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Electrophysiological Assessment of Pediatric Peripheral Nerve Injuries Using EMG

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Abstract: A cross-sectional study was conducted on 90 Iraqi paediatric patients. The study aimed to evaluate the clinical and electrophysiological characteristics of peripheral nerve injuries in pediatric patients using electromyography (EMG). This study was designed to analyze a specific cross-section of patients of a specific age group who were diagnosed with upper extremity injuries over a 24-month study period, from 2023 to 2025. The demographic data and information were analyzed using IBM SPSS 22 statistical analysis software. Microsoft Excel 2013 was also used to create figures related to the study results. The results found in this study are: Mean age (years) 8.5 ± 3.3, (Gender (M/F) 54/36). The results according to the time post-injury (months) were < 3.5 (5.6%), < 3.5 (5.6%), and> 12.20. (22.2%). We conclude from this study that there is some disagreement among peripheral nerve surgeons regarding the optimal approach to managing children with this condition. Surgical decisions must be made with full consideration of the potential risks and benefits, given the known complications associated with such interventions.

Keywords: Paediatric Patients, Electrophysiological, Nerve Injuries, Emg, Complications.

INTRODUCTION

Electromyography (EMG) studies the electrical properties of muscles at rest and during voluntary contraction, as well as those of peripheral nerves during stimulation. Based on neuroanatomical principles and neuroelectrophysiological characteristics, it assesses and analyzes peripheral nerve function, providing a reliable basis for further clinical diagnosis [Chim, H. *et al*., 2014; Blaauw, G. *et al*., 2008]. The F wave and H reflex, also known as late responses, are primarily used to study proximal nerve segments. Electromyography and conduction velocity studies are an extension of the clinical examination for the evaluation of the peripheral nervous system (lower motor neuron, roots, plexuses, nerves, neuromuscular junction, and nerve muscle) [Dorsi, M. J. *et al*., 2010; GILBERT, A. *et al*., 1991].

The H reflex and F wave in electromyography (EMG) are delayed responses. The former is the gold standard for the S1 segment sensory-motor reflex arc, while the latter is used to screen multisegmented proximal motor nerve conduction. The two complement each other, and combined testing can improve the sensitivity and specificity of neuropathy diagnosis [Wilson, T. J. *et al*., 2018; Slooff, A. C. J. 1993; Dong, Z. H. *et al*., 2010].

The electrodiagnostic studies, which include nerve conductivity studies and electromyography, are an extension of the clinical examination for the evaluation of the nervous system [Li, Q. I. U. *et al*., 2009; Wang, Y. *et al*., 2010]. With a brief electrical pulse applied to the skin, it is easy to stimulate nerves and obtain an action potential from them. Motor, with driving speeds in newborns that are roughly half of adult values, reaching 75% of adult values for the first year and the range of adult values for the third to fifth years [Ahrari, M. N. *et al*., 2006; Uzun, N. *et al*., 2005].

As a dynamic investigation, the electromyography and conduction velocity method is basically an extension of the clinical evaluation [Yoshida, T. *et al*., 1999]. In other words, although studying each nerve and muscle follows a conventional method, the examining physician decides how to proceed and whether to analyze one, two, three, or four extremities based on the clinical data and study results. Every patient has unique factors that need to be taken into account when performing and interpreting the surgery. [Robinson, L. R. 2022] Age and corrected age (in patients born before their due dates) • Family and personal pathological history (e.g., family history or genetic disorders) • The patient's present condition and state of awareness. • The investigation will be limited if there are skin breaks in the region to be investigated. [Bergmeister, K. D. *et al*., 2020] Working together to execute voluntary muscular contraction exercises. The following should also be considered if the research is conducted on a patient who is in critical condition: • Evaluation of

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consciousness; • Use of neuromuscular relaxants and/or sedatives (specify which ones). • Sensitivity to sound, touch, or unpleasant stimuli [Ellidokuz, H. 2005]. Evaluation of the lengthening of the study period and the quantity of muscles and nerves to be inspected in accordance with medical standards and a particular diagnosis. • Technical aspects of the recording that are impacted by the patient's equipment (such as an oximeter, portable ventilator, portable monitor, and infusion pumps) [Roy, N. *et al*., 2002; Tanida, N. 1996]

This study aims to determine the appropriate and technically safe results of electromyography and nerve conduction velocity tests for pediatric patients diagnosed with diseases affecting the peripheral nervous system, lower motor neurons, nerve roots, plexuses, nerves, neuromuscular junctions, and muscles, as well as for neurophysiological monitoring of chronic patients receiving stable treatment [Del Papa, J. *et al*., 2019].

