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The Intercontinental Journal of
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Dear Esteemed Readers, Authors, Editors and Peer Reviewers,

As we conclude the inaugural year of the Intercontinental Journal of Emergency Medicine, we are excited to present our fourth and final issue. This year has been a remarkable journey, marked not only by academic resilience but also by our collective response to extraordinary global challenges, including the ongoing COVID-19 pandemic, various conflicts, terrorist attacks, and natural disasters like earthquakes in different areas of the world. These events have underscored the vital importance of emergency medicine and the fundamental human rights that guide our work, including the right to life, safety, justice, education, nationality, and the right to seek asylum.

In this issue, we feature ten significant contributions—seven original articles and three case reports—that considerably enhance the diverse landscape of emergency medicine. These articles reflect the dynamic and evolving nature of our field, emphasizing the crucial role our journal plays in advancing emergency medical care while steadfastly upholding human rights.

Below, you will find the original articles presenting a broad spectrum of research and studies. Each one offers unique perspectives and findings to the field of emergency medicine:

1. An examination of the effects of COVID-19 on musculoskeletal pain, fatigue, and hand grip strength in pregnant women contributed to our understanding of the pandemic's impact on this specific demographic.
2. A research piece on the effectiveness of biomarkers in predicting traumatic brain injury in pediatric patients with minor head trauma.
3. A study exploring the role of biochemical parameters, including the neutrophil-lymphocyte ratio, in predicting mortality among cancer patients in emergency settings.
4. A comprehensive comparison of the Canadian and San Francisco syncope rules, providing valuable insights for emergency department protocols.
5. An analysis of the rescue operations and outcomes from a recent avalanche disaster, offering crucial lessons in safety and emergency response strategies.
6. An innovative evaluation of the effectiveness of echocardiography and compression ultrasonography in diagnosing pulmonary embolism, enhancing our diagnostic capabilities.
7. An in-depth examination of occupational accidents and injuries, calling attention to the need for improved safety measures in the workplace.

Complementing these articles, our case reports delve into specific, complex scenarios, offering deep insights and critical learning:

1. A unique presentation of simultaneous atrioventricular nodal reentrant tachycardia attacks in a mother and daughter, drawing attention to the familial nature of the condition.
2. An innovative approach to treating mesenteric vein thrombosis linked to synthetic drug use, demonstrating the versatility and adaptability required in emergency medical care.
3. A case highlighting the dangers of anticoagulant dose reduction in a patient with atrial fibrillation, leading to rapid thromboembolism development and death.

We extend our deepest gratitude to our contributors,whose rigorous research and analyses formed the bedrock of this journal. This year, our journal has been particularly enriched by contributions not only from the field of emergency medicine but also from related disciplines such as anesthesiology, cardiology, intensive care, internal medicine,interventional radiology, orthopaedics, perinatology, pulmonology, radiology, general surgery, neurology, and neurosurgery. The interdisciplinary nature of these contributions has helped provide a comprehensive and nuanced understanding of the challenges and solutions in emergency medical care.

Our editorial board members and reviewers have been instrumental in maintaining high standards, ensuring we remain a trusted source of specialist knowledge in emergency medicine, representing a diverse range of expertise.

As we look forward to the future, we eagerly anticipate another year of groundbreaking research and stimulating discussion. We invite contributions that address current gaps in emergency medicine literature, especially those reflecting the global challenges and experiences of practitioners facingpandemics, wars, terrorist attacks, and life-changing natural disasters

Thank you for your unwavering support and dedication through a year that has tested our resilience and adaptability. Your commitment inspires us to continue our path of discovery and innovation in emergency medical care, always with a focus on protecting and advocating for human rights. As we step into the New Year, we look forward to new discoveries and ongoing collaboration in our shared journey of advancing emergency medicine.

Wishing you a Happy New Year filled with new insights, breakthroughs, and collective success.

Sincerely,

Umut OCAK, MD

Chief Editor

Intercontinental Journal of Emergency Medicine

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Original Article

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Investigation of the effects of COVID-19 on muscle skeletal pain, fatigue, and hand grip strength in pregnant woman

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ABSTRACT

Aims: Hand grip strength is an important parameter that can be measured with a cheap, effective, and simple technique that can provide information about general health status. This study aimed to investigate the relationship between hand grip strength and musculoskeletal system findings and fatigue in pregnant COVID-19 patients. The data on common symptoms, laboratory findings, vaccination rates, and smoking rates of pregnant COVID-19 patients were evaluated as secondary results in the study.

Methods: The study had a cross-sectional, single-center, and retrospective case design. Demographic information, clinical findings, musculoskeletal symptoms, laboratory findings, and body temperatures of the patients were recorded. The relationship between the patient's hand grip muscle strength and the recorded data was evaluated. Myalgia severity was evaluated in kg by using the Numerical Rating Scale (NRS), physical fatigue by the Visual Analog Scale (VAS), and muscle strength by kg using a CAMRY digital hand dynamometer.

Results: The negative relationship between hand grip strength, focal muscle pain, and physical fatigue in pregnant COVID-19 patients was found to be statistically significant (P=0.010 and p=0.020 for focal muscle pain and physical fatigue, respectively). In laboratory data, a positive relationship was detected with the neutrophil/lymphocyte ratio (NLR) and neutrophil percentage, and a negative relationship was detected with lymphocyte percentage at a statistically significant level (P=0.042, p=0.027, p=0.037 for NRL, percentage of neutrophils and percentage of lymphocytes, respectively). (Statistical significance level was accepted as $p<0.05$)

Conclusion: We think that the evaluation of hand grip strength in pregnant women infected with COVID-19 will provide useful information for diagnosis, treatment, and prognosis.

Keywords: Hand grip strength, COVID-19, focal muscle pain

INTRODUCTION

COVID-19 was first identified in December 2019 for strains infected with the virus named SARS-CoV-2. Previous studies have shown that SARS-CoV-2 can affect all cells and systems with angiotensin-converting enzyme-2 (ACE-2) receptors.[1] Cough, high fever, sore throat, headache, diarrhea, muscle and joint pain, fatigue, and loss of sense of smell and taste are among the common symptoms of COVID-19.[2] Although symptoms such as myalgia, arthralgia, and fatigue are frequently detected in the acute and chronic stages of the disease, there is insufficient data on special patient groups such as pregnancy.[3]

"Hand grip muscle strength", which can be measured with an inexpensive, reliable, and noninvasive technique, is a frequently used parameter in the evaluation of the musculoskeletal system. The relationship between hand grip muscle strength and musculoskeletal symptoms and physical fatigue in pregnant COVID-19 patients was evaluated in the present study. The first aim of our study was to investigate whether hand grip strength can be used as a meaningful parameter in determining the diagnosis, treatment, and prognosis of pregnant COVID-19 patients. As secondary results of the study, the symptoms, laboratory findings, vaccination rates, and smoking status of our pregnant COVID-19 patients were evaluated.

