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Electromyographic Findings in Patients Referred to İzmir Tepecik Education and Research Hospital as a Remote Center Following the February 6, 2023 Earthquake

6 Şubat 2023 Depremi Sonrası Uzak Bir Merkez Olarak İzmir Tepecik Eğitim ve Araştırma Hastanesine Sevkedilen Hastalarda Elektromiyografi Deneyimi

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Abstract

Objective: On February 6, 2023, two powerful earthquakes struck our country, resulting in at least 50.000 fatalities and over 122.000 injuries, according to official reports. This study examines the demographic data, clinical features, and electromyography (EMG) findings of children and adults referred to the EMG laboratory at University of Health Sciences Türkiye, İzmir Tepecik Education and Research Hospital for evaluation of suspected peripheral nerve damage sustained during the earthquake.

Methods: We analyzed the demographic, clinical, and EMG findings of patients who were referred to the EMG laboratory between February and July 2023 with a provisional diagnosis of peripheral nerve injury.

Results: A total of 45 patients (aged 3 to 62 years; mean age 22.1 years) were evaluated in the EMG laboratory between February and July 2023. Three of them sustained injuries after jumping from a height during the earthquake. The remaining 42 patients were rescued from beneath collapsed structures, with entrapment durations ranging from 2 to 105 h (mean: 22 h). The initial EMG examination was performed, on average, 32 days after the injury. At least two follow-up EMG examinations were conducted in six patients. No statistically significant difference was noted between the symptomatic and the injured sides. Electrophysiological evidence of peripheral nerve or plexus injuries was identified in 89% of patients, whereas 11% had normal EMG findings. Simultaneous involvement of multiple peripheral nerves or plexuses was detected in 22% of patients (n=10). A positive correlation was found between entrapment duration and the occurrence of crush/compartment syndrome.

Conclusion: EMG is a crucial diagnostic tool for evaluating traumatic peripheral nerve injuries. The EMG and laboratory findings reported in this study highlight the challenges faced by patients who survived two devastating earthquakes and were referred to our remote center for assessment of suspected traumatic nerve injuries.

Keywords: Electromyography, peripheral nerve damage, earthquake, crush syndrome

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Öz

Amaç: 6 Şubat 2023'te ülkemizde iki büyük deprem yaşandı. Depremler sonucunda resmi rakamlara göre en az 50,000 kişi hayatını kaybetti ve 122,000'den fazla kişi ise yaralandı. Bu çalışma ile 6 Şubat depremi sonrası Sağlık Bilimleri Üniversitesi, İzmir Tepecik Eğitim ve Araştırma Hastanesi elektromiyografi (EMG) laboratuvarına, periferik sinir hasarlanması ön tanısı ile gönderilen, çocuk ve erişkin hastalara ait demografik veri, klinik ve muayene özellikleri ile EMG bulgularını derledik.

Yöntem: Şubat-Temmuz 2023 tarihleri arasında periferik sinir hasarı ön tanısıyla EMG laboratuvarına yönlendirilen çocuk ve erişkin hastalara ait demografik veri, klinik ve muayene özellikleri ile EMG bulguları incelendi.

Bulgular: Şubat-Temmuz 2023 tarihlerinde EMG laboratuvarına yaşları 3 ile 62 arasında değişen, yaş ortalaması 22,1 olan 45 hasta başvurdu. Hastaların 3'ü deprem sırasında kaçmaya çalışırken yüksekten atlama sonucu yaralanmıştı. Diğer hastalarda enkaz altında kalma süresi 2 ile 105 saat arasında ve ortalama 22 saatti. Laboratuvarımızdaki ilk EMG incelemesi yaralanmadan sonra ortalama ilk 32,13 günde yapılmıştı. Altı hastaya en az 2 takip EMG incelemesi yapılabilmişti. Hastaların yakınmaları olan ve travmaya uğradıkları taraflar arasında belirgin farklılık gözlenmedi, %89'unda bir periferik sinir ya da pleksus hasarını düşündüren elektrofizyolojik bulgular saptanırken, %11'inde inceleme normal sınırlardaydı. Aynı anda birden fazla periferik sinir ya da pleksus hasarı oranı ise %22'ydi (10 hasta). Enkaz altında kalma süresi ile crush/kompartman sendromu oluşumu arasında anlamlı bir pozitif korelasyon bulundu.

