

Electrophysiological and etiological evaluation of 119 cases of wrist drop: A single center study

Zaheer Ahmed Gill,¹ Saeed Bin Ayaz,² Arshia Ahmad,³ Sumeera Matee,⁴ Nadeem Ahmad⁵

Abstract

Objectives: To explore the pattern of electrodiagnostic findings in cases of wrist drop and compare gender, involved side of the body, and military versus civilian population for the aetiology of wrist drop.

Methods: This cross-sectional study was conducted at Armed Forces Institute of Rehabilitation Medicine Rawalpindi, Pakistan, from August 2013 to December 2014, and comprised wrist drop cases regardless of age or gender. Evaluation was done using XLTEK Neuromax 1004 EMG unit in line with the recommended protocol for electrodiagnostic evaluation of a suspected radial nerve injury (RNI). SPSS 20 was used for data analysis.

Results: Of the 119 patients, 97(81.5%) were males, 66(55.5%) were in the 16-30 years' age group, and 96(80.7%) were military personnel. RNI at the mid-arm level was the commonest cause in 88(73.9%) cases. The frequent inciting event was trauma with fracture of the humerus in 39(32.8%) cases. Eighty-four (70.6%) lesions were axonal. Ninety-four (79%) individuals had no associated injury to other nerves. Injuries due to trauma were more frequent in males ($p < 0.001$), on the right side ($p = 0.046$), and in the military population ($p = 0.05$).

Conclusions: RNI at the mid arm level was the commonest cause of wrist drop in our sample and fracture of the humerus was the main inciting event.

Keywords: Axonotmesis, Electrodiagnosis, Electromyography, Neurotmesis, Radial nerve lesions. (JPMA 69: 672; 2019)

Introduction

Wrist drop is a manifestation of radial nerve injury (RNI), posterior cord brachial plexopathy, C7 radiculopathy, or a central lesion. RNI is the most frequent aetiology of wrist drop. Along the proximal portion, RNI can result from fracture of the humerus, blunt or penetrating trauma, compression or ischaemia, and rarely from tumours.¹⁻³ The treatment can be conservative or surgical, depending upon the nature of the inciting event and site as well as severity of the injury. Although literature is replete with methods and approaches for RNI management, there remains a substantial dispute over the ideal management even in the best centres of the world.⁴

The success of treatment in RNI is directly related to the appropriate decision-making regarding the requirement of surgery or alternative interventions. This necessitates the localization and assessment of the severity of the lesion. Electrodiagnostic (EDX) studies serve this purpose by confirming, localizing, and quantifying the lesion severity. It can narrow down the differential diagnoses

and find out subclinical recovery or hidden clinical disorders.⁵ EDX studies, therefore, are an important investigation complementing a thorough history, physical examination, and imaging studies that can lead to an accurate diagnosis and treatment plan.

Nerve conduction studies (NCS) and needle electromyography (EMG) form the core of EDX evaluation. The current study was planned to use EDX evaluation to find out the commonest pattern and frequent aetiology as well as document the neurophysiological findings of nerve injury in patients with wrist drop. It was also planned to compare the study population based on gender, involved side of the body, and military versus civilian population.

Subjects and Methods

This cross-sectional study was conducted at Armed Forces Institute of Rehabilitation Medicine Rawalpindi, Pakistan, from August 2013 to December 2014, and comprised wrist drop cases regardless of age or gender. After permission from the institutional ethics committee, the sample was raised using non-probability consecutive sampling. The included individuals had wrist drop for more than 3 preceding weeks. Those with a history of poly-trauma, head injury, polyneuropathy, neoplasm, stroke or other diseases of the central nervous system were excluded.

After detailed history and physical examination, EDX

.....
^{1,5}Consultant Rehabilitation Medicine, Combined Military Hospital, Bahawalpur, Pakistan, ²Consultant Rehabilitation Medicine, Combined Military Hospital, Quetta, Pakistan, ³Consultant Neurologist, Indiana University-Purdue University Indianapolis, USA, ⁴Consultant Rehabilitation Medicine, Combined Military Hospital, Hyderabad, Sindh, Pakistan.

