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Relationship between earthquake ınjuries and ınflammatory blood parameters

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Abstract

Objective: An earthquake is a significant natural disaster with the potential to cause considerable mortality, economic disruption, and psychological effects. The purpose of this study was to investigate the impact of laboratory parameters on the triage, treatment, and survival of patients with injuries of varying severity who sustained traumatic injuries amid debris.

Methods: This retrospective study included 1250 adult earthquake victims who were received outpatients and inpatient treatment in our hospital between February 6 and February 23, 2023. The patients were classified into three categories. The first group includ ed individuals with soft tissue injuries but no fractures or major injuries. The second group included those with fractures but no major visceral injuries and crush syndrome. The third group included individuals with lung contusion, pneumothorax, intracranial hemorrhage, intra-abdominal hemorrhage, crush syndrome and compartment syndrome.

Results: Alanine transaminase, creatine kinase, myoglobin, D-dimer, white blood cell count, absolute neutrophil count, absolute monocyte count, C- aspartate transaminase reactive protein, neutrophil/lymphocyte ratio, platelet/lymphocyte ratio, monocyte/lymphocyte ratio, and the systemic inflammatory index were progressively higher in all three groups. Absolute-lymphocyte counts and calcium were progressively less different ($p<0.001$). Patients in the third group exhibited elevated creatinine levels and diminished blood sodium levels in comparison to the other groups ($p<0.001$).The mean hemoglobin level was lower in the third group than in the first group, while the mean gamma glutamyl transaminase level was higher($p<0.001$).

Discussion: These specific laboratory parameters can be used to identify high-risk patients with crush syndrome and major organ injury. This approach could enable the prioritisation of treatment for those who need it most, ensuring the optimal allocation of resources.

Keyword: Earthquake, Crush, Injury

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Deprem yaralanmaları ve inflamatuar kan parametreleri arasındaki ilişki

Öz

Giriş ve Amaç: Depremler, ekonomik ve psikolojik etkilerinin yanı sıra çok sayıda ölüme neden olan en önemli doğal afet olaylarındandır. Bu çalışmadaki amacımız , Kahramanmaraş depremi sonrası travmaya maruz kalmış farklı şiddetlerde yaralanan hastalarda laboratuvar parametrelerdeki değişkenliği incelemek ve bu konuda literatüre ışık tutmaktır.

Yöntemler: Bu retrospektif çalışmaya 06.02.2023 ve 23.02.2023 tarihleri arasında hastanemizde ayaktan veya yatarak tedavi gören 699'u (%55,9) kadın, 551'i (%44,1) erkek olmak üzere toplam 1250 katılımcı dahil edildi. Hastalar 3 gruba ayrılmıştır. 1. grup yumuşak doku zedelenmesi olup kırık veya majör yaralanması olmayan gruptur. 2. grup kırık olup majör iç organ yaralanması ve ezilme sendromu gelişmeyen grup olup 3. grup ise akciğer kontüzyonu pnömotoraks, intrakranial kanama, batın içi kanama, crush sendromu ve kompartman sendromu olan bireyleri içermektedir.

Bulgular: Kan alanin transaminaz, aspartat transaminaz,laktat dehidrogenaz kreatin kinaz, miyoglobin ve C-reaktif protein düzeyi; beyaz kan hücresi sayısı, mutlak nötrofil sayısı, mutlak monosit sayısı, nötrofil/lenfosit oranı , trombosit/lenfosit oranı, monosit/lenfosit oranı ve sistemik inflamatuar indeks (SII) en düşük 1. grup hastalarda en yüksek 3. grup hastalarda bulunmuştur ($p<0.001$). Kan kalsiyum düzeyi ve mutlak lenfosit sayısı ise en düşük 3. grup hastalarda, en yüksek 1. grup hastalarda bulunmuştur ($p<0.001$). 3. grup hastalarda kreatinin düzeyi diğer gruplara göre daha yüksek, kan sodyum düzeyi değeri daha düşüktü ($p<0.001$). Hemoglobin düzeyi 1. grup hastalarda, 2. grup hastalara göre daha yüksekti ($p<0.001$); ancak hemoglobin düzeyi açısından diğer gruplar arasında anlamlı fark yoktu ($p>0.05$).