METHODS

Study Design and Participants

This cross-sectional, single-center, retrospective case series study was conducted in Karaman Education and Research Hospital between December 2021 and May 2022. The Ethics Committee Approval was obtained from the Ethics Committee of Karamanoğlu Mehmetbey University

Faculty of Medicine with the date 29 Jun 2022, and decision no 06-2022/10. Permission was obtained from the boards of Karaman Education and Research Hospital to conduct the study in our hospital. The study was designed in line with the principles of the Declaration of Helsinki. The study was registered retrospectively on Clinicaltrials.gov with the number NCT05970874. Pregnant women who were over the age of 18, who were clinically diagnosed with COVID-19, whose throat swab samples were positive in real-time reverse transcription polymerase chain reaction analysis, who were hospitalized and treated, and who signed the written consent documents they were informed about were included in the study. Recordings were made on the first day of admissions to the wards and on the second day of afternoon admissions. Those with neurological and physical disabilities that would affect muscle strength measurements, those with psychiatric disorders, those with myopathy, those who could not read or write Turkish, those with abnormal mental status, and those who did not allow their data to be used for scientific purposes were not included in the study.

Data Collection

Age, height, weight, gestational week, weight changes during pregnancy, smoking status, comorbidities (hypertension, diabetes, goiter, rheumatological diseases), demographic data, and vaccination data were recorded. Symptoms from the onset of the disease to the moment they were registered, cough, fever, diffuse myalgia, focal muscle pain, low back pain, back pain, muster, elbow, wrist, knee, hip, and ankle joint pain, dyspnea, headache, anorexia, diarrhea, or asymptomatic presence, were questioned and recorded in the study. Complete blood count, blood glucose, D-dimer, ferritin, C-reactive protein (CRP), procalcitonin, lactate dehydrogenase (LDH), creatine kinase (CK), and isoenzyme CK-MB levels during hospitalization were analyzed.

Evaluation of Musculoskeletal Symptoms

Musculoskeletal symptoms, myalgia, and arthralgia were questioned in detail, and localizations were determined. The severity was determined by the Numerical Rating Scale (NRS), and the Visual Analog Scale (VAS) was used to assess fatigue.

Hand Grip Strength Measurements

Hand grip muscle strength was recorded when the patients were admitted to the service. Hand grip strength (HGS) was measured in kg with the CAMRY Digital Hand Dynamometer (Model No. EH101, CAMRY) with three consecutive measurements made with the dominant hand, elbows at the side, and forearm flexed at right angles. The highest measurement was included in the data.[3] For females over the age of 18, the HGS reference value determined by previous studies was accepted as 19 kg.[3]

In our study, the hand grip muscle strength of pregnant COVID-19 patients, who were deemed suitable for hospitalization, was evaluated during their hospitalization. Detailed physical examinations of the patients were performed. Arthralgia and myalgia findings were evaluated. Standard treatment protocols (Intravenous hydration, nasal O2, paracetamol) and pregnancy follow-ups were performed. Patients who required intensive care were not included in the study. Post-discharge follow-up of the patients could not be done regularly due to the pandemic and they were excluded from evaluation.

Body Temperature Measurements

The body temperatures of the patients were measured from the right and left ears using a digital tympanic thermometer during hospitalization.

Primer Outcome

The relationships of hand grip strength with musculoskeletal system symptoms and findings, laboratory values, and burnout were investigated. The effectiveness of the relationship between these parameters in determining diagnosis, treatment, and prognosis during hospitalization was evaluated.

Seconder Outcome

Common symptoms, laboratory findings, vaccination rates, and smoking status in pregnant COVID-19 patients were questioned and presented as secondary results of the study.

Statistics

The IBM Statistical Package for Social Sciences (IBM-SPSS Inc., Chicago, IL, USA) 22.0 program was used in the analysis of the data obtained in the study. The suitability of the data to the normal distribution was examined with the Shapiro–Wilk test, and the continuous variables were expressed as the mean and standard deviation or median (25-75%) according to distribution status, and categorical variables were expressed as numbers and percentages. The Spearman relationship test was used for the relationship between muscle strength and other parameters in the analysis of the continuous variables. Logistic regression analysis was used to identify possible independent risk factors for muscle strength in patients, and the statistical significance level was accepted as $p<0.05$.

RESULTS

Demographic and Clinical Findings

A total of 23 patients were included in the present study. The records of 25 patients were obtained from the system. Two patients were excluded from the statistical evaluation because of missing data. The mean age of the patients was 29±6 (years), and the mean body mass index (BMI) was 28.83±5.14 (kg/m2). The mean value of the patient's weight changes during pregnancy was 4.96±6.96 kg. Considering the weeks of pregnancy, at least 5 pregnant women and a maximum of 40 weeks were evaluated. The demographic characteristics of the patients are given in **Table 1**.

Considering the symptoms and findings of the patients, the frequency was found to be cough (82.6%), fever (52.2%), and diffuse myalgia (43.5%). Patient symptoms and findings are given in **Table 2**.

Considering the symptoms associated with the musculoskeletal system and the findings of the patients, back pain (56.5%), diffuse myalgia (43.5%), and knee arthralgia (43.5%) were found to be the most common symptoms. Patient symptoms and findings are given in **Table 2**.

Table 1. Demographic characteristics of the patients

Demographic feature	Mean± SD or Median (Percentile 25-75)	Minimum-Maximum
Age(years)	29±6	21-43
Height(cm)	162±7	150-178
Weight (kg)	75±14	59-103
BMI (kg/m²)	28.83±5.14	21.16-40.74
PrePre-gnancy weight(kg)	70±13	50-97
PrePre-gnancy BMI (kg/m²)	26.93±5.11	18.82-37.78
Weight gained during pregnancy (kg)	5(0-10)	(-15)-17
Pregnancy week	23(14-33)	5-40
Comorbid disease (yes/no) (%)	7(30.4%)/26 (60.6%)	
Smoking (yes/no) (%)	4(17.4%)/19(82.6%)	

Values are presented as numbers either mean ± standard deviation (SD) or median. BMI: Body Mass Index.