Correspondence: Saeed Bin Ayaz. Email: saeedbinayaz@gmail.com

evaluation was done using XLTEK Neuromax 1004 EMG unit (Xltek, Ontario, Canada). The protocol recommended by Preston and Shapiro for EDX evaluation of a suspected RNI was followed.⁶ NCS were performed by two operators, who were qualified physiatrists, using surface electrodes to assess sensory and motor nerves of the upper extremities. The nerves sampled were radial, ulnar, median, and superficial radial nerves. The sensory and motor nerve conduction velocities, latencies, and amplitudes were recorded. EMG was carried out at rest and with muscle activation using concentric needle electrodes. The muscles sampled were extensor indicis proprius, extensor digitorum communis, brachioradialis, triceps brachii, deltoid, flexor carpi radialis, pronator teres, flexor pollicis longus, and cervical paraspinals. Involuntary activity like fibrillations, positive sharp waves, and fasciculations were noted during rest while shape, size and recruitment patterns of motor unit action potentials were observed during voluntary muscle activation.

The data were recorded in a structured proforma. The sample was subdivided into groups based on gender, side of the body affected, and military versus civilian population. Statistical analysis was done using SPSS 20. The subgroups were compared for the aetiology of wrist drop using Pearson's Chi-square analysis. $P \leq 0.05$ was considered significant.

Results

Table-1: Demographic and clinical description of the sample.

Variables	n %	Variables	n %
Age groups of the sample		Cause of wrist drop	
15 years or less	7 (5.9)	Trauma (MVA, stab injuries, GSI) with fracture of the humerus	39 (32.8)
16 - 30 years	66 (55.5)	Trauma (MVA, stab injuries, GSI) without humeral fracture	36 (30.3)
31 - 45 years	28 (23.5)	Iatrogenic injuries (Misplaced intramuscular injection, surgical intervention)	33 (27.7)
46 - 60 years	12 (10.1)	Following sleep	5 (4.2)
61 years or more	6 (5)	Others	6 (5)
Source of patients		Severity of injury	
Military population	96 (80.7)	Axonotmesis	84 (70.6)
Civilian population	23 (19.3)	Neurotmesis	21 (17.6)
		Neurapraxia	14 (11.8)
Referring physician		Associated nerve injury	
General surgeon	44 (37)	C6 nerve root	1 (0.8)
Physiatrist	32 (26.9)	Median nerve	7 (5.9)
Orthopaedic surgeon	30 (25.2)	Median and ulnar nerves	12 (10.1)
Internal medicine specialist	5 (4.2)	Ulnar nerve	5 (4.2)
Plastic surgeon	5 (4.2)	Nil	94 (79)
Neurosurgeon	1 (0.8)		
General practitioner	1 (0.8)		
Others	1 (0.8)		

n= frequency; MVA= motor vehicle accidents; GSI= gunshot injuries.

Of the 119 patients, 97(81.5%) were males. The overall mean age was 31 ± 15 years, and 66(55.5%) were in the 16-30 years age group. Besides, 96(80.7%) were military personnel (Table-1).

Referral for EDX evaluation was made by general surgeons in 44(37%) cases, followed by physiatrists 32(26.9%), and orthopaedic surgeons 30(25.2%). In 56(47.1%) individuals, the injury was on the right side while in 63 (52.9%), it was left-sided.

The commonest cause of wrist drop was trauma with fracture of the humerus in 39(32.8%) cases caused by motor vehicle accidents (MVAs), stab injuries, and gunshot injuries (GSIs). It was followed by trauma without associated humeral fracture in 36 (30.3%) cases. Iatrogenic injuries caused by misplaced intramuscular (IM) injections and surgical complications were 33(27.7%).