Sonuç: Ezilme sendromu ve majör organ yaralanması olan yüksek riskli hastaların belirlenmesi, bu spesifik laboratuvar parametrelerinin kullanılmasıyla sağlanabilir. Bu yaklaşım, en çok ihtiyaç duyan hastalar için tedavinin önceliklendirilmesine olanak tanıyarak kaynakların optimum şekilde tahsis edilmesini sağlayabilir.

Anahtar kelimeler: Deprem, Ezilme, Yaralanma, Kırık.

INTRODUCTION

The earthquake that occurred on February 6, 2023, in the Kahramanmaraş region of southern Turkey, with a magnitude of 7.8, has been described as the catastrophe of the century in Turkey, a designation that is well-founded. A second earthquake, with a magnitude of 7.6, occurred in the same region nine hours later. The earthquake affected 11 provinces, resulting in 50.783 fatalities and over 100.000 injuries[1]. In the aftermath of the seismic event, survivors were transported to the nearest medical facility. Individuals who were rescued from the rubble may have sustained minor injuries, such as soft tissue damage, as well as more severe injuries, including fractures and limb ruptures, hemopneumothorax, and intracranial hemorrhages. The most prevalent injuries resulting from traumatic events are those affecting the extremities[2,3]. Complications that result in death, especially in cases of delayed intervention, are crush syndrome, sepsis, and hemorrhage[4]. Crush syndrome, also known as traumatic rhabdomyolysis, manifests as a consequence of rhabdomyolysis resulting from muscle trauma. It is more common in patients sustaining multiple traumas[5]. In the course of crush syndrome, electrolytes, myoglobin, and sarcoplasmic proteins such as creatine kinase and AST (aspartate transaminase) are released into the systemic circulation due to crushing in the muscles[6]. Myoglobin, one of the released proteins, may accumulate in the kidney and subsequently cause acute tubular necrosis and, ultimately, acute renal failure[7]. Compartment syndrome may also develop after crushing. Compartment syndrome is a condition that results in the necrosis of muscle and nerve tissues due to increased pressure within a closed compartment. Additionally, necrosis of the skin may occur as a consequence of excessive stretching. This syndrome may

necessitate extremity fasciotomy and amputation if appropriate precautions are not taken[8].

This study aimed to examine the variability in laboratory parameters in patients exposed to trauma under debris and who had been classified according to the severity of their injuries. The goal of the present study was to elucidate the extant literature on the subject. By examining these parameters, high-risk patients can be identified earlier and given priority in terms of treatment. This will result in a better disaster response strategy and management plan.

METHODS

This study was conducted retrospectively with 1250 adult patients admitted to the emergency outpatient clinic of a tertiary care hospital between February 6, 2023 and February 23, 2023. The patients were categorized into three groups according to the severity of their trauma and injury. The first group consisted exclusively of patients with soft tissue injuries, without any fractures or internal organ injuries. The second group included patients with fractures anywhere on the body, but without major visceral injuries and crush syndrome. The third group included patients with lung contusion, pneumothorax, crush syndrome, intra-abdominal injury, compartment syndrome, or intracranial hemorrhage. The study included patients 18 years of age and older. The study excluded pregnant women, breastfeeding women, and those with chronic diseases.

In this study, retrospective data on blood glucose levels, serum urea, creatine, sodium, potassium, calcium, AST (aspartate transaminase), ALT (Alanine transaminase), GGT (gamma glutamyl transaminase), ALP (alkaline phosphatase), creatinine kinase (CK), myoglobin, LDH (lactate dehydrogenase), C-reactive protein (CRP), D-dimer, and hemogram were obtained from the hospital information system and meticulously recorded for further analysis.

NLR (neutrophil/lymphocyte ratio) is determined by division of the absolute peripheral neutrophil (N) count by the absolute peripheral lymphocyte (L) count: NLR=N/L[9]. PLR (platelet/lymphocyte ratio) is determined by division of the absolute peripheral platelet (P) count by the absolute peripheral lymphocyte (L) count: PLR=P/L[10]. Similarly, MLR (monocyte/lymphocyte ratio) is determined by a division of the absolute peripheral monocyte count by the absolute peripheral lymphocyte (L) count: MLR=M/L[11]. SII (systemic inflammatory index) is determined using an equation that incorporates peripheral neutrophil, lymphocyte, and platelet counts. The equation is as follows: SII= (PxN) /L[12].