MATERIAL AND METHOD

A cross-sectional study was conducted in Iraq on 90 from different hospital from Iraq with study period from 2023 to 2025 of pediatric patients diagnosed with upper extremity nerve injury while The actual duration of the study was 24 months, with an average age ranging from 6 to 12 years. Based on the results presented in this study, electrical diagnosis was based on two methods: nerve conduction studies (NCS) and needle electromyography (EMG), where Motor nerve conduction studies were performed by stimulating multiple sites along the nerve to capture conduction velocity and detect conduction blocks. These results were obtained. Assessment included insertional activity, spontaneous muscle activity at rest (twitching, positive sharp waves), and analysis of motor unit action potentials (MUAPs) during minimal and maximal voluntary contractions, in addition to the time of injury, which, according to the results, ranged from one to six months. This provides an accurate description of the denervation patterns. According to the tables below, the data collected included demographic information, the etiology of the injury, the affected nerves, and EMG criteria. Electromyography and clinical findings.

RESULTS

Table 1: Description of primary and demographic data for 90 patients

Parameter	Value
Number of patients	90
Mean age (years)	8.5 ± 3.3
Gender (M/F)	54/36
Injury cause (%)	
	Trauma (70%),
	Compression (15%),
	Infection (5%),
	Others (10%)
Most affected nerve sites	Peroneal (30%), Posterior tibial (25%), Ulnar (15%), Median (10%), Radial (8%), Brachial plexus (12%)
Time from injury to EMG	2.5 ± 1.3 months

Table 2: Assessment Outcomes of Electrophysiological Findings by Nerve Site

Nerve	**Amplitude (mV)**	**Duration (ms)**	**Recruitment Score (0-3)**	**Denervation Score (0-3)**	**Conduction Velocity (m/s)**
Peroneal (n=27)	**1.5 ± 0.7**	**15.2 ± 4.8**	**1.8 ± 0.6**	**2.1 ± 0.5**	**35.5 ± 7.4**
Posterior tibial (n=23)	**1.2 ± 0.6**	**16.8 ± 5.1**	**1.6 ± 0.7**	**2.3 ± 0.6**	**33.1 ± 6.8**
Ulnar (n=14)	**2.3 ± 0.9**	**14.5 ± 3.2**	**2.5 ± 0.5**	**1.8 ± 0.7**	**42.0 ± 5.5**
Median (n=9)	**2.5 ± 1.1**	**13.8 ± 3.7**	**2.7 ± 0.4**	**1.6 ± 0.8**	**44.3 ± 6.1**
Radial (n=7)	**2.1 ± 0.8**	**15.4 ± 3.9**	**2.3 ± 0.6**	**1.9 ± 0.6**	**40.0 ± 5.8**
Brachial plexus (n=11)	**1.8 ± 0.7**	**17.0 ± 5.7**	**1.4 ± 0.5**	**2.5 ± 0.5**	**32.0 ± 7.2**