Sonuç: EMG incelemesi, travmatik periferik sinir yaralanmaları sonrasında sıklıkla başvurulan tanı yöntemlerindendir. Ülkemizin 11 ilini etkileyen iki büyük deprem sonrası kurtulan hastalardan travmatik periferik sinir yaralanması öntanısıyla bölgeye uzak bir merkez olan kliniğimize yönlendirilen hastalardan elde edilen EMG veri ve laboratuvar deneyimleri paylaşılmıştır.

Anahtar Kelimeler: Elektromiyografi, periferik sinir hasarı, deprem, crush sendrom

Introduction

On February 6, 2023, two powerful earthquakes struck our country, resulting in at least 50.000 fatalities and over 122.000 injuries, according to official reports[1]. Earthquakes are catastrophic natural disasters that result not only in extensive structural damage but also in significant physical and psychological trauma. Musculoskeletal injuries are the most frequently encountered conditions following an earthquake. These injuries include fractures, dislocations, crush injuries, compartment syndrome, and amputations[2]. Traumatic peripheral nerve injuries may also occur following an earthquake. Such injuries are frequently reported and occur secondary to mechanical trauma (e.g., musculoskeletal injuries) or to infection. The type and severity of nerve damage play a key role in determining prognosis and guiding treatment. Electrophysiological methods are critical for early diagnosis and follow-up[3]. Acute stress symptoms, such as anxiety and depression, are commonly reported among earthquake survivors. In the same way, children may develop psychiatric symptoms such as anxiety and depression[4]. Furthermore, short sleep duration, sleep insufficiency, poor sleep quality, and insomnia symptoms have been reported. These disturbances are often associated with financial hardship and disruptions to healthcare services[5]. This study examines the demographic data, clinical features, and electromyography (EMG) results of children and adults referred to the EMG laboratory at University of Health Sciences Türkiye, İzmir Tepecik Education and Research Hospital with suspected peripheral nerve damage following the earthquake.

Materials and Methods

This retrospective study included 45 patients who were referred to the EMG laboratory between February and July 2023 with a provisional diagnosis of peripheral nerve injury. Eligible participants were those who sustained injuries during the earthquake and exhibited clinical signs or symptoms suggestive of at least one peripheral nerve injury. Patients were excluded if they had a known history or clinical evidence of pre-existing peripheral nerve injury, declined to undergo EMG, or were unable to undergo the procedure due to contraindications such as a cardiac pacemaker, limb amputation, or open wounds at the stimulation or recording sites.

Hospital records were retrospectively reviewed, and the following variables were recorded for each patient: age, sex, time spent under the rubble (in h), time interval from injury to the first EMG assessment (in days), affected extremity (upper or lower; right or left limb), specific injured peripheral nerves, and the presence of compartment syndrome or crush syndrome. Patients were stratified into two groups according to the presence or absence of compartment syndrome, and the time spent under the rubble was compared between groups.

Electrophysiological studies were performed using a Nihon Kohden MEB-9200K (2007) device. Motor and sensory nerve conduction studies were conducted using standardized protocols, with filter settings between 2 Hz and 20 kHz, stimulus durations of 0.05-0.1 ms, and a sweep speed

of 2 ms/division. Peripheral nerve injury was defined electrophysiologically by any of the following: reduced compound muscle action potential and/or sensory nerve action potential amplitudes; prolonged distal latency; decreased conduction velocity; conduction block; needle EMG evidence of denervation (fibrillation potentials, positive sharp waves); and neurogenic motor unit potential changes, including increased amplitude, prolonged duration, polyphasic morphology, and reduced recruitment.