The research was formally endorsed by the Ethics Committee of the Mersin University. (approval no: 2023/282). Throughout the course of the study, the investigators maintained the tenets of patient confidentiality and adhered to the ethical standards for clinical research as set forth in the Declaration of Helsinki.

Statistical Analyses

A specialized statistical program was used to analyze the data gathered in the study. (SPSS for Windows version 22, IBM Corporation, Armonk, NY, USA). Whether the parameters were normally distributed was determined using visual (histogram and probability plots) and analytical methods (Kolmogorov-Smirnov and Shapiro-Wilk's test). The demographic data and evaluated parameters are presented using the median and interquartile range. Categorical parameters are presented as numbers (n) and percentages (%). The Kruskal Wallis test was used to compare the parameters, including numeric variables, between groups (first, second and third groups). When there was a

difference between these groups, the Mann-Whitney U test was used for pairwise comparisons to determine the source of the observed difference. The Chi-square test or Fisher's exact test, where appropriate, were used to compare the proportions between the groups. For statistical significance, a total type-1 error level of 5% was used.

The effect of the fracture region (cervical, thoracic, lumbar, head, and upper and lower extremity) on platelet/lymphocyte ratio, systemic inflammatory index scores, neutrophil/lymphocyte ratio, and monocyte/lymphocyte ratio were analyzed using multiple regression analysis.

RESULTS

The research comprised 1250 individuals, with 699 women (55.9%) and 551 men (44.1%), who were allocated to one of three groups. The first group comprises patients who have sustained soft tissue injury but no fracture or major injury. The second group includes individuals who have sustained a fracture in any part of the body but no major internal organ injury or crush syndrome. The third group comprises patients who have suffered lung contusion, pneumothorax, intracranial hemorrhage, intra-abdominal hemorrhage, crush syndrome, and compartment syndrome, in addition to or without a fracture in any part of the body. The first group comprised 405 participants who had been traumatized (212 women and 193 men), the second group comprised 429 participants who had been traumatized (255 women and 174 men), and the third group comprised 416 participants who had been traumatized (232 women and 184 men). Patient with third group had lower age compared to patients first group and patients with second group ($p < 0.001$). The Fasting glucose level, blood urea nitrogen level, blood alanine transaminase level, blood aspartate transaminase level, blood lactate dehydrogenase level, white blood cell count (WBC), blood creatine kinase level, blood myoglobin level, D-dimer, absolute neutrophil count, C-reactive protein level, absolute monocyte count, PLR, MLR, SII, and NLR were found to be considerably lower in the first group than in the second and third groups ($p<0.001$). Furthermore, these parameters were greater in the third group than in the second group ($p<0.001$). The first group exhibited elevated blood calcium levels and absolute lymphocyte counts in comparison to the second ($p=0.004$) and third groups ($p<0.001$). Similarly, patients in the second group exhibited elevated blood calcium levels and absolute lymphocyte counts in comparison to patients in the third group ($p < 0.001$). The creatinine level was increased and the blood sodium level was decreased in the third group than in the other groups. ($p<0.001$). The mean hemoglobin level was increased in the first group than in the second group ($p<0.001$), which did not exhibit a substantial difference between the other groups. ($p>0.05$). The third group had a higher the blood gamma glutamyl transaminase level ($p<0.001$); nevertheless, no notable discrepancy was observed between the remaining groups. ($p>0.05$) (Table 1).

Table I: Clinical and demographic information of the groups.