Table 2. Patient symptoms and findings

Symptoms and Signs	Yes, n (%)	No, n (%)
Cough	19(82.6%)	4(17.4%)
Fever	12(52.2%)	11(47.8%)
Common myalgia	10(43.5%)	13(56.5%)
Low back pain	7(30.4%)	16(69.6%)
Focal muscle pain	8(34.8%)	15(65.2%)
Back pain	13(56.5%)	10(43.5%)
Shoulder arthralgia	6(26.1%)	17(73.9%)
Elbow arthralgia	4(17.4%)	19(82.6%)
Wrist arthralgia	1(4.3%)	22(95.7%)
Knee arthralgia	10(43.5%)	13(56.5%)
Hip arthralgia	10(43.5%)	13(56.5%)
Angle arthralgia	4(17.4%)	19(82.6%)
Dyspnea	10(43.5%)	13(56.5%)
Headache	11(47.8%)	12(52.2%)
Anorexia	12(52.2%)	11(47.8%)
Diarrhea	3(13.0%)	20(87%)

Vaccination Status

When the patients were evaluated in terms of vaccination status, a total of 13 patients were vaccinated against COVID-19. Those who were vaccinated in the last three months, 6 months, or before were evaluated as of the hospitalization date. The vaccination information of the patients is given in **Table 3**.

Table 3. Covid-19 vaccination status of the patients

Vaccination Status	Yes, n(%)	No, n(%)
Vaccination Situations	13 (56.5%)	10 (43.5%)
Vaccination of the last three months	5 (11.7%)	18 (78.3%)
Getting vaccinated more than six months ago	4 (17.4%)	19 (82.6%)
Sinovac	2 (8.7%)	21 (91.3%)
BioNTech	11 (47.8%)	12 (52.2%)

Laboratory Findings

The laboratory parameters of the patients are given in **Table 4**.

Fatigue, myalgia, muscle strength, and temperature parameters of the patients were also examined and are given in **Table 5**.

Table 4. Patient laboratory parameters

Laboratory parameters	Mean± SD or Median (Percentile 25-75)	Minimum-Maximum
WBC count, (106/L)	8870(6290-11130)	4970-14570
Lymphocyte count, (106/L)	1460(980-1850)	210-3380
Neutrophil count, (106/L)	7140(5000-8190)	2760-11950
Hemoglobin, (g/L)	11.83±1.83	6.90-14.30
Platelet count, (106/µL)	230000(193000-247000)	125000-287000
CRP (mg/L)	14.2(8.4-19.4)	0.6-76.8
CK, (µg/L)	45(32-54)	18-260
CKMB, (µg/L)	10.9(8.0-12.0)	4-25.7
Ferritin, (µg/L)	19.20(9.40-58.90)	5.1-230
LDH, (U/L)	163(157-190)	113-285
D-dimer (U/L)	950(450-1736)	170-2472
Procalcitonin (ng/mL)	0.07(0.01-0.09)	0.01-0.5
Platelet/Neutrophil	152.17(103.42-204.13)	78.86-595.24
Neutrophil/Lymphocyte	4.85(2.53-8.21)	1.31-24.81
Lymphocyte percentage, (%)	15.44(9.79-25.60)	3.64-38.16
Neutrophil percentage, (%)	77.85(66.85-80.98)	49.91-90.29
Blood glucose mg/dl	98(88-133)	77-153

Values are presented as numbers either mean ± standard deviation (SD) or median. WBC: White blood cell, CRP: C-reactive protein, CK: Creatine kinase, CKMB: Creatine kinase myocardial band, LDH: Lactate dehydrogenase

Table 5. Patient fatigue, myalgia, muscle strength, and temperature parameters

Characteristic Feature	Mean± SD or Median (Percentile 25- 75)	No, n(%)
Myalgia NRS	5(2-7)	1-9
fatigue VAS	6(4-8)	1-10
Muscle strength kg	21.9(16.1-27.1)	6.7-31.1
Tc right side, (°C)	37.0±0.6	35.6-7.9
Tc left side, (°C)	37.0±0.5	35.8-38

Values are presented as numbers either mean ± standard deviation (SD) or median. Numerical Rating Scale (NRS), Visual Analog Scale (VAS), Tc: Core body temperature (Tc)

Relationship of Data with Muscle Strength

HGS was evaluated in pregnant women infected with COVID-19. Values below the determined reference value (19 kg) were found in 8 patients (34.8%). Fifteen patients (65.2%) were not considered to have low HSG.

The relationship between patient demographic data and muscle strength was examined, and the results are given in **Table 6**.

Table 6. The relationship between patient demographics and muscle strength

	Relationship With Muscle Strength	
Characteristic	R value	P value
Age(years)	-0.132	0.547
Height(cm)	-0.333	0.120
Weight(kg)	-0.238	0.273
BMI (kg/m²)	-0.085	0.701
Gestational week	0.249	0.253
PrePre-gnancy weight(kg)	-0.325	0.130
Weight Gained During Pregnancy	0.115	0.600
Comorbid Disease	-0.071	0.747
Smoking	-0.104	0.637

BMI: body mass index. The Spearman correlation test was applied.
* P value is below the threshold of 0.05.

Evaluation of Laboratory Parameters

Although the negative relationship was statistically significant for the percentage of lymphocytes (p=0.037), it was not found to be significant for other parameters (p>0.05). The relationship between laboratory parameters and muscle strength is given in **Table 7**.

Table 7. Relationship between patient laboratory parameters and muscle strength

	Muscle Strength	
Laboratory parameters	R value	P value
Ferritin, (µg/L)	0.082	0.737
D-Dimer (µg FEU/L)	0.125	0.611
Procalcitonin (ng/mL)	-0.014	0.956
WBC count, × 106/L	0.155	0.480
Lymphocyte count × 106/L	-0.348	0.104
Neutrophil count × 106/L	0.226	0.300
HemoHaemoglobin, g/L	0.039	0.859
Platelet count 106/L	-0.380	0.074
CRP (mg/L)	-0.258	0.247
CK, (µg/L)	0.021	0.937
CKMB, (µg/L)	0.171	0.543
LDH, U/L	0.240	0.409
Blood sugar, g/dl	0.288	0.182
Platelet/Lymphocyte	0.175	0.423
Neutrophil/l/ Lymphocyte	0.428	0.042*
Percentage of Lymphocyte, (%)	-0.437	0.037*
Percentage of Neutrophils, (%)	0.461	0.027*

The Spearman correlation test was applied. * P value is below the threshold of 0.05.
WBC: White blood cell, CRP: C-reactive protein, CK: Creatine kinase, CKMB: Creatine kinase myocardial band, LDH: Lactate dehydrogenase

Vaccination Situations

The relationship between the vaccination status of the patients and their muscle strength was examined in the present study and was not found to be statistically significant (p>0.05). The relationship between vaccination status and muscle strength is given in **Table 8**.

Table 8. Relationship between patient COVID-19 vaccination status and muscle strength

	Muscle Strength	
Characteristic feature	R value	P value
Don't get vaccinated	-0.033	0.881
Vaccination of the last three mouths	0.143	0.515
Vaccination of the last six mouths	-0.156	0.478
Getting vaccinated more than six months ago	-0.043	0.845
BioNTech	-0.19	0.384
Sinovac	0.279	0.197
HemoHaemoglobin, g/L	0.039	0.859

The Spearman correlation test was applied.
* P value is below the threshold of 0.05.