All EMG evaluations were conducted by two clinical neurophysiology specialists simultaneously to ensure diagnostic accuracy. The primarily affected extremity was systematically assessed and, when the patient cooperated, the contralateral (unaffected) extremity was also examined for comparison.

This study was approved by the Non-Interventional Research Ethics Committee of the University of Health Sciences Türkiye, İzmir Tepecik Education and Research Hospital (approval no: 2025/03-06, date: 10.04.2025). Written informed consent was obtained from all patients or their legal representatives before EMG testing. Consent also included permission for the use of anonymized data for research purposes.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, New York, USA). Depending on the distribution of the data, descriptive statistics were reported as mean ± standard deviation, median (minimum-maximum), or frequency and percentage, as appropriate. Patients were divided into two groups based on the presence or absence of compartment syndrome. Differences in time spent under the rubble between these groups were assessed using the Mann-Whitney U test. Spearman correlation analysis was used to evaluate the relationship between time spent under the rubble and the likelihood of developing compartment syndrome. In addition, logistic regression analysis was conducted to assess the predictive effect of time spent under the rubble on the risk of developing compartment syndrome. A p-value of <0.05 was considered statistically significant.

Results

A total of 45 patients aged 3-62 years (mean age: 22.1 years) were included in the study. These patients were evaluated in the EMG laboratory between February 6, 2023 (the date of the earthquake) and July 2023. Among them, 25 (55.6%) were children (<18 years of age) and 20 (44.4%) were adults (≥18 years of age). Three patients sustained injuries after jumping from a height during the earthquake. The remaining 42 patients were rescued from beneath collapsed structures, with time spent under the rubble ranging from 2 to 105 h (mean: 22 h).

The initial EMG examination was performed in our laboratory on average 32 days after the injury. At least two follow-up EMG exams were conducted on six patients, all of whom were under the age of 18. During these evaluations, nerve regeneration was observed to varying degrees and at different rates. No statistically significant difference was noted between the symptomatic and injured sides. However, lower extremity involvement was more frequent than upper extremity involvement (Table 1).

Electrophysiological evidence of peripheral nerve or plexus injury was identified in 89% of patients, while 11% had normal EMG findings. Simultaneous involvement of multiple peripheral nerves or plexuses was present in 22% of patients (n=10). The distribution of affected nerves, ranging from mild or partial involvement to complete axonal loss, is shown in Figure 1. The peroneal and sciatic nerves were most frequently affected.

Crush syndrome, compartment syndrome, and/or fasciotomy were observed in 16 of the 42 patients who had been trapped under the rubble. The mean time spent under the rubble

Table 1. Demographic and clinical characteristics of earthquake survivors (n=45)

Characteristics		Number of patients
Sex	Male	21 (46.7%)
	Female	24 (53.3%)
	Total	45 (100.0)
Age (year)	Male	22±17.8
	Female	22.2±17.3
	Total	22.1±17.3
Time under the rubble (h)		21.9±25.2
Time of the first EMG test (days)		32.1±32.7
Affected extremity	Right	21 (47%)
	Left	19 (42%)
	Bilateral	5 (11%)
	Upper extremity	12 (27%)
	Lower extremity	27 (60%)
	Upper and lower extremities	6 (13%)

EMG: Electromyography

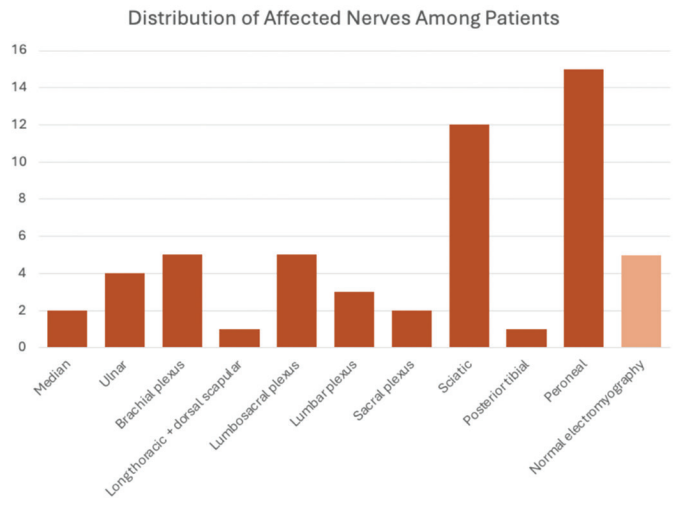

Figure 1. Distribution of affected nerves among patients. The peroneal and sciatic nerves were the most frequently affected; electromyographic findings were normal in five patients

was significantly longer in the group that developed crush or compartment syndrome (p=0.002).