Parameters	First Group (n=405)	Second Group (n=429)	Third Group (n=416)	*p*
Age (year)	47 (32-63)	47 (34-62)	41 (28-54) [1]	**<0.001***
Crush syndrome (yes/no)	0/405	0/429	183/233	**<0.001***
Dialysis requirement (yes /no)	0/405	0/429	112/304	**<0.001***
Death(yes /no)	0/405	0/429	47/369	**<0.001***
Fasting blood sugar level (mg/dL)	105 (95-128) [2]	112 (97-134) [3]	120 (98-151)	**<0.001***
Blood urea nitrogen level (mg/dL)	30 (21-39) [2]	32 (24-45) [3]	56 (32-95)	**<0.001***
Creatinine level (mg/dL)	0.7 (0.6-0.8)	0.7 (0.6-0.8)	1 (0.6-2.5) [1]	**<0.001***
Blood sodium level (mmol/L)	139 (138-141)	139 (138-141)	138 (135-141) [1]	**<0.001***
Blood potassium level (mmol/L)	4.3 (4.0-4.6) [2]	4.2 (3.9-4.5) [3]	4.7 (4.1-5.6)	**<0.001***
Blood calcium level (mg/dL)	9.0 (8.6-9.3) [2]	8.8 (8.4-9.1) [3]	8.1 (7.5-8.7)	**<0.001***
Blood alanine transaminase level (u/L)	23 (16-34) [2]	32 (20-67) [3]	151 (68-320)	**<0.001***
Blood aspartate transaminase level (u/L)	31 (23-44) [2]	45 (27-119) [3]	288 (98-709)	**<0.001***
Blood gamma glutamyl transaminase level (u/L)	15 (11-20)	15 (11-20)	18 (11-33) [1]	**<0.001***
Blood lactate dehydrogenase level	65 (41-156) [2]	340 (231-564) [3]	750 (652-750)	**<0.001***
Blood creatine kinase level (u/L)	71 (42-142) [2]	748 (251-1000) [3]	1000 (1000-1000)	**<0.001***
Blood myoglobin level (ng/ mL)	45 (32-62) [2]	242 (65-1000) [3]	1000 (1000-1000)	**<0.001***
D-dimer (mg/L)	0.2 (0.2-0.3) [2]	2.6 (1.6-4.2) [3]	12.3 (7.9-15.1)	**<0.001***
White blood cell count (x10^3/uL)	8.4 (6.7-10.0) [2]	9.3 (7.4-12.1) [3]	14.7 (10.0-19.7)	**<0.001***
Haemoglobin level (g/dL)	13.0 (11.9-14.0) [4]	12.4 (11.0-13.7)	12.7 (10.3-14.9)	**<0.001***
Platelet count (x10^3/uL)	245 (213-294) [3]	244 (200-294)	235 (183-291)	**<0.001***
Absolute neutrophil count (x10^3/uL)	5.5 (4.1-7.3) [2]	6.7 (5.0-9.7) [3]	11.8 (7.7-17.0)	**<0.001***
Absolute lymphocyte count (x10^3/uL)	1.78 (1.30-2.27) [2]	1.59 (1.18-1.93) [3]	1.20 (0.90-1.63)	**<0.001***
Absolute monocyte count (x10^3/uL)	0.50 (0.40-0.61) [2]	0.58 (0.44-0.78) [3]	0.84 (0.58-1.20)	**<0.001***
C-reactive protein level (mg/dL)	0.4 (0.3-0.9) [2]	4.5 (1.7-9.1) [3]	13.9 (9.6-18.0)	**<0.001***
Neutrophil/lymphocyte ratio (%)	3.1 (2.1-4.5) [2]	4.4 (2.9-7.0) [3]	10.0 (5.6-16.6)	**<0.001***
Platelet/lymphocyte ratio (%)	144 (111-189) [2]	155 (122-206) [3]	191 (131-274)	**<0.001***
Monocyte/lymphocyte ratio (%)	0.27 (0.20-0.39) [2]	0.38 (0.26-0.56) [3]	0.69 (0.47-1.12)	**<0.001***
Systemic inflammatory index	778 (508-1175) [2]	1026 (696-1656) [3]	2029 (1200-4126)	**<0.001***

** p<0.05, Kruskal-Wallis test. Data was presented as median (interquartile range).*
[1]p<0.001, Mann-Whitney U test (Statistically different from second group and first groups).
[2]p<0.001, Mann-Whitney U test (Statistically different from second group and third groups).
[3]p<0.001, Mann-Whitney U test (Statistically different from third group).
[4]p<0.001, Mann-Whitney U test (Statistically different from second group).

A comparison of the categorical parameters of the groups revealed that the proportion of patients with head fracture, upper and lower extremity fracture, cervical fracture, lumbar fracture, pelvic fracture, lower extremity travma, thoracic spine fracture were increased in the second and third groups than in the first group (p<0.001). Nevertheless, a conspicuous discrepancy between the second and third groups was not observed. (p>0.05). The rates of chest trauma, abdominal trauma and intraabdominal bleeding, intracranial hemorrhage, and pneumothorax-hemothorax were increased in the second group relative to the first group. (p<0.001). Moreover, the rates of chest trauma, intracranial hemorrhage, and pneumothorax-hemothorax were higher in the second group compared to the first group (p>0.05). Furthermore, the rate of lower extremity trauma was elevated in the second and third groups versus the first group. (p<0.001) (Table 2).