When the relationship between the physical fatigue, myalgia, and temperature parameters of the patients and muscle strength were examined, negative relationships were detected for all parameters. This relationship was statistically significant for the fatigue parameter (p=0.020). The relationship between fatigue, myalgia temperature parameters, and muscle strength is given in **Table 9**.

Table 9. Relationship between patient fatigue, muscle strength, temperature parameters, and muscle strength

	Muscle Strength	
Characteristic feature	R value	P value
Myalgia NRS	-0.396	0.062
Fatigue VAS	-0.483	0.020*
Tc right, °C	-0.160	0.465
Tc left, °C	-0.252	0.246
BioNTech	-0.19	0.384

The Spearman correlation test was applied.
* P value is below the threshold of 0.05.
Numerical Rating Scale (NRS), Visual Analog Scale (VAS), Tc: Core body temperature (Tc)

Table 10. Relationship between patient symptoms and findings and muscle strength

	Muscle Strength	
Characteristic Feature	R value	P value
Smoking	-0.104	0.637
Cough	0.017	0.938
Fever	-0.125	0.571
Common myalgia	-0.397	0.061
Low back pain	-0.221	0.311
Focal muscle pain	-0.523	0.010*
Back pain	-0.066	0.764
Shoulder arthralgia	-0.321	0.135
Elbow arthralgia	-0.372	0.081
Wrist arthralgia	0.0001	1.000
Knee arthralgia	-0.185	0.398
Hip arthralgia	-0.218	0.317
Ankle arthralgia	0.061	0.784
Dyspnea	-0.370	0.082
Headache	-0.230	0.292
Anorexia	-0.112	0.612
Diarrhea	-0.311	0.148

The Spearman correlation test was applied. * P value is below the threshold of 0.05.

When the relationship between patient symptoms and signs and muscle strength was examined, a negative relationship was detected between focal muscle pain parameters and muscle strength at a statistically significant level (p=0.010). The relationship between patient symptoms and signs and muscle strength is given in **Table 10**.

Multivariate logistic regression analysis was applied to the study using muscle strength parameters and statistically significant and clinically significant variables. Among these independent variables, only the physical fatigue parameter was found to be significant (B value: -1.062; 95% CI: (-2.087--0.037) (p=0.043). The logistic regression model examining the risk factors for muscle strength is presented in **Table 11**.

Table 11. Relationship between significant variables and muscle strength

Risk Factor	B value (95% CI)	P value
Focal muscle pain	-5.399(-11.203- 0.406)	0.066
Neutrophil percentage, (%)	0.397(-0.343-1.138)	0.274
Lymphocyte percentage, (%)	0.177(-0.687-1.041)	0.672
Fatigue	-1.062(-2.087--0.037)	0.043*

Computer output of the logistic regression model examining risk factors for muscle strength. CI: Confidence interval. * P value is below the threshold of 0.05. * B value is the beta coefficient.

DISCUSSION

In the present study, it was found that hand grip strength was associated with the neutrophil/lymphocyte ratio, neutrophil percentage, lymphocyte percentage, focal muscle pain, and fatigue parameters in pregnant COVID-19 patients. The negative relationship between hand grip strength, focal muscle pain, and physical fatigue in pregnant COVID-19 patients was found to be statistically significant. In laboratory data, a positive relationship was detected with the neutrophil/lymphocyte ratio (NLR) and neutrophil percentage, and a negative relationship was detected with lymphocyte percentage at a statistically significant level. The clinical findings, severity of musculoskeletal symptoms, and vaccination status of pregnant COVID-19 patients were also evaluated.

In our work, the most common symptoms were cough (82.6%), back pain (56.5%), fever (52.2%), and diffuse myalgia (43.5%). In a previous study that included 108 pregnant women infected with SARS-CoV-2, the most common symptoms were fever (68%), cough (34%), fatigue (13%), and shortness of breath (12%).[4] The reason for this may be that the average gestational week for the applications in the present study was in the second trimester, and the applications in the severe disease category were not evaluated.

In our work, knee, hip, and muscular arthralgia were the most common arthralgia findings. Questioning must be done in detail because arthralgia can overlap with myalgia findings. In a previous study that examined 150 adult COVID-19 patients, the most common arthralgia findings were found to be wrist, ankle, and knee arthralgia.[5] We think that the difference in arthralgia findings occurred because our patients were young females, and the weights changed with pregnancy.

In our work, a statistically significant and positive relationship was found between hand grip strength and NRL and neutrophil percentages, and a negative relationship was detected with lymphocyte percentage. Inflammation is associated with the development and possibly poor prognosis of COVID-19. The innate immune response is characterized by the influx of neutrophils into the respiratory system in respiratory tract infections.[6] Intense neutrophil influx may lead to lymphopenia with apoptosis in lymphocytes.[7-9] In previous studies, 80% of patients who had severe COVID-19 and 25% of those who had mild infections reported lymphopenia.[10,11] In our study, a negative relationship was found between muscle strength and lymphocyte percentage, which is consistent with the results of current studies. Muscle strength is likely to decrease with disease severity in COVID-19 infection. Increased neutrophil count with the severity of inflammation may be associated with low muscle strength. In the present study, a positive relationship was found between NLR and neutrophil percentage. Muscle strength decreases with disease severity. The positive relationship that was found between NLR and neutrophil percentage and muscle strength may be associated with pregnancy physiology. Increasing neutrophil counts and decreasing lymphocyte counts are expected in pregnant women and are associated with pregnancy physiology.[12,13] It can be argued that the high number of patients in the second trimester and our evaluation of severe COVID-19 cases contributed to this result.

The relationship between hand grip strength and respiratory functions was examined in a previous study, and it was reported that the goodness of respiratory function was associated with increased hand grip strength.[14] A study conducted on patients over the age of 50 showed that higher grip strength was associated with a lower risk of COVID-19 hospitalization and argued that age, obesity, and muscle strength were independent risk factors for COVID-19.[15] We also found in the study that lower hand grip strength was associated with physical fatigue. More comprehensive studies are needed to determine whether hand grip strength is a parameter that can determine the prognosis of COVID-19.

The rate of smoking was found to be 17.4% in the present study. Despite all warnings about smoking, the high rate of smoking may indicate that smoking addiction is a very strong addiction.[16] The relationship between COVID-19 and smoking is not yet clear. In a large-scale meta-analysis conducted with pregnant women who had a confirmed diagnosis of COVID-19, obesity, preeclampsia, smoking, and diabetes were reported as risk factors for severe COVID-19.[17] Some publications argue that nicotine may be a potential preventive factor for COVID-19.[18,19] It was argued in these studies that smoking reduces the rate of being infected with SARS-CoV-2 but may increase the severity of the disease in infected people.