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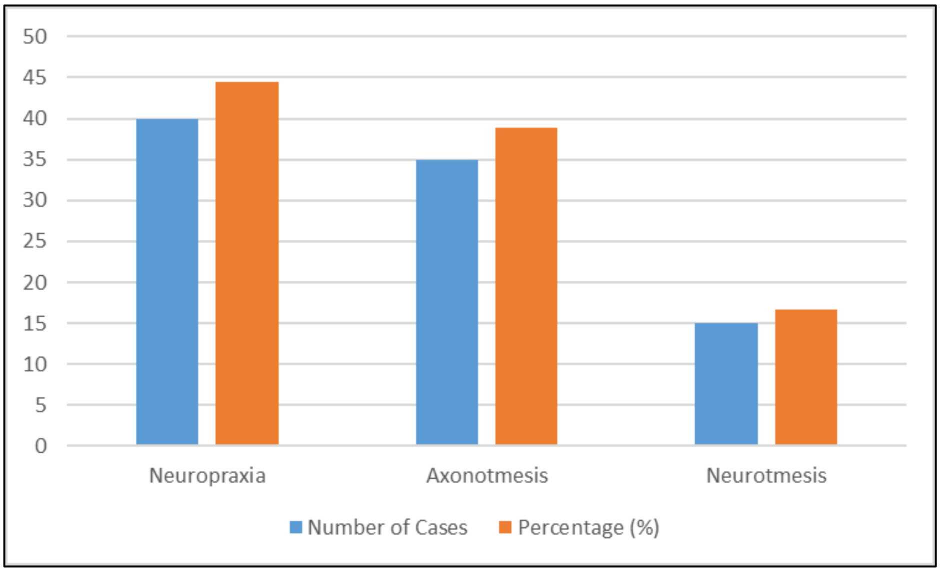

Figure 1: Distribution of patients according to the Classification of Nerve Injury by EMG

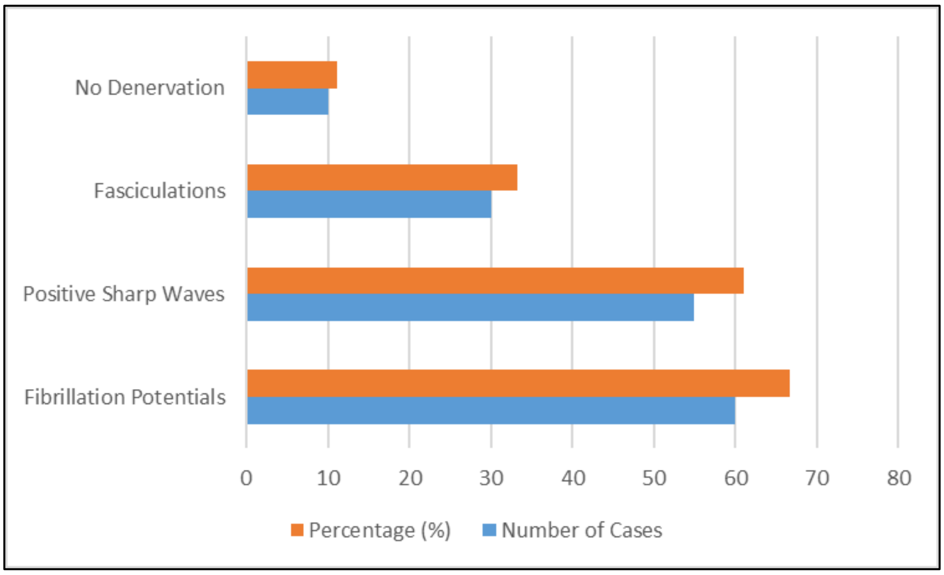

Figure 2: Description of data and results according to denervation patterns in electromyography