Table II: The proportions of categorical parameters assessed of the groups.

Parameters		First Group (n=405)	Second Group (n=429)	Third Group (n=416)	*p*
Sex	Female, n (%)	212 (52.3)	255 (59.4)	232 (55.8)	0.119
	Male, n (%)	193 (47.7)	174 (40.6)	184 (44.2)	
Head fracture	No, n (%)	405 (100) [1]	407 (94.9)	396 (95.2)	**<0.001***
	Yes, n (%)	0	22 (5.1)	20 (4.8)	
Upper extremity fracture	No, n (%)	405 (100) [1]	330 (76.9)	301 (72.4)	**<0.001***
	Yes, n (%)	0	99 (23.1)	115 (27.6)	
Humerus fracture		0	37	44	
Ulna-radius fracture		0	10	18	
Fingers fracture		0	33	25	
Multiple fractures in the region		0	19	28	
Lower extremity fracture	No, n (%)	405 (100) [1]	254 (59.2)	253 (60.8)	**<0.001***
	Yes, n (%)	0	175 (40.8)	163 (39.2)	
Femur fracture		0	54	70	
Tibia-Fibula fracture		0	42	38	
Foot fracture		0	60	14	
Multiple fractures in the region		0	19	31	
Lumbar fracture	No, n (%)	405 (100) [1]	336 (78.3)	351 (84.4)	**<0.001***
	Yes, n (%)	0	93 (21.7)	65 (15.6)	
L1-2		0	52	20	
L3-5		0	14	14	
Sacrum-coxix		0	22	5	
Multiple fractures in the region		0	5	26	
Cervikal fracture	No, n (%)	405 (100) [1]	417 (97.2)	400 (96.2)	**<0.001***
	Yes, n (%)	0	12 (2.8)	16 (3.8)	
C1-2		0			
C3-7		0			
Multiple fractures in the region		0			
Thoracic spine fracture	No, n (%)	405 (100) [1]	367 (85.5)	301 (72.4)	**<0.001***
	Yes, n (%)	0	62 (14.5)	115 (27.6)	
T1-4 rib		0	8	14	
T5-8 rib		0	38	46	
T9-12 rib		0	12	34	
Multiple fractures in the region		0	4	21	
Pelvic fracture	No, n (%)	405 (100) [1]	345 (80.4)	343 (82.5)	**<0.001***
	Yes, n (%)	0	84 (19.6)	73 (17.5)	
Head trauma	No, n (%)	343 (84.7) [3]	363 (84.6)	326 (78.4)	**0.022***
	Yes, n (%)	62 (15.3)	66 (15.4)	90 (21.6)	
Abdominal trauma	No, n (%)	375 (92.6)	381 (88.8)	330 (79.3) [2]	**<0.001***
	Yes, n (%)	30 (7.4)	48 (11.2)	86 (20.7)	
Chest trauma	No, n (%)	325 (80.2) [1]	298 (69.5) [3]	187 (45)	**<0.001***
	Yes, n (%)	80 (19.8)	131 (30.5)	229 (55)	
Upper extremity trauma	No, n (%)	214 (52.8) [4]	266 (62) [3]	210 (50.5)	**0.002***
	Yes, n (%)	191 (47.2)	163 (38)	206 (49.5)	
Lower extremity trauma	No, n (%)	223 (55.1) [1]	183 (42.7)	162 (38.9)	**<0.001***
	Yes, n (%)	182 (44.9)	246 (57.3)	254 (61.1)	
Intracranial hemorrhage	No, n (%)	405 (100) [1]	429 (100) [3]	374 (89.9)	**<0.001***
	Yes, n (%)	0	11 (2.6)	42 (10.1)	
Pneumothorax-hemothorax	No, n (%)	405 (100) [1]	429 (100) [3]	247 (59.4)	**<0.001***
	Yes, n (%)	0	12 (2.8)	169 (40.6)	
Intraabdominal bledding	No, n (%)	405 (100) [1]	429 (100) [3]	398 (95.7)	**<0.001***
	Yes, n (%)	0	1 (0,2)	18 (4,3) [2]	

** p<0.05, Chi-squared test or Fisher's exact test.*
[1]p<0.05, Chi-squared test or Fisher's exact test (Statistically different from second and third group).
[2] p<0.05, Chi-squared test or Fisher's exact test (Statistically different from first and second group).
[3]p<0.05, Chi-squared test or Fisher's exact test (Statistically different from third group).
[4]p<0.05, Chi-squared test or Fisher's exact test (Statistically different from second group).