The data on vaccination rates were also given in the present study. The vaccination rate was 56.5% in pregnant COVID-19 patients who were included in the present study. The choice of vaccine is made by the individuals who will be vaccinated after the necessary information is given in our country. The preferences of the patients for the vaccine within the specified date range were mRNA vaccine (BioNTech) with 47.8% and inactivated vaccine (Sinovac) with 8.7%. There are limited data on the safety and efficacy of COVID-19 vaccines in pregnancy.[20] The relationship between the status of being vaccinated in the last 3 months, 6 months, and more than 6 months and muscle strength was also evaluated in the present study, and no significant relationship was detected. No study was detected in the literature review about muscle strength

and SARS-CoV-2 vaccines. We think that these data increase the value of the present study.

The fact that we could not reach a higher number of patients in our study can be considered a limitation. This is associated with the decreased incidence of the disease and the severity of the clinical course worldwide and in our country. Although the pandemic has reduced its severity today, it is possible to experience exacerbations or new outbreaks associated with the coronavirus family. For this reason, we believe that the data on specific patient groups, such as pregnant women, must be very valuable.

Pregnancy involves many physical, hormonal, immunological, and psychological changes.[21] Long-term studies conducted on the effects and results of a newly identified virus must be evaluated in this process, which involves many variables. Differences in individual sensitivities, variations in exposure time and frequency, and limitations in the use of radiological imaging methods and pharmacological agents limit the evidence in the literature on pregnant women.

In the present study, the data of pregnant women who had an oxygen saturation of 94 and above and needed hospitalization were analyzed. No comparisons were made regarding the severity of the disease. Imaging methods must be used objectively to compare the severity of the disease. The use of imaging methods depends on the permission of the physician, pregnant COVID-19 patients, and their spouses. Additionally, standardizing pulmonary changes regarding pregnancy physiology could not be performed in the present study because it is associated with many different variables, such as gestational week, weight change, and hormonal and immunological changes.

The fact that our sample was relatively small and we could not evaluate the severity of the disease can be considered a limitation in our study. Studies with larger samples are needed to support our results.

CONCLUSION

Handgrip strength measurement is a noninvasive, safe, and easily accessible parameter in pregnant women who have various limitations in diagnosis and treatment. We recommend that hand grip strength be evaluated at the first admission in pregnant COVID-19 patients. We hope that future studies will find results that support this idea.

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ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Karamanoğlu Mehmetbey University Ethics Committee (Date: 29.06.2022, Decision No: 06-2022/10). The study was registered retrospectively on Clinicaltrials.gov with the number NCT05970874. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declared that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Original Article

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The usefulness of S100β protein and fractalkine in predicting traumatic brain injury in pediatric patients with minor head trauma

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ABSTRACT

Aims: In this study it was aimed to demonstrate the effectiveness of S100β protein levels which are biomarkers related to central nervous system, and fractalkine levels, which are known to play a role in inflammation processes in prediction trauma induced brain damage.

Methods: Patient aged 2 to 18 years who came to the emergency department due to minor head trauma and underwent brain computer tomography were included in our study. It was investigated whether there was a relationship between the two groups, according to the causes of trauma, symptoms at presentation and the level of serum S100β and Fractalkine according to the lesions detected in cranial computer tomography.

Results: The other symptoms including vomiting, retrograde amnesia, loss of consciousness, confusion, post traumatic amnesia is significantly higher in patients with brain lesions (p<0,05). Patients with lesions on cranial computer tomography have significantly low Glasgow coma score. (p<0,05). Patients with lesions on cranial computer tomography have a significantly high S100β and Fractalkine levels. (p<0,05). S100β area under the curve 0.700 sensivity is 55%, specificity is 87.5%. Fractalkine area under the curve 0,785, sensitivity is 62.5% specificity is 85%.

Conclusion: As a result, the child patients with cranial computer tomography lesions from minor cranial trauma levels for S100β and Fractalkine levels are significantly higher and can be a criteria for cranial computer tomography usage in emergency medicine.

Keywords: Child, fractalkinee, head trauma, S100β

INTRODUCTION

Trauma is one of the major causes of morbidity and mortality in childhood. In high-income countries, 691/100.000 children are taken to emergency departments due to head trauma (traumatic brain injury (TBI) every year.[1] It is considered as a public health problem since it is among the causes of preventable mortality and morbidity all over the world.[2]

While indoor falls are the most common cause of head trauma in children under 2 years of age, the frequency of motor vehicle accidents increases in play-age and school-age children and reaches similar rates with falls.[3]

Minor head trauma (MHT) constitutes 90% of all head traumas, and a small part leads to clinically significant TBI.[4] The use of brain computed tomography (BCT) is recommended for this purpose.[5] Children with MHT constitute 40-60% of all TBIs examined by BCT. Less than 10% of them show radiological signs of TBI.5 Approximately 1% of children who are considered to have mild TBI need neurosurgical intervention, and 0.2% of these cases die.[5,6]

It is estimated that the rate of fatal malignancy caused by pediatric BCT scans is between 1/1000-1/5000 and that there is a higher risk at younger ages.[7,8] Therefore, they attempted to develop algorithms for use in children with MHT. The Pediatric Emergency Care Applied Research Network (PECARN) algorithm is the most commonly used of these algorithms.[9]

Recently, the view that some serum markers (S100β protein and neuron-specific enolase (NSE), Tumor Necrosis Factor (TNF), Glial fibrillary acidic protein (GFAP), TNF-α, interleukin (IL)-6 and myelin basic protein (MBP) can be used to detect trauma-related damage in patients with MHT has rapidly become valuable and studies are shifting accordingly.[10,11]

The S100β protein is a member of the calcium-binding S100 protein family and is expressed from the subtype of mature astrocytes in the central nervous system and the Schwann cells in the peripheral nervous system. While the levels of S100β protein are quite low in normal people, there is an increase first in the cerebrospinal fluid (CSF) and then in blood levels in the presence of brain injury, which is due to the impaired blood brain barrier. In many studies, the increase in S100β protein blood levels has been found to be associated with abnormalities in BCT.[12]

Fractalkine (FKN) is a glycoprotein and is an adhesion molecule for monocytes, T cells and natural killer cells. It has been demonstrated in studies that FKN is involved in many inflammatory processes such as coronary artery disease, asthma, and rheumatoid arthritis.[13]

In this study, it was aimed to reveal the effectiveness of the levels of S100β protein, one of the biomarkers related to the central nervous system, and the levels of fractalkine, which is known to be involved in inflammation processes, in predicting brain injury due to trauma.