There was a positive correlation between time spent under the rubble and occurrence of crush/compartment syndrome (r=0.480, p=0.001). Logistic regression indicated that the odds of developing this syndrome increased by 4% per additional hour under the rubble (odds ratio =1.040; 95% confidence interval: 1.007-1.075; p=0.018).

Discussion

Earthquakes are catastrophic natural events that often result in mortality and injuries. Peripheral nerve injuries, frequently resulting from prolonged compression during an earthquake, are a major cause of morbidity. These injuries can result from crush injuries, ischemia, bone fractures, and compartment syndrome; crush injuries are the most common type of peripheral nerve damage. Two main mechanisms are responsible for these injuries: mechanical crushing and ischemia. Short-term ischemic changes are generally reversible; however, with increasing duration and severity of compression, nerve damage worsens, recovery is delayed, and sustained compression may lead to irreversible damage[6].

This study analyzed data from 45 earthquake survivors who were evaluated in the EMG laboratory of our neurology clinic. Sex and age distributions in disaster-related injuries can vary. Although several studies suggest that females may be more frequently injured[7-10], a study investigating peripheral nerve injuries following the 1999 Marmara earthquake reported no significant sex difference (females, 52.5%; males, 47.5%) [11]. Similarly, we found no significant sex-related differences in the incidence of peripheral nerve injury (females, 53.3%; males, 46.7%), suggesting that sex does not appear to be a major risk factor in this context.

Extremity injuries are common following earthquakes, with the lower extremities more frequently affected than the upper extremities[12-14]. The Marmara earthquake study reported lower limb injuries as the most common, accounting for 47.5%, with no significant difference between the right and left sides[11]. Our finding that lower extremity injuries were more frequent (60%) is consistent with previous reports, such as Özdemir et al.[15] who reported 59.07%. This similarity supports the reproducibility of injury patterns in large-scale earthquakes.

Although our sample size was relatively small, this likely reflects the remote location of our center, which limited referrals despite a high number of injured individuals in the region. Nevertheless, our findings regarding the distribution of nerve injuries are consistent with previous studies from more centrally located tertiary hospitals[11,15,16]. This suggests that the injury pattern we observed is likely representative and not due to referral bias.

Electrophysiological examinations play a crucial role in identifying the distribution and extent of nerve damage. Follow-up assessments allow tracking of recovery and prognostication. In this study, the average time for the initial EMG was 32 days. Based on the electrophysiological findings, the sciatic nerve (24%) and the peroneal nerve (30%) were the most frequently affected. Previous studies of peripheral nerve injuries following earthquakes have also reported the sciatic nerve as the most frequently injured[16-18].

Two-year follow-up of patients with peripheral nerve injuries has demonstrated regeneration in 60%-70% of cases, indicating a favorable prognosis[11,19]. Although follow-up data were available for only six pediatric patients, these cases showed varying degrees of improvement and provided preliminary insight into prognosis.

The term crush denotes severe compression or crushing, whereas crush syndrome refers to the systemic consequences of such injuries. Crush syndrome was first described by Bywaters and Beall[20] in 1941. It results from muscle damage sustained during major earthquakes,

other disasters, or intense physical exertion. It includes medical and surgical complications such as acute renal failure, electrolyte imbalance, hemodynamic instability, respiratory failure, infection, compartment syndrome, and bleeding[20]. It is the second leading cause of disaster-related deaths, following fatalities from direct trauma. Compartment syndrome occurs when muscle edema raises intracompartmental pressure, impairing capillary perfusion. This increased pressure leads to ischemic damage to nerve and muscle cells and exacerbates rhabdomyolysis[21]. In this study, compartment syndrome was observed in 38% of earthquake survivors. Patients who developed compartment syndrome spent more time under the rubble than those who did not. Previous studies have reported a positive correlation between the time trapped under rubble and the severity of nerve damage[22,23], a finding that was also confirmed in our study.