NCS/EMG evaluation revealed that 88(73.9%) cases had RNI at the mid-arm level, 16(13.4 %) had posterior interosseous nerve injury, 9(7.6%) had injury to all trunks of the brachial plexus, 5(4.2%) had injury to the posterior cord, while 1(0.8%) had a C7 radiculopathy. Besides, Ninety-four (79%) individuals had no associated injury to other nerves. One (0.1%) associated nerve injury was a combination of injuries to the median and ulnar nerves. Majority (70.6%, n=84) of the participants suffered from axonal lesions.

The association of aetiology of wrist drop with gender,

Table-2: Association of aetiology of wrist drop with gender, involved side of the body, and military versus civilian population in our sample (n=119).

Variables	Sub-groups	Aetiology of wrist drop Trauma (MVA, stab injuries, GSI) causing fracture of humerus	Trauma (MVA, stab injuries, GSI) without humeral fracture	Iatrogenic injuries (Misplaced intramuscular injection, Surgical intervention)	Following sleep	Others	P
Gender							
Male	n (%)	36 (37.1)	35 (36.1)	17 (17.5)	3 (3.1)	6 (6.2)	<0.001
Female	n (%)	3 (13.6)	1 (4.5)	16 (72.7)	2 (9.1)	0	
Side of involvement							
Right	n (%)	17 (30.4)	19 (33.9)	11 (19.6)	5 (8.9)	4 (7.1)	0.046
Left	n (%)	22 (34.9)	17 (27)	22 (34.9)	0	2 (3.2)	
Source of patients							
Civilian population	n(%)	7 (30.4)	3 (13)	9 (39.1)	3 (13)	1 (4.3)	0.05
Military population	n (%)	32 (33.3)	33 (34.4)	24 (25)	2 (2.1)	5 (5.2)	

n= frequency; MVA= motor vehicle accidents; GSI= gunshot injuries; P= P-value.

involved side of the body, and military versus civilian population was noted and given in Table-2.

Discussion

The commonest cause of wrist drop in the current study was RNI, which is one of the most often injured nerves of the body.^{4,7} The frequent reason of RNI is fracture of the humerus caused by blunt trauma or penetrating injury.¹ The fracture of the humerus may cause RNI acutely at the time of injury, during fracture manipulation, or from a settling callus.⁴ The majority in our sample had RNI due to fracture of the humerus.

Our results were similar to most studies on peripheral nerve injuries,^{4,7,8-11} which revealed that wrist drop is most common in a younger age group i.e. 15-30 years. This age group is considered most productive in terms of physical exertion and there is a huge negative impact on economic growth and fiscal sustainability if the injuries in this age group are not managed efficiently.⁹⁻¹¹

The most common aetiological factor found in the current sample was trauma in the form of MVA, GSI, and Stab injuries. An earlier study⁴ from Pakistan reported trauma being the leading cause of RNI. A study¹² found GSI and trauma as the primary causes of peripheral nerve injuries and a similar trend was observed in other series.^{7,8-10} The apparent reason is an increase in the incidence of MVA and upsurge of violence in the society. Furthermore, the armed forces personnel that made the bulk of our sample, are involved in combat-oriented activities and exercises that expose them to traumatic injuries.

The second most important cause of RNI was iatrogenic and it was caused by misplaced IM injections and surgical

complications. A study⁴ identified misplaced injections and poor management of fractures (21% each) as the second most common cause of RNI. In developing countries, nerve lesions caused by inappropriate IM injections are still common.¹⁴ The mechanisms of injection-related nerve injury include direct damage affected by the needle, nerve ischaemia, encroachment by scar tissue, and direct nerve fibre damage by the neurotoxic agents.^{15,16}

Injuries related to trauma were more common in the military population compared to the civilians (Table-2). The current war against terrorism has affected Pakistan directly and severely. Pakistani military personnel are persistently engaged in armed conflicts and, therefore, sustain nerve injuries primarily due to trauma as a major component of war-related injuries. This finding is endorsed by earlier studies.^{17,18}

Trauma was found to be a more prevalent cause of nerve injury in male than female subjects. The reason appears to be greater participation of males in outdoor activities in keeping with the Pakistani social and cultural values, and thus getting more chances of exposure to trauma-related events in the form of MVA, physical brawl, GSI or blast injuries. The right side was commonly involved in traumatic aetiologies because the dominant hand in most people is the right hand which is mostly exposed during armed conflicts and is habitually used during physical brawls.