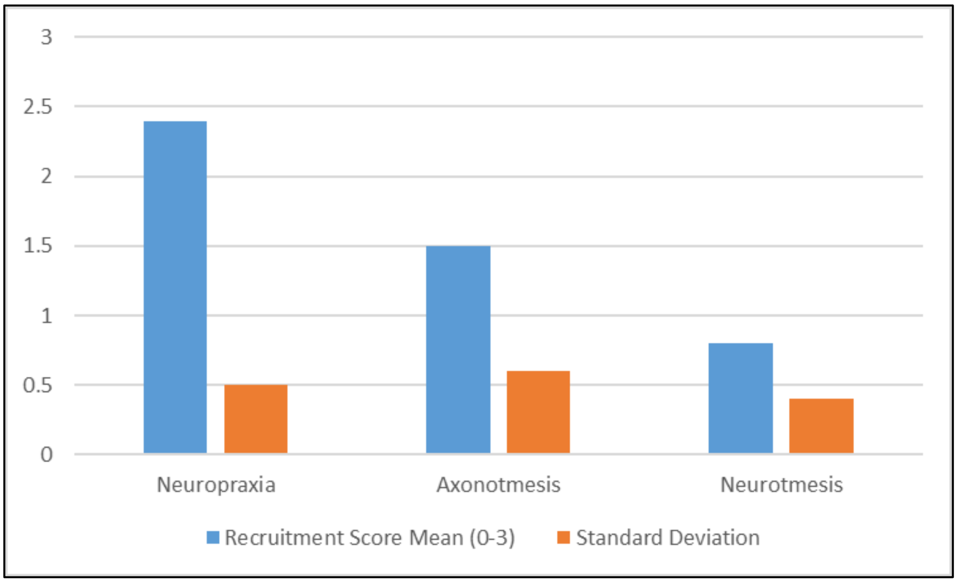

Figure 3: Patient outcomes according to EMG scores by injury type

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Table 3: Description of data related to this study according to Time Since Injury vs Regeneration Evidence on EMG

time Post-Injury (months)	Cases with Regeneration Evidence (%)
< 3	5 (5.6%)
3-6	25 (27.8%)
6-12	40 (44.4%)
> 12	20 (22.2%)