Study Limitations

This study has several limitations. First, because our hospital is a referral center in a remote area, only a limited number of patients were included; this may restrict the generalizability of the findings. Second, not all patients can undergo follow-up EMG tests, limiting our ability to fully assess long-term recovery. Third, because the data were collected retrospectively from hospital records, some data may have been incomplete or missing, which could have affected certain analyses. Finally, psychological factors, such as posttraumatic stress or depression, which can significantly impact recovery, were not systematically evaluated in this study.

Conclusion

Earthquakes are unpredictable and devastating natural disasters that result in extensive human suffering and long-term health consequences. Among the most frequent and impactful outcomes in survivors are peripheral nerve injuries, which can lead to lasting neurological deficits and functional impairments, often necessitating prolonged rehabilitation. The risk and severity of these injuries increase proportionally with the time spent under the rubble, particularly when associated with compartment and crush syndromes, both of which are time-sensitive, life-threatening complications. Thus, timely and well-coordinated search and rescue operations are vital, not only for saving lives but also for minimizing long-term neurological damage.

Although peripheral nerve injuries are often considered a secondary concern in the post-earthquake period, they may in fact be a leading cause of long-term morbidity. Therefore, neurological evaluations should not be neglected during patient follow-up, and EMG should be used routinely for diagnostic and prognostic assessment. In our study, certain nerves were more frequently affected, suggesting that clinical evaluations in the field should prioritize these nerves. Furthermore, in these patients, physical trauma and psychological effects of prolonged time spent under the rubble may significantly influence rehabilitation and recovery processes. Finally, the diagnostic, therapeutic, and long-term rehabilitation needs associated with peripheral nerve injuries create a lasting and multifaceted burden on post-disaster healthcare systems. For these reasons, developing preventive and supportive strategies at both the individual and systemic levels is essential.

Ethics

Ethics Committee Approval: This study was approved by the Non-Interventional Research Ethics Committee of the University of Health Sciences Türkiye, İzmir Tepecik Education and Research Hospital (approval no: 2025/03-06, date: 10.04.2025).

Informed Consent: Written informed consent was obtained from all patients or their legal representatives before EMG testing. Consent also included permission for the use of anonymized data for research purposes.

Footnotes

Authorship Contributions

Surgical and Medical Practises: A.Ç.T., E.B., Concept: A.Ç.T., E.B., Design: A.Ç.T., E.B., Data Collection or Processing: A.Ç.T., E.B., Analysis or Interpretation: A.Ç.T., Literature Search: A.Ç.T., E.B., Writing: A.Ç.T.

Conflict of Interest: No conflict of interest was declared by the authors.

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References

1. World Health Organization. Türkiye earthquake: external situation report no. 5, 13-19 March 2023. Copenhagen: WHO Regional Office for Europe; 2023. Available from: https://iris.who.int/bitstream/handle/10665/366587/WHO-EURO-2023-7145-46911-68823-eng.pdf?sequence=1
2. Uluöz M, Gökmen MY. The 2023 Turkey earthquake: management of 627 pediatric musculoskeletal injuries in the first month. Children (Basel). 2023;10:1733.