It was found that the fracture site explained 8% of the change in monocyte/lymphocyte ratio, 3.7% of the change in the systemic inflammatory index, 2% of the change in platelet/lymphocyte ratio, and 5.8% of the change in neutrophil/lymphocyte ratio. The presence of upper and lower extremity (p<0.001), cervical (p=0.011), and thoracic spine (p=0.049) fractures was found to be the determining parameters for monocyte/lymphocyte ratio. For the systemic inflammatory index and platelet/lymphocyte ratio, the presence of upper and lower extremity fractures was found to be the determining parameters (p<0.05). For neutrophil/lymphocyte ratio, the presence of fractures in the upper and lower extremities and thoracic spine regions was found to be the determining parameters (p<0.05) (Table 3).

Table III: Multiple regression analysis results.

Model	Monocyte/lymphocyte ratio				Systemic inflammatory index				Platelet/lymphocyte ratio				Neutrophil/lymphocyte ratio			
	Unstandardized Coefficients B	Standardized Coefficients Beta	*P*	R^2	Unstandardized Coefficients B	Standardized Coefficients Beta	*P*	R^2	Unstandardized Coefficients B	Standardized Coefficients Beta	*P*	R^2	Unstandardized Coefficients B	Standardized Coefficients Beta	*P*	R^2
Head fracture	0.086	0.032	0.242		51.695	0.004	0.891		27.612	0.042	0.133		-0.086	-0.002	0.946	
Upper extremity fracture	0.253	0.195	**<0.001**		852.280	0.132	**<0.001**		21.351	0.068	**0.016**		3.653	0.166	**<0.001**	
Lower extremity fracture	0.192	0.175	**<0.001**		687.959	0.125	**<0.001**		16.549	0.062	**0.036**		2.515	0.135	**<0.001**	
Lumbar fracture	0.031	0.021	0.460	0.08	291.286	0.040	0.170	0.037	14.862	0.042	0.152	0.02	1.396	0.056	0.051	0.058
Cervical fracture	0.231	0.070	**0.011**		277.908	0.017	0.548		23.584	0.029	0.298		1.638	0.029	0.293	
Pelvic fracture	0.060	0.041	0.155		208.848	0.028	0.336		19.800	0.055	0.062		1.393	0.056	0.057	
Thoracic spine fracture	0.077	0.055	**0.049**		288.577	0.041	0.149		15.445	0.046	0.115		1.492	0.063	**0.027**	

DISCUSSION

An earthquake is a significant natural disaster with the potential to cause considerable mortality, economic disruption, and psychological effects on individuals of all ages. In a study of the Marmara earthquake, it was found that the average age of people who developed crush syndrome was lower. Similarly, in our study, the average age of the third group who developed crush syndrome was significantly lower than the other groups[13]. This result may be due to the increased susceptibility of older adults to trauma and death, which likely resulted in immediate

fatalities. Conversely, the tendency for developing crush syndrome is more prevalent in younger and middle-aged individuals, likely due to the higher muscle mass density in this demographic.

Anemia in patients trapped under rubble is a significant health concern. It was observed that anemia was prevalent among outpatients in the aftermath of the Mexico earthquake[14]. The low hemoglobin values observed in both the second and third groups in our study may be indicative of hemodilution resulting from blood loss or excessive fluid administration to patients with oliguria.

In a clinical study by Yaşar et al. examining the complete blood counts of patients with crush injuries after the Kahramanmaraş earthquake in 2024, the findings indicated a significant correlation between PLR and MLR and the duration of hospitalization. Furthermore, MLR and SIRI were found to be significantly associated with the need for dialysis[15]. In a clinical study by Lee et al. in severe trauma patients, low NLR and PLR values were found to be associated with mortality[16]. In the present study, it was observed that parameters such as PLR, SII, NLR and MLR exhibited significantly higher values in the second group in comparison to the first group, and in the third group in comparison to the other groups. As the third group consisted of individuals with major organ injury, crush syndrome, and the need for dialysis, the NLR, PLR, MLR, and SIRI calculated at the time of presentation to the emergency department may be predictive of the duration of hospitalization and the necessity for dialysis.