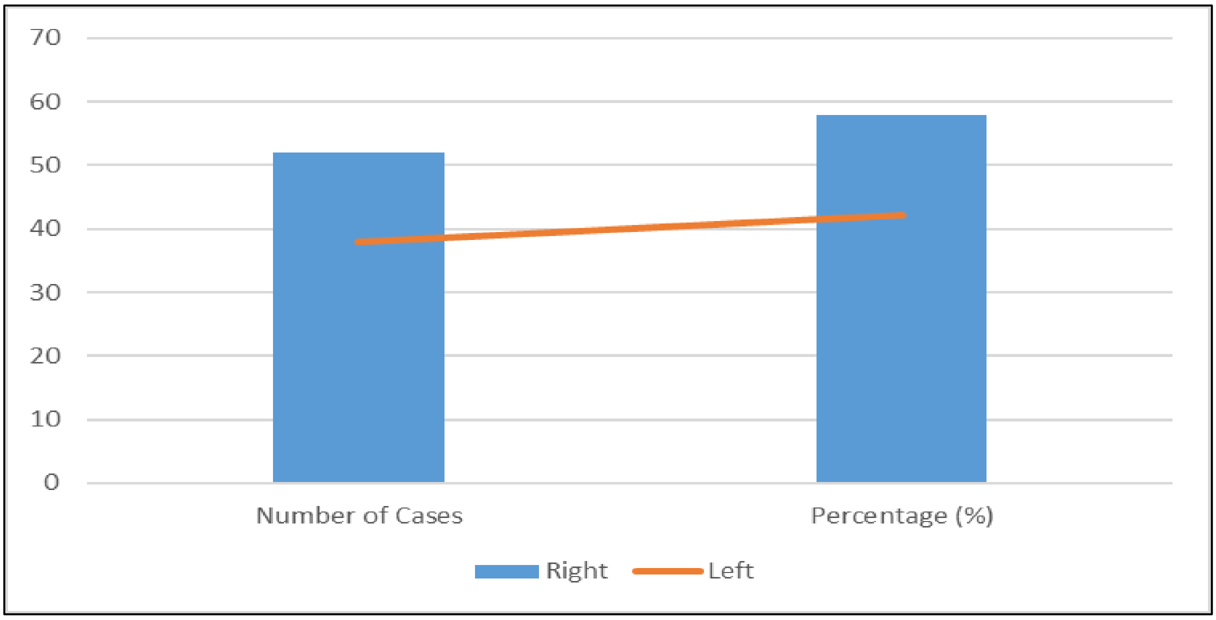

Figure 4: Distribution of patients according to Side of Injury

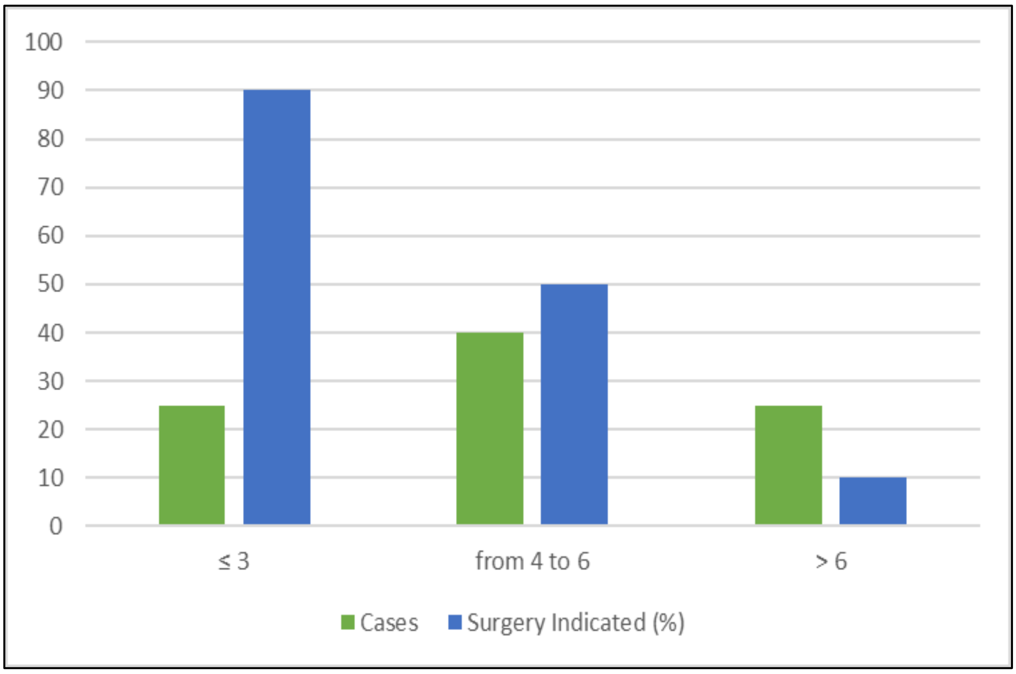

Figure 5: Description of the findings related to the need for surgical intervention according to the EMG score thresholds

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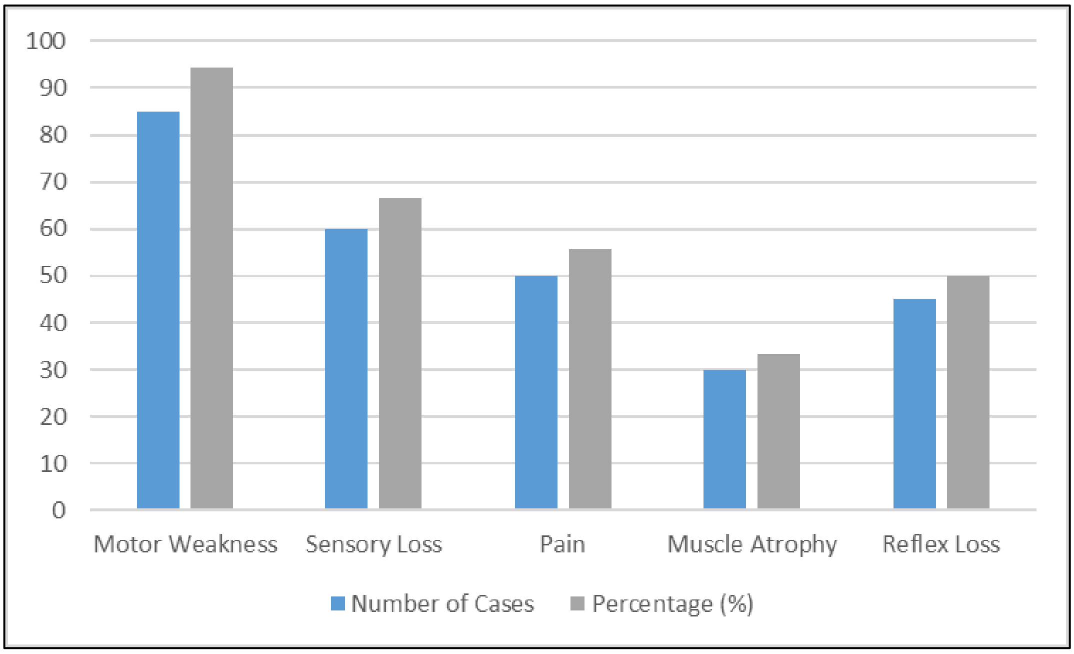