METHODS

Our study was conducted prospectively in Kahramanmaraş Sütçü İmam University, Department of Emergency Medicine with the ethics committee approval dated 21.09.2021 and numbered 2021/31 of Kahramanmaraş Sütçü İmam University Non-interventional Clinical Researches Ethics Committee (GAEK). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Age, gender, causes and symptoms of trauma, lesions detected in BCT, serum S100β and serum FKN levels of the patients included in the study were examined.

In our study, patients who underwent BCT according were divided into two groups as those with and without lesions. Among the patients with lesions, 40 patients who met the exclusion criteria were randomly selected. Among the patients without lesions, 40 patients who met the exclusion criteria were randomly selected.

Statistical Analysis

The data obtained in our study were recorded and analyzed in the IBM SPSS Statistics 21 program. The normality of the data was tested by the Kolmogorov-Smirnov test. Median and interquartile range (IQR) were used to represent non-parametric data, and the number of cases (n) and percentile (%) were used to represent the categorical variables. The Mann-Whitney U test was used to compare non-parametric data with categorical variables, the Pearson Chi-square test was used for the analysis of categorical variables within themselves, and the Spearman correlation test was used to compare non-parametric variables within themselves. The ROC curve was used to calculate the area under the curve (AUC), cut-off value, specificity and sensitivity of the data. A value of $p<0.05$ was considered significant for all tests.

RESULTS

In our study, the S100β level of the patients with lesions on BCT was 11.1 pg/mL (IQR: 126.9 pg/mL), and the S100β level of the patients without lesions was 0 pg/mL (IQR: 0.1 pg/mL). S100B levels of patients with lesions were found to be significantly higher ($p<0.05$) (**Figure 1**).

In our study, the FKN level of the patients with lesions on BCT was 546.2 pg/mL (IQR: 447.4 pg/mL), and the FKN level of the patients without lesions was 293.3 pg/mL (IQR: 235.9 pg/mL). The FKN level of the patients with lesions were found to be significantly higher ($p<0.05$) (**Figure 2**).

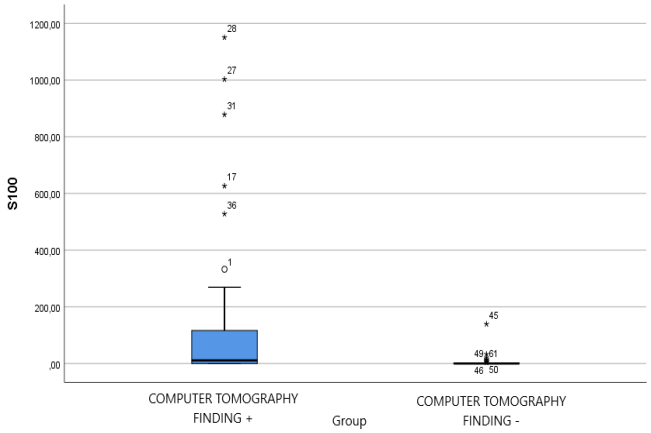

Figure 1. Relationship between the presence of trauma and the level of S100β (p:0.001)

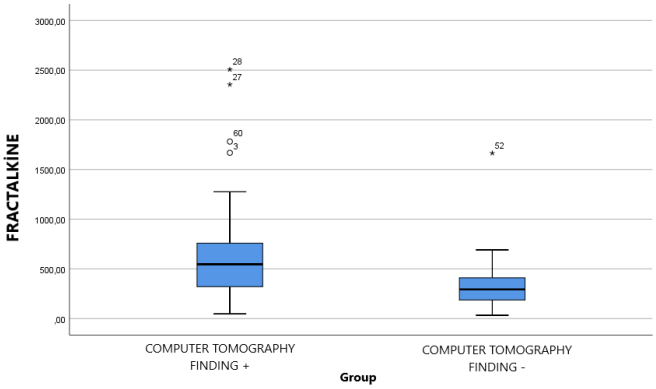

Figure 2. Relationship between the presence of trauma and the level of S100B (p:0.000)

Relationship of GCS with S100β and fractalkine levels at **Table 1**.

Table 1. Relationship of GCS with S100β and fractalkine levels

	Glasgow Coma Score (GCS)		
	15 (n:75) Median (IQR)	14 (n:5) Median (IQR)	P
S100β	0 (14.5)	94.5 (571.7)	0.047
Fractalkine	360.7 (346.9)	621.5 (455.1)	0.088

In our study, the level of S100B was found to be significantly higher in patients with EDH, SDH, depressed fracture and contusion ($p<0.05$). The S100β levels of the patients with SAH, linear fracture and subgaleal hematoma were similar to those without them ($p>0.05$) (**Table 2**).

Table 2. Relationship between the lesions detected on BCT and the S100β level

	Lesion + S100β Median (IQR)	Lesion - S100β Median (IQR)	p
Epidural hematoma	70.7 (614.9)	0 (12.1)	<0.001
Subdural hematoma	250.9 (528.0)	0 (10.3)	<0.001
Subarachnoid hemorrhage	0	0 (33.4)	0.365
Linear fracture	0 (82.1)	0 (14.4)	0.302
Depressed fracture	75.1 (461.3)	0 (11.4)	0.006
Subgaleal hematoma	0 (194.4)	0 (16.0)	0.635
Contusion	34.8 (300.7)	0 (11.4)	0.024

In our study, the level of FKN was found to be significantly higher in patients with EDH, SDH and linear fracture ($p<0.05$). The FKN levels of the patients with SAH, depressed fracture, subgaleal hematoma and contusion were similar to those without them ($p>0.05$) (**Table 3**).

Table 3. Relationship between the lesions detected on BCT and the level of fractalkine

	Lesion + Fractalkine Median (IQR)	Lesion - S100β Median (IQR)	p
Epidural hematoma	674.6 (257.8)	344.6 (329.3)	0.002
Subdural hematoma	714.4 (672.9)	342.1 (339.7)	0.002
Subarachnoid hemorrhage	494.8	363.5 (374.8)	0.628
Linear fracture	568.8 (432.6)	363.5 (288.1)	0.004
Depressed fracture	464.5 (1295.8)	362.0 (380.2)	0.217
Subgaleal hematoma	570.1 (785.8)	348.4 (310.5)	0.097
Contusion	587.4 (759.4)	344.6 (338.8)	0.053

In our study, for the presence of lesions on BCT, the AUC value of S100β was 0.700 (95Cl: 0.583-0.817), the appropriate cut-off value was 8.7, and the sensitivity and specificity at this value were found to be 55% and 87.5%, respectively. In our study, for the presence of lesions on BCT, the AUC value of FKN was 0.748 (95Cl:0.638-0.858), the appropriate cut-off value was 456.0, and the sensitivity and specificity at this value were found to be 62.5% and 85, respectively (**Figure 3**).