The frequency of iatrogenic RNI was higher among females and on the left side. Women in Pakistan are relatively more heavily clad than their Western counterparts. Generally, they are unable to sufficiently expose the shoulder for IM deltoid injection either due to religious/traditional reasons or tight clothing. Therefore,

blind injections through the clothing are liable to deposit the drug in triceps making them prone to RNI. Iatrogenic injuries were more frequently encountered on the left side because people prefer to receive injections in the non-dominant arm to avoid pain during movement of the dominant hand.

Axonotmesis was the most common type of injury in our sample, which is consistent with the literature.^{4,19-21} The severity of injury affects the prognosis of nerve regeneration. The outcome is best with neurapraxia and worst with neurotmesis.^{5,22,23} EDX is the tool of choice for the quantitative evaluation of the injured peripheral nerves.²⁰⁻²³ It is technically demanding but is of great value in localising the lesion, assessing the underlying pathophysiology, estimating the degree of severity, and predicting subsequent prognosis.²⁰⁻²³ In Pakistan, EDX services are not widely available and few physicians are adequately trained to handle them. That is why only major cities have these facilities. Moreover, there are no regulatory services to monitor the quality of EDX procedures due to which unqualified technicians are operating these machines in some parts of the country. This is counter-productive and can actually harm the patient by giving wrong and inappropriate diagnosis. Hence, there is a need to establish and empower regulatory services to authorise and standardise such facilities in Pakistan.

RNI, in general, is not accompanied by injury to other nerves. In our study, 79% sample had isolated RNI resulting in wrist drop. This is similar to an earlier study⁴ that reported isolate RNI in 82% of its sample. Comparable results are found elsewhere as well.²⁴

Following nerve injury, non-operative management should be considered for all patients in the first place. Conservative management involves advising the patients to avoid activities that result in trauma or irritate the nerve. Other aspects of treatment include biofeedback, therapeutic exercises, analgesics, neuroprotective vitamins, orthotic devices, and gait aids.^{4,5,25} Surgery is indicated if the nerve is seen or expected to be divided or severely damaged or if the recovery is inappropriately delayed and the diagnosis is in doubt.^{26,27}

Wrist drop can contribute to major social and economic burden since it occurs generally in the young population. Functional disability associated with nerve injuries can be distressing. EDX evaluation in such cases is of great importance in avoiding the nerve injury-related disability through timely and appropriate decision-making.

Conclusion

The commonest cause of wrist drop in the sample was RNI at the mid arm level produced by fracture of the humerus. The injuries due to trauma were more frequent in males, on the right side, and in the military population, while iatrogenic injuries were more common in females, on the left side, and in the civilian population. RNI primarily occurred in majority of the lesions were axonal.

Disclaimer: Nil.

Conflicts of Interest: None.