Figure 6: Secondary data accompanying clinical symptoms

DISCUSSION

A thorough depiction of actual clinical findings and characteristics is offered by the study on the electrophysiological evaluation of juvenile peripheral nerve injury using electromyography, or EMG. Most occurrences are trauma-related and involve nerves in the lower extremities, such as the posterior tibial and peroneal nerves [Glass, R. I. *et al*., 1977] while It takes an average of 2.5 months from the moment of damage to the EMG examination, which gives electrophysiological alterations enough time to appear and With neuropraxia and axonotmesis being the most prevalent, the study divides nerve damage into three categories: neuropraxia, axonotmesis, and neurotmesis [ASHRAF, G. K. *et al*., 2008] Injury categories are associated with denervation patterns, recruitment scores, and time where Two neurophysiological methods for examining the peripheral nervous system (PNS) from a functional standpoint are electromyography (ENG) and electromyography (EMG). This approach is trustworthy and can provide details on how skeletal muscles and peripheral nerves work so Additionally, it is a diagnostic tool that makes it possible to identify neurological illnesses of the PNS, such as those that impact muscles, neuromuscular junctions, peripheral nerves, nerve roots, and nerve plexuses [Tang, B. *et al*., 2017] EMG is a vital diagnostic tool for PNS disorders discovered by neurological examination, particularly in cases when the type, location, and extent of the lesion are unknown where The study also demonstrates the relationship between the need for surgery and EMG severity scores, with lower values suggesting more serious injuries that frequently require surgery. Clinical symptoms that are linked to the research include discomfort, muscular atrophy, sensory loss, motor weakness, and reflex loss. Also, according to the 12-month follow-up results, more over half of the patients recover completely, one-third recover somewhat, and a small percentage do not recover at all [Peek-Asa, C. *et al*., 1998]

Both a doctor and a technician do EMG. The neurophysiologist's initial task is to electrically stimulate the peripheral nerves and record the accompanying reactions in the muscles that the nerve innervates where A coaxial electrode needle is inserted into the muscles to be studied in the second step, which is carried out by the doctor. A thorough medical history and clinical evaluation of the patient, backed up by data from the prescribing physician and any laboratory and instrumental tests completed thus far, are the first steps in the examination beside this The electromyographer creates a treatment plan based on the patient's information and clinical symptoms with the goal of making the right diagnosis with the least amount of discomfort to the patient by evaluating the fewest muscles and nerves feasible and It is hard to predict how long the exam will take in advance, but it usually takes 15 to 30 minutes.

Electromyography Examination: An electromyography examination does not consist of a fixed or predetermined sequence of measurements; rather, these measurements must be

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individually determined based on the patient's current problems. Based on the neurological deficit, the electromyographer plans the details of the examination, assessing the nerves and muscles to be examined and the neurophysiological tests to be performed. The nerves and EMG analysis methods may differ from the initial program based on the results of previous measurements. An electromyography study consists of two stages: electroneurography (ENG) and electromyography (EMG). The two techniques are performed sequentially and complement each other in diagnosis; therefore, electromyography is often also referred to as electroneurography.

Nerve conduction studies, performed using electroneurography (ENI), assess the functional status of nerve trunks through electrical stimulation and surface recording. These studies measure the ability of motor nerves to transmit commands to different muscles, or the ability of sensory nerves to transmit sensory information from peripheral receptors to spinal cord centers. In some cases, nerve trunks can be stimulated or recorded using needles inserted under the skin near the nerve.

CONCLUSION

The study emphasizes how crucial EMG is as a diagnostic method for assessing pediatric peripheral nerve damage. EMG supports clinical decision-making and prognosis by offering comprehensive data on injury categorization, severity, and regeneration state. The majority of injuries have a strong correlation with clinical symptoms and are connected to trauma. In many individuals, EMG also shows continuous nerve regeneration.

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