilitation specialist performed complete sensory and motor examination as well as electrodiagnostic investigations (electromyography (EMG) and nerve conduction study (NCS)). The median, ulnar, and radial were examined using both sensory nerve action potential (SNAP) and compound muscle action potential (CMAP). To examine musculocutaneous nerves, medial, and lateral ante-brachial cutaneous nerves (MAC, LAC) SNAP method and for axillary nerve, CMAP method have been used. Complete Needle Electromyography (EMG) of all muscles innervated from different cervical nerve roots, brachial plexus (trunk, division, cord and terminal branches) and peripheral limb nerves were performed. Concentric EMG needles were used.

All statistical tests were performed using SPSS for windows Version 17 (Chicago, IL, USA). Quantitative data were presented as mean $\pm$ standard deviation (SD), while qualitative data were demonstrated as frequency and percent (%).

4. Results

In this study, 106 patients with upper extremity or cervical traumatic injury, including 88 male and 18 female with mean age of 36.6 $\pm$ 14.91 years, were included. Only 1 patient had a previous history of PNI (0.9%).

Trauma was caused with vehicular accidents in 50 patients (47.2%), fight in 33 patients (31.1%), and work-related in 23 patients (21.7%). The injuries were made by 3 types of factors including, hard objects in 72 patients (68.6%), sharp objects in 32 patients (30.5%), and gunshot in only 1 patient (0.9%). Patients' main chief complaints were pain (17%), weakness (37.7%), parasthesia (26.4%), and pain, weakness or parasthesia together (18.9%).

Of 106 patients, 85 patients (80.2%) had upper extremities trauma, 19 patients (17.9%) had cervical trauma, and 2 patients (1.9%) had both upper extremities and cervical trauma (Table 1).

Table 1. Detailed Location of Trauma Site in Patients

Trauma Site	Number of Patients (Percent)
Cervical	18 (17%)
Shoulder girdle	20 (18.8%)
Arm	10 (9.4%)
Forearm	33 (31.1%)
Hand	13 (12.2%)
Cervical + shoulder	2 (1.9%)
Cervical + hand	1 (0.9%)
Shoulder + arm	1 (0.9%)
Shoulder + forearm	1 (0.9%)
Shoulder + forearm + hand	1 (0.9%)
Arm + forearm	1 (0.9%)
Arm + hand	1 (0.9%)
Arm + forearm + hand	1 (0.9%)
Forearm + hand	3 (2.8%)
Total	106 (100%)

Of 106 traumatic patients enrolled in this study, 44 patients (42.3%) had open wound injury in trauma location, 27 patients (26.0%) had tendon injury, 35 patients (33.7%) had fracture or dislocation in the traumatic extremity, and 44 patients (42.3%) had limitation in range of motion in the injured joint. In physical examination of patients, in 67 patients (63.2%) there was some degree of impairment in the sensory function of upper extremities including 60 male and 7 female; and in 74 patients (69.8%) there was some degree of muscle force reduction (64 male and 10 female) (Table 2).

Duration time between injury and first electrodiagnostic exam was between 3 - 6 weeks after injury. PNI were present in 56 cases (52.8%), which were mild in 9 patients (8.5%), moderate in 7 (6.6%), and severe in 42 cases (39.6%) (55 male and 3 female). Injuries in ulnar and median nerves alone or along with other nerves injury were the most common PNIs (Table 3). Electrodiagnostic examination revealed radiculopathy in 10 patients (9.4%) including mild radiculopathy in 6 and moderate in 4 cases. EMG findings showed plexopathy in 10 patients (9.4%) (including 5 moderate and 5 severe plexopathy).