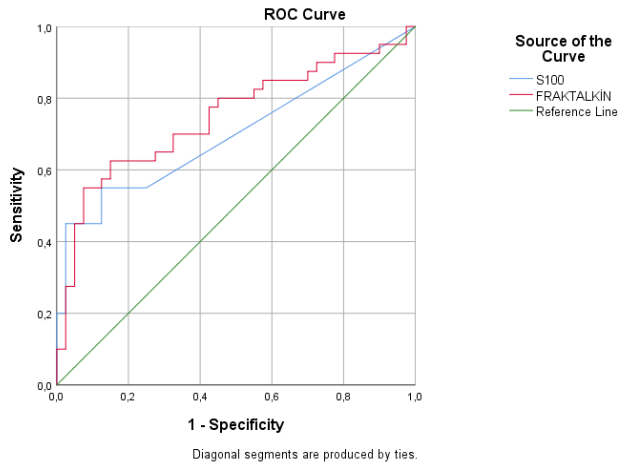

Figure 3. ROC analysis of S100β and fractalkine levels for the presence of lesions on BCT

DISCUSSION

The biomarkers of brain injury are promising for facilitating early management and triage decisions.[14] Furthermore, the development of biomarkers in MHT is important since it will reduce unnecessary requests for BCT and therefore exposure to radiation in childhood.[15] In a study, it was indicated that the rate of BCT scan decreased by 34% with the use of S100β.[16]

While there some potential markers of brain tissue fate, S100β is the most studied protein biomarker of brain injury.15 In the study of Piazza, the level of S100β was found to be high in children with MHT.[17] Filippidis et al.[18] indicated that some authors may have made a biased selection according to the BCT finding in cases with mild head trauma, however, studies on S100β were promising.In our study, it was determined that the S100β level of patients with positive intracranial lesion among patients with MHT was significantly higher.

In the study conducted by Zanier et al.[19] in mice induced with traumatic brain injury, they stated that although there was a temporary protection of brain tissue in the early stages of TBI in the absence of FKN, there was a deterioration in the late period. In an experimental study, it was demonstrated that the fractalkine level of the subjects with mild trauma increased significantly at the 8th hour and played a role in the activation of the immune system.[20] In our study, it was determined that the level of FKN was significantly increased in patients with intracranial lesions. In our study, the presence of lesions on BCT was found to be significantly higher in cases brought due to falling from high. Although S100β and FKN levels were found to be high in ADTK, this relationship was not statistically significant. This situation can be explained by the increase in the incidence of intracranial lesion as a result of the high severity of trauma in ADTK and in cases of falling from high, and thus the increase in S100β and FKN levels.

In a meta-analysis, it was reported that there was a significant relationship between S100β and GCS.[16] In our study, 93.7% and 6.3% of the patients had a GCS of 15 points and 14 points, respectively, BCT finding positivity and S100β level were found to be significantly higher in patients with a GCS of 14, and although the FKN levels of the patients with a GCS of 14 were found to be high, it was not statistically significant.

In their review, Thelin et al.[15] indicated that S100β was sensitive enough to detect and evaluate different traumatic intracranial lesions such as cerebral contusions, SDHs, traumatic SAH and EDH.In our study, while S100β level and FKN were found to be significantly higher in EDH and SDH, S100β was significantly higher in patients with depressed fracture and contusion, and the level of FKN was significantly higher in patients with linear fractures. S100β and FKN levels of SAH and subgaleal hematoma were similar in patients with and without intracranial lesion.

In a study, when BCT findings were used as a factor to evaluate S100β marker performance, it was reported that the sensitivity was 100%, the specificity was 42%, and the AUC was 0.68.[20] No study evaluating the sensitivity and specificity of FKN level was found in the literature. In our study, the AUC of S100β was 0.7, the sensitivity was 55%, and the specificity was 87.5% for the presence of lesions on BCT, and AUC was 0.748, the sensitivity was 62.5%, and the specificity was 85% for FKN. Considering these values, we think that we can say that both S100β and FKN support the presence of lesions on BCT.

In our study, the S100β and FKN levels of the patients with lesions on BCT were found to be significantly higher. S100β and FKN levels were found to be significantly higher in patients with retrograde amnesia and loss of consciousness. In our study, although the FKN levels of patients with a GCS of 14 were found to be high, they were not statistically significant. While the S100β level and FKN level were found to be significantly higher in EDH and SDH, the S100β level was significantly higher in patients with depressed fracture and contusion, and the FKN level was significantly higher in patients with linear fractures. S100β and FKN levels of SAH and subgaleal hematoma were similar in patients with and without intracranial lesions. AUC was 0.700, sensitivity was 55% and specificity was 87.5% for S100β, and AUC was 0.748, sensitivity was 62.5%, and specificity was 85% for FKN.

CONCLUSION

In pediatric patients presenting with MHT, the S100β and FKN levels were found to be high in patients with BCT lesions, which causes a view that it can be included in BCT scan criteria. Nevertheless, there is a need for more studies especially in terms of FKN.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Kahramanmaraş Sütçü İmam University Non-interventional Clinical Researches Ethics Committee (GAEK) (Date: 21.09.2021, Decision No: 2021/31-9).

Informed Consent: All patients signed and free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

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Original Article

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The effect of neutrophil lymphocyte ratio and other biochemical parameters on mortality in cancer patients admitted to the emergency department

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ABSTRACT

Aims: To investigate the effectiveness of the neutrophil/lymphocyte ratio and other biochemical parameters in predicting mortality in oncology patients with cancer admitted to the emergency department.

Methods: This was a retrospective, observational, single-center study. The study period included a two-year period from January 2014 to December 2015. Demographic data, cancer history and blood tests, emergency department diagnoses, blood parameters evaluated in the emergency department, discharge, and mortality status of the patients were recorded in the data form. The APACHE 2 and SOFA scores of all patients were also calculated. Patients whose data could not be reached were excluded from the study. $p<0.05$ was considered statistically significant.

Results: A total of 180 patients were included in the study. The mean age of the survivor group was 66.4±10.752 years, while the mean age of the non-survivor group was 65.18±13 years. The mean neutrophil/lymphocyte (NLR) ratio of the non-survivor group was 1.0288±11.3, while the NLR of the survivor group was 4.400±3.563. ($p<0.05$) The mean lactate ratio of the non-survivor group was 2.60±3.384, while the mean lactate ratio of the survivor group was 1.36±1. 090. ($p<0.05$) When survivor and non-survivor patient groups were compared, a statistically significant difference was observed in mean white blood cell count, neutrophil count, hemoglobin, hematocrit, and blood urea nitrogen (BUN) values. ($p<0.05$)

Conclusion: According to the results of this study, NLR, elevated white blood cell and neutrophil values, decreased hemoglobin and hematocrit, and elevated BUN and lactate levels seem to be predictors of mortality during emergency admissions in cancer patients.