In a study by Sever et al. (2002) examining the laboratory characteristics after the Marmara earthquake, the leukocyte ratio was found to be high, similar to our study[17]. High leukocyte, CRP, and absolute neutrophil counts may be the result of rhabdomyolysis, a process whereby muscle cells are broken down and released into the bloodstream[18,19]. This phenomenon can occur as a result of the body's response to the acute event or accompanying infectious complications.

In the present study, the first group exhibited elevated absolute lymphocyte counts in comparison to the second and third groups. the second group exhibited elevated absolute lymphocyte counts in comparison to the third group. A comprehensive literature review did not yield any data on lymphocyte levels and earthquakes. In our study, lymphocyte levels were observed to be diminished in patients with crush syndrome and major organ injury after earthquakes, which represents a novel contribution to the existing literature on this subject.

The fasting blood glucose level was higher in the third group in comparison to the second group. It should be noted that our study was retrospective, and due to the disaster situation, we were unable to access all the chronic disease data of the patients admitted to the emergency room. It is therefore unclear how many of these patients had diabetes mellitus.

Hypocalcemia represents a significant electrolyte abnormality in patients entrapped under rubble. The primary cause of hypocalcemia in the initial stages is the precipitation of phosphorus and calcium ions released due to muscle injury in patients trapped under rubble. These ions form crystals in soft tissues, which can lead to a reduction in calcium levels in the body[20]. Hypocalcemia was identified also in a study conducted in 1999. This was demonstrated by Canbakan et al. in patients with crush syndrome following the Marmara earthquake[21]. In the present study, calcium levels were found to be significantly lower in the second group compared to the first group and in the third group compared to the second group.

The findings of rhabdomyolysis observed in patients with crush syndrome as a result of

skeletal muscle injury and muscle cells mixing with plasma include hyperkalemia, hyperphosphatemia, hypocalcemia, and hyperuricemia. Among these, hyperkalemia is the most common and most important because it can lead to fatal arrhythmias and heart failure. In the study conducted by Sever et al. following the Marmara earthquake, it was observed that patients with traumatized and fasciotomized extremities exhibited elevated levels of creatine kinase (CK) and potassium[22]. The concentration of CK was observed to be elevated in patients undergoing dialysis following the Marmara and Kobe earthquakes in comparison to those who were not undergoing dialysis[22,23]. As the number of traumatized muscles increases, the levels of potassium, CK, and myoglobin also increase[24]. As the third group comprised patients who had experienced multiple traumas, major organ injury, and AKI, these parameters were found to be elevated in line with the findings of previous studies.

In the study conducted by Omrani et al. following the Kermanshah earthquake in Iran in 2021, serum CK, LDH, AST, and uric acid levels were identified as the most significant predictors of AKI development in patients with traumatic rhabdomyolysis[25]. In our study, similar elevations were observed in the third group due to traumatic rhabdomyolysis. In the present study, as in previous investigations, significant increases in these parameters were observed in the second group compared with the first group and in the third group compared with the other groups, due to traumatic rhabdomyolysis.

In the present study, elevated levels of gamma-glutamyl transaminase were observed in all three groups. A comprehensive literature search did not yield any data on the relationship between GGT levels and earthquakes. It can be postulated that a high GGT level may be indicative of crush syndrome.

The present study demonstrates an association between high levels of inflammatory markers, including SII, MLR, NLR and PLR, and upper and lower extremity fractures. Given the absence of prior research on this topic, further investigation is required to clarify the link between fracture and these inflammatory markers.

CONCLUSION

İf the SII, MLR, NLR and PLR, which are associated with the inflammatory process, are elevated in earthquake victims who are admitted to the emergency room, these patients should be subjected to a more expeditious and comprehensive examination with regard to extremity traumas. The presence of lymphopenia and neutrophilia in complete blood count parameters, in conjunction with elevated C-reactive protein and d-dimer, on arrival to the emergency department, may serve as a guide for the emergency department to evaluate patients more rapidly and plan treatments in terms of earthquake-related organ injury and serious complications such as crush syndrome and compartment syndrome. This may also result in a reduction in health expenditures.

Ethics Committee Approval: The research was formally endorsed by the Ethics Committee of the Mersin University. (approval no: 2023/282). Throughout the course of the study, the investigators maintained the tenets of patient confidentiality and adhered to the ethical standards for clinical research as set forth in the Declaration of Helsinki.

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