Table 2. Sites of Muscle Force Reduction in Patients

Site	Number of Patients (Percent)
No muscle force reduction	32 (30.2%)
Shoulder	6 (5.7%)
Wrist	4 (5.7%)
Hand fingers	26 (24.5%)
Shoulder + elbow	3 (2.8%)
Shoulder + elbow + wrist	1 (0.9%)
Shoulder + elbow + hand fingers	1 (0.9%)
Elbow + hand fingers	1 (0.9%)
Elbow + wrist + hand fingers	3 (2.8%)
Wrist + hand fingers	16 (15.1%)
Whole upper extremity	13 (12.3%)
Total	106 (100%)

Table 3. Upper Extremities Peripheral Nerve Injuries in Patients

Injured Nerve	Number of Patients (Percent)
No peripheral nerve injuries	48 (45.3%)
Median	8 (7.5%)
Ulnar	21 (19.8%)
Radial	8 (7.5%)
Axillary	2 (1.9%)
Superficial Radial	5 (4.7%)
Accessory	2 (1.9%)
Median + Ulnar	6 (5.7%)
Median + Radial	1 (0.9%)
Median + Musculocutaneous	1 (0.9%)
Ulnar + Radial	2 (1.9%)
Musculocutaneous + Axillary	1 (0.9%)
Median + Ulnar + Musculocutaneous + Axillary	1 (0.9%)
Total	106 (100%)

5. Discussion

In this study we evaluated the gender ratio, physical symptoms, and electrodiagnostic findings of cervical and upper extremity PNI. We observed a higher rate of PNI in males than females; similarly, Nobel et al. (2) showed that peripheral nerve injuries in extremities are more prevalent in males than females; while Taylor et al. (10) reported equal rate of PNI in both males and females. Higher trauma and PNI rate in males may be because males are more prone to high-risk situations like fight and work-related traumas and their related PNIs.

Vehicular accidents were the most common cause of trauma and trauma by sharp objects only occurred in 30.5% of cases. Similarly, previous studies have reported motor vehicle accidents as the main cause of injury and sharp objects as a small proportion of cases (2, 7, 9). Immediate nerve reconstruction is indicated in PNIs with sharp nerve lacerations (2).

Some mechanisms of trauma could be prevented; e.g. with proper preventive measures at the structural, organizational, and personnel levels to increase the safety of industrial workers especially those performing hard tasks, these traumas could be prevented (17).

Nerve injury should be considered when a patient experiences pain, weakness, or paresthesia in the absence of a known bone, soft tissue, or vascular injury (1). We observed that weakness and parasthesia were more common than pain as the main complaint of these patients.

In this study, decrease in muscle force of traumatic site was found in physical examination of most patients and wrist and fingers were the most prevalent sites. Other clinical findings as sensory loss were not considerable. The most common sites of injury were forearm, shoulder girdle, and cervical region respectively.

It is reported that the majority of PNI occur at the level of the upper arm (18, 19). Additionally, other studies have reported that the majority of PNIs occurred in the wrist and hand region (20). Saadat and colleagues (21) reported the forearm to be the most frequently involved area, followed by the wrist and hand. PNI at the forearm level can result in substantial functional loss and have major social consequences (22). Superficial location of the nerves in the forearm, wrist, and hand as well as their exposure in daily work with sharp cutting objects could be a reason for higher rate of PNI in these regions (21).

Electrodiagnostic assessment of peripheral nerve involvement is useful in different studies (23) and could be useful in detecting PNI. In our study all patients have some complaints recommending possible PNI. However, EMG-NCS findings showed that PNI were only present in 54.7% and the prevalence of radiculopathy and plexopathy was low (less than 10%). The most common PNI in upper extremity were ulnar nerve and then median nerve alone or along with others. Cervical root, brachial plexus, median, and radial nerves were also injured. The most prevalent combined nerve injury was median with ulnar nerve involvement.

This study results are similar to the studies done by Kouyoumdjian (8) as well as Saadat and colleagues (21), which reported that most of the PNIs are single rather than multiple nerve injuries and combined lesions most commonly involved the ulnar and median nerves. Previous reports have also reported the ulnar nerve as the main injured nerve followed by median nerve injury and the lower

involvement of radial nerve (7, 8). However, several studies have reported radial nerve as the most frequent nerve (2, 24, 25). In a population selected from the hand surgery unit, McAllister et al. (9) also reported digital nerves as the most commonly injured nerves in the upper limb. In our study as well as the Ayromlou et al. (23) study, axial nerve involvement was the less frequent nerve. The difference in the involved nerves in upper limb traumatic injuries could be related to their anatomic location and also the position of victims when the trauma happened.