Sources of Funding: None

References

1. Tuncel U, Turan A, Kostakoglu N. Acute closed radial nerve injury. *Asian J Neuro surg.* 2011; 6: 106-9.
2. Shao YC, Harwood P, Grotz MR, Limb D, Giannoudis PV. Radial nerve palsy associated with fractures of the shaft of the humerus: a systematic review. *J Bone Joint Surg Br.* 2005; 87: 1647-52.
3. Pan CH, Chuang DC, Rodriguez-Lorenzo A. Outcomes of nerve reconstruction for radial nerve injuries based on the level of injury in 244 operative cases. *J Hand Surg Eur.* 2010; 35: 385-91.
4. Rasheed MH, Mashhood AA, Akhtar MR, Khan MB. Radial nerve injuries; presenting as wrist drop-analysis of 100 patients. *Prof Med J.* 2008; 15: 67-73.
5. Moran SL, Steinmann SP, Shin AY. Adult brachial plexus injuries: mechanism, patterns of injury, and physical diagnosis. *Hand Clin.* 2005; 21: 13-24.
6. Preston DC, Shapiro BE. Radial neuropathy. In: Preston DC, Shapiro BE eds. *Electromyography and Neuromuscular Disorders: Clinical-Electro physiologic Correlations* 3rd ed. London: Elsevier Inc, 2013; pp-337-9.
7. 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: 116-22.
8. Filiz Eser, Lale Akbulut Aktekin, Hatice Bodur, Cigdem Atan. Etiological factors of traumatic peripheral nerve injuries. *Neurology India.* 2009; 57: 434-7.
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; 21:4-13.
10. Kouyoumdjian JA. Peripheral nerve injuries: A retrospective survey of 456 cases. *Muscle Nerve.* 2006; 34:7858.
11. 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; 45:116-22.
12. Skirbekk V. Age and individual productivity: A literature survey. *Vienna yearbook of population Res.* 2004; 133-53.
13. Guo Y, Chiou-Tan FY. Radial nerve injuries from gunshot wounds and other trauma: comparison of electrodiagnostic findings. *Am J Phys Med Rehab.* 2002; 81: 207-11.
14. Hutin YJ. Injection safety: A global challenge. *Bull World Health Organ.* 1999; 77: 7-8.
15. Napiontek M, Ruszkowski K. Paralytic drop foot and gluteal fibrosis after intramuscular injections. *J Bone Joint Surg Br.* 1993; 75: 83-5.
16. Villarejo FJ, Pascual AM. Injection injury of the sciatic nerve (370 cases). *Childs Nerv Syst.* 1993; 9: 229-32.
17. Razaq S, Yasmeen R, Butt AW, Akhtar N, Mansoor SN. The pattern of peripheral nerve injuries among Pakistani soldiers in the war

18. Bashir RA, Qasmi SA, Yasin M, Mansoor SN. Pattern of combat casualties in war against terror among soldiers wearing body armor at CMH, Peshawar. *Pak Armed Forces Med J.* 2012; 30: 29-32.
 19. Uzun N, Savrun FK, Kiziltan ME. Electrophysiologic evaluation of peripheral nerve injuries in children following the Marmara earthquake. *J Child Neurol.* 2005; 20: 207-12.
 20. Parry GJ. Electrodiagnostic studies in the evaluation of peripheral nerve and brachial plexus injuries. In: Evans RW eds. *The Neurologic Clinics of North America. The Neurology of Trauma.* Philadelphia: WB Saunders, 1992; pp-921-34.
 21. Oh SJ. *Clinical Electromyography: Nerve Conduction Studies.* Philadelphia: Lipponcott Williams and Wilkins, 1993.
 22. Uzun N, Tanriverdi T, Savrun FK, Kiziltan ME, Sahin R, Hanimoglu H, et al. Traumatic Peripheral Nerve Injuries: Demographic and Electrophysiologic Findings of 802 Patients from a Developing Country. *J Clin Neuromusc Dis.* 2006; 7: 97-103.
 23. Quan D, Bird SJ. Nerve conduction studies and electromyography in the evaluation of peripheral nerve injuries. *Univ Pa Orthop J.* 1999; 12: 45-51.
 24. Markovic D, Bajek G, Eskinja N, Stancic M, Motika L. Peripheral nerve injuries in the 1991-1993 war in Croatia and Bosnia and Herzegovina. *Croat Med J.* 1995; 36: 108-13.
 25. Noval CB, Mackinnon SE, Baratz ME. *Peripheral Nerve Injuries Treatment & Management.* [Online] 2014 [Cited 2015 Jul 12]. Available from URL: <http://emedicine.medscape.com/article/1270360-treatment.html>
 26. Willett K, Marsh D, Moran C, Giannoudis P, Bircher M. British Orthopaedic Association standards for trauma. *J Bone Joint Surg Br.* 2009; 91: 985-6.
 27. Warwick D, Srinivasan H, Solomon L. Peripheral nerve disorders. In: Solomon L, Warwick D, Nayagam S, eds. *Apley's system of orthopedics and fractures*, 9th ed. London: Hodder Arnold, 2010; pp- 274-6.
-