3. Uzunçakmak Uyanık H, Yıldız Sarıkaya FG. Periferik sinir yaralanmalarında elektrofizyolojik değerlendirme. İçinde: Gürler T, editör. Periferik sinir cerrahisinde güncel bilgiler. 1. baskı. Ankara: Türkiye klinikleri; 2022:9-13.
4. Özyurt G, Totur G, Üzüm Ö, et al. Psychiatric characteristics of child survivors after the Kahramanmaraş double earthquake. Pediatr Int. 2025;67:e15830.
5. Li X, Buxton OM, Hikichi H, et al. Predictors of persistent sleep problems among older disaster survivors: a natural experiment from the 2011 Great East Japan earthquake and tsunami. Sleep. 2018;41:zsy084.
6. Valone F 3rd, Lyon R, Lieberman J, Burch S. Efficacy of transcranial motor evoked potentials, mechanically elicited electromyography, and evoked electromyography to assess nerve root function during sustained compression in a porcine model. Spine (Phila Pa 1976). 2014;39:989-93.
7. Ellidokuz H, Ucku R, Aydin UY, Ellidokuz E. Risk factors for death and injuries in earthquake: cross-sectional study from Afyon, Turkey. Croat Med J. 2005;46:613-8.
8. Roy N, Shah H, Patel V, Coughlin RR. The Gujarat earthquake (2001) experience in a seismically unprepared area: community hospital medical response. Prehosp Disaster Med. 2002;17:186-95.
9. Tanida N. What happened to elderly people in the great Hanshin earthquake. BMJ.1996;313:1133-5.
10. Del Papa J, Vittorini P, D'Aloisio F, et al. Retrospective analysis of injuries and hospitalizations of patients following the 2009 earthquake of L'Aquila City. Int J Environ Res Public Health. 2019;16:1675.
11. Uzun N, Savrun Karaali F, Yazıcı S, Caksıbaeva C, Kızıltan ME. Experience obtained in an electromyography laboratory after the August 17, 1999 earthquake. Cerrahpaşa J Med. 2001;32:169-74.
12. Tang B, Chen Q, Chen X, et al. Earthquake-related injuries among survivors: a systematic review and quantitative synthesis of the literature. Int J Disaster Risk Reduct. 2017;21:159-67.
13. Peek-Asa C, Kraus JF, Bourque LB, Vimalachandra D, Yu J, Abrams J. Fatal and hospitalized injuries resulting from the 1994 Northridge earthquake. Int J Epidemiol. 1998;27:459-65.
14. Roces MC, White ME, Dayrit MM, Durkin ME. Risk factors for injuries due to the 1990 earthquake in Luzon, Philippines. Bull World Health Organ. 1992;70:509-14.
15. Özdemir G, Karlıdağ T, Bingöl O, et al. Systematic triage and treatment of earthquake victims: our experience in a tertiary hospital after the 2023 Kahramanmaras earthquake. Jt Dis Relat Surg. 2023;34:480-7.
16. 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;46:59-62.
17. Castillo-Galván ML, Martínez-Ruiz FM, de la Garza-Castro O, Elizondo-Omaña RE, Guzmán-López S. Estudio de la lesión nerviosa periférica en pacientes atendidos por traumatismos [Study of peripheral nerve injury in trauma patients]. Gac Med Mex. 2014;150:527-32.
18. Guner S, Guner SI, Isik Y, et al. Review of Van earthquakes form an orthopaedic perspective: a multicentre retrospective study. Int Orthop. 2013;37:119-24.
19. Yoshida T, Tada K, Uemura K, Yonenobu K. Peripheral nerve palsies in victims of the Hanshin-Awaji earthquake. Clin Orthop Relat Res. 1999;362:208-17.
20. Bywaters EG, Beall D. Crush injuries with impairment of renal function. Br Med J. 1941;1:427-32.
21. Better OS, Rubinstein I, Reis DN. Muscle crush compartment syndrome: fulminant local edema with threatening systemic effects. Kidney Int. 2003;63:1155-7.
22. Tahmasebi MN, Kiani K, Mazlouman SJ, et al. Musculoskeletal injuries associated with earthquake. A report of injuries of Iran's December 26, 2003 Bam earthquake casualties managed in tertiary referral centers. Injury. 2005;36:27-32.
23. Gesoğlu Demir T, Ethemoglu KB. Clinical, etiological, and electrophysiological characteristics of patients with peripheral nerve damage caused by the February 6 earthquake in Türkiye. Turk J Neurol. 2024;30:141-8.