5.1. Conclusion

The electrodiagnostic study seems to be necessary in case of suspicion for cervical or peripheral nerve lesions after trauma and about half of the patients with positive physical examinations for nerve lesions had negative precise EMG-NCS study. Upper limb nerve lesions due to trauma is highest among middle-aged males and traffic accident is leading cause. Ulnar, cervical root, brachial plexus, median, and radial nerves are the most prevalent traumatic upper limb nerve injuries.

Footnotes

Authors' Contribution: Study design, data collection, and critical revision: Bina Eftekharsadat; data collection, data analysis, and data interpretation: Arash Babaei-Ghazani; literature research, study design, writing, and clinical revision of the article: Bahram Samadirad; literature research, writing, critical revision: Vida Mamaghany.

Funding/Support: This study was sponsored by Tabriz University of Medical Sciences.

References

1. Neal S, Fields KB. Peripheral nerve entrapment and injury in the upper extremity. *Am Fam Physician*. 2010;**81**(2):147–55. [PubMed: 20082510].
2. Noble J, Munro CA, Prasad VS, Midha R. Analysis of upper and lower extremity peripheral nerve injuries in a population of patients with multiple injuries. *J Trauma*. 1998;**45**(1):116–22. [PubMed: 9680023].
3. Selecki BR, Ring IT, Simpson DA, Vanderfield GK, Sewell MF. Trauma to the central and peripheral nervous systems. Part II: A statistical profile of surgical treatment New South Wales 1977. *Aust N Z J Surg*. 1982;**52**(2):111–6. [PubMed: 6952849].
4. Scholz T, Krichevsky A, Sumarto A, Jaffurs D, Wirth GA, Paydar K, et al. Peripheral nerve injuries: an international survey of current treatments and future perspectives. *J Reconstr Microsurg*. 2009;**25**(6):339–44. doi: 10.1055/s-0029-1215529. [PubMed: 19301234].
5. Campbell WW. Evaluation and management of peripheral nerve injury. *Clin Neurophysiol*. 2008;**119**(9):1951–65. doi: 10.1016/j.clinph.2008.03.018. [PubMed: 18482862].
6. Arslantunali D, Dursun T, Yucel D, Hasirci N, Hasirci V. Peripheral nerve conduits: technology update. *Med Devices (Auckl)*. 2014;**7**:405–24. doi: 10.2147/MDER.S59124. [PubMed: 25489251].
7. Adeyemi-Doro HO. Pattern of peripheral traumatic neuropathy of the upper limb in Lagos. *Injury*. 1988;**19**(5):329–32. [PubMed: 3255711].
8. Kouyoumdjian JA. Peripheral nerve injuries: a retrospective survey of 456 cases. *Muscle Nerve*. 2006;**34**(6):785–8. doi: 10.1002/mus.20624. [PubMed: 16881066].
9. McAllister RM, Gilbert SE, Calder JS, Smith PJ. The epidemiology and management of upper limb peripheral nerve injuries in modern practice. *J Hand Surg Br*. 1996;**21**(1):4–13. [PubMed: 8676027].
10. Taylor CA, Braza D, Rice JB, Dillingham T. The incidence of peripheral nerve injury in extremity trauma. *Am J Phys Med Rehabil*. 2008;**87**(5):381–5. doi: 10.1097/PHM.0b013e31815e6370. [PubMed: 18334923].
11. Murovic JA. Upper-extremity peripheral nerve injuries: a Louisiana State University Health Sciences Center literature review with comparison of the operative outcomes of 1837 Louisiana State University Health Sciences Center median, radial, and ulnar nerve lesions. *Neurosurgery*. 2009;**65**(4 Suppl):A11–7. doi: 10.1227/01.NEU.0000339130.90379.89. [PubMed: 19927055].
12. Intiso D, Grimaldi G, Russo M, Maruzzi G, Basciani M, Fiore P, et al. Functional outcome and health status of injured patients with peripheral nerve lesions. *Injury*. 2010;**41**(5):540–3. doi: 10.1016/j.injury.2009.05.002. [PubMed: 19524899].
13. Zangiabadi N, Ahrari MN. Electro-diagnostic and clinical changes of peripheral neuropathies in bam earthquake victims. *American J Environment Sci*. 2005;**1**(3):206–8. doi: 10.3844/ajessp.2005.206.208.
14. Eftekharsadat B, Ahadi T, Raissi GR, Shakoory SK, Fereshtehnejad SM. Validity of current electrodiagnostic techniques in the diagnosis of carpal tunnel syndrome. *Med J Islam Repub Iran*. 2014;**28**:45. [PubMed: 25405111].
15. Jalilzadeh SH, Bahrami A, Eftekharosadat B, Mobasseri M, Pezeshki Z. Peripheral nerve function in subclinical hypothyroidism: A case-control study. *Int J Endocrinol Metab*. 2006;**4**:78–83.
16. Robinson LR. Traumatic injury to peripheral nerves. *Muscle Nerve*. 2000;**23**(6):863–73. [PubMed: 10842261].
17. Moussavi Najarkola SA, Mirzaei R. Evaluation of upper limb musculoskeletal loads due to posture, repetition, and force by rapid upper limb assessment in a textile factory. *J Health Scope*. 2012;**1**(1):18–24. doi: 10.5812/jhs.4532.
18. Stone L, Keenan MA. Peripheral nerve injuries in the adult with traumatic brain injury. *Clin Orthop Relat Res*. 1988;**233**:136–44.
19. Hirasawa Y, Sakakida K. Sports and peripheral nerve injury. *Am J Sports Med*. 1983;**11**(6):420–6. doi: 10.1177/036354658301100607. [PubMed: 6650720].
20. Asplund M, Nilsson M, Jacobsson A, von Holst H. Incidence of traumatic peripheral nerve injuries and amputations in Sweden between 1998 and 2006. *Neuroepidemiology*. 2009;**32**(3):217–28. doi: 10.1159/000197900. [PubMed: 19174611].
21. Saadat S, Eslami V, Rahimi-Movaghar V. The incidence of peripheral nerve injury in trauma patients in Iran. *Ulus Travma Acil Cerrahi Derg*. 2011;**17**(6):539–44. doi: 10.5505/tjtes.2011.75735. [PubMed: 22290008].
22. Jaquet JB, Luijsterburg AJ, Kalmijn S, Kuypers PD, Hofman A, Hovius SE. Median, ulnar, and combined median-ulnar nerve injuries: functional outcome and return to productivity. *J Trauma*. 2001;**51**(4):687–92. [PubMed: 11586160].
23. Ayromlou H, Mohammad-Khanli H, Yazdchi-Marandi M, Rikhtegar R, Zarrintan S, Golzari SE, et al. Electrodiagnostic evaluation of peripheral nervous system changes in patients with multiple sclerosis. *Malays J Med Sci*. 2013;**20**(4):32–8. [PubMed: 24043994].
24. Ahrari MN, Zangiabadi N, Asadi A, Sarafi Nejad A. Prevalence and distribution of peripheral nerve injuries in victims of Bam earthquake. *Electromyogr Clin Neurophysiol*. 2006;**46**(1):59–62. [PubMed: 16607868].
25. Ciaramitaro P, Mondelli M, Logullo F, Grimaldi S, Battiston B, Sard A, et al. Traumatic peripheral nerve injuries: epidemiological findings, neuropathic pain and quality of life in 158 patients. *J Peripher Nerv Syst*. 2010;**15**(2):120–7. doi: 10.1111/j.1529-8027.2010.00260.x. [PubMed: 20626775].