Keywords: Mortality, oncology, emergency department, blood tests

INTRODUCTION

Cancer is the non-survival or abnormal growth and proliferation of cells as a result of DNA damage. Cancer is an umbrella term of disorders characterized by the loss of typical tissue features, uncontrolled cell growth, and the ability to invade nearby tissues and distant organs.[1] There are over 200 diseases in this group histopathologically. Cancer patients may succumb to secondary complications that might be fatal, in addition to their initial ailment. The aforementioned conditions include infection, sepsis, hemorrhages, thromboembolic events, as well as single and multiple organ failure.[2] At the same time, neutropenic fever and sepsis are important problems in cancer patients, and their mortality rates are as high as 40-70% if they are not treated appropriately without losing time.[3]

An increased neutrophil-to-lymphocyte ratio (NLR) has also been found to be an indicator of poor prognosis in patients undergoing cardiovascular intervention. Recent studies have shown a correlation between elevated NLR (neutrophil-to-lymphocyte ratio) and higher fatality rates in cases of acute coronary syndromes.[4,5] Studies have shown that NLR is a predictive indicator for survival in patients with colorectal and ovarian cancer.[6,7] It has been suggested that preoperative NLR may be a simple method to identify patients with poor prognosis in colorectal cancer.[8] NLR in peripheral blood is used as a parameter that provides information about the relationship between the inflammatory environment and physiological stress.

APACHE II, which is a combination of the total acute physiology score, age, and chronic health status scores, is assessed in the first 24 hours of ICU admission, with a maximum score of 71. When the total score is 25, the estimated mortality is 25%, whereas this increases to over 80% when the score is above 35.

Emergency departments are the most frequent destination for oncology patients. With their twenty-four-hour accessibility, emergency departments are the first place these patients go in case of complications secondary to any kind of treatment. Evaluating the mortality expectancy of patients with simple examinations taken at emergency department visits can be used in clinical practice as a simple, fast, and inexpensive method. In this way, physicians can use more aggressive or alternative treatment modalities in complication management.

METHODS

This study is a retrospective, observational cohort study. The study period covers a two-year period between January 2014 and December 2015. Patients diagnosed with cancer and admitted to the emergency department of a tertiary care hospital were included in the study. This study is a specialty thesis in the field of emergency medicine. Before 2020, institutional approval was obtained, and ethics committee decisions were not taken for that period. The data on the patients was accessed from the hospital database. Patients whose data could not be accessed, who had incomplete information in their files, and who could not be examined in the emergency department were excluded from the study. The parameters analyzed from the records were age, gender, date of admission, type of cancer, metastases, treatment for cancer, reasons for admission to the emergency department, laboratory findings in the emergency department (white blood cells, neutrophils, lymphocytes, hemoglobin, hematocrit, blood urea nitrogen, creatine, sodium, potassium, ALT, AST, pH, bicarbonate, lactate), diagnosis in the emergency department, where they were transferred or discharged from the emergency department, and mortality. APACHE 2 and SOFA scores were also calculated for all patients. Patients were divided into two groups: survivors and non-survivors. The variables used in the study were statistically compared between these two groups.

Statistical Analysis

The data we obtained were analyzed with the Statistical Package for Social Sciences (SPSS) version 17.0 data analysis program. Student t tests for parametric data and chi-square tests for nonparametric data were used for data analysis. P<0.05 was considered statistically significant.

RESULTS

The study was completed with a total of 180 patients. While 107 patients had a history of surgical intervention, 73 patients had no history of surgical intervention. Patients presented to the emergency department with the most common complaint of shortness of breath (n=32), followed by pain (n=22), nausea, and vomiting (n=20). When the treatments received by the patients were examined, symptomatic treatment was the most common treatment in the emergency department, followed by pneumonia and anemia. While 86 of the patients were discharged from the emergency department, 41 were transferred to the internal medicine service, and 21 were transferred to the intensive care unit. Patients were analyzed as survivors and non-survivors according to their mortality status. The mean age of the survivor group was 66.4±10.752, and the mean age of the non-survivor group was 65.18±13. There was no statistically significant relationship between the two groups in terms of age (p=0.533). (**Table 1**) The mean WBC of the survivor group was 8.18±3.576, and the mean WBC of the non-survivor group was 12.9±8.233. There was a statistically significant relationship between the two groups in terms of WBC (p<0.05). The mean neutrophil count of the survivor group was 5.89±3.242, and the mean neutrophil count of the non-survivor group was 10.27±7.418. There was a statistically significant relationship between the two groups in terms of neutrophils (p<0.05). The mean lymphocyte count of the survivor group was 1.11±0.982, and the mean lymphocyte count of the non-survivor group was 1.10±1.522. There was no statistically significant relationship between the two groups in terms of lymphocytes (p=0.970). The mean NLR of the survivor group was 4.400±3.563, and the mean NLR of the non-survivor group was 1.0288±11.3. There was a statistically significant relationship between the two groups in terms of NLR (p<0.05).

Patients were also compared according to hemoglobin (HGB) and hematocrit (HTC) values. The mean HGB of the survivor group was 11.42±2.105, and the mean HGB of the non-survivor group was 9.85±2.254. There was a statistically significant relationship between the two groups in terms of HGB (p<0.05). The mean HTC of the survivor group was 35.62±5.859, and the mean HTC of the non-survivor group was 30.78±6.866. There was a statistically significant relationship between the two groups in terms of HTC (p<0.05).

Table 1. Descriptive characteristic of study participants

	Mortality	Mean	Standard Deviation	Standard Error Mean
Age	0	66.40	10.752	1.603
	1	65.18	13.000	1.119
White blood cell count 103/uL	0	8.18	3.576	0.533
	1	12.90	8.233	0.709
Neutrophil count 103/uL	0	5.89	3.242	0.483
	1	10.27	7.418	0.638
Lymphocyte count 103/uL	0	1.11	0.982	0.146
	1	1.10	1.522	0.131
NLR	0	4.400	3.563	0.531
	1	1.028	11.131	0.958
Hemoglobin g/dl	0	11.42	2.105	0.314
	1	9.85	2.254	0.194
Hematocrit %	0	35.62	5.859	0.873
	1	30.78	6.866	0.591
BUN mg/dl	0	21.93	11.963	1.783
	1	35.68	21.682	1.866
Creatinine mg/dl	0	0.71	1.854	0.276
	1	0.90	1.309	0.113
Alanine aminotranseraz U/L	0	33.40	55.794	8.317
	1	41.87	67.000	5.766
Aspartate aminotransferaz U/L	0	42.11	114.917	17.131
	1	71.31	148.811	12.808
Sodium mmol/L	0	137.00	4.447	0.663
	1	135.334	10.657	0.917
Potassium mmol/L	0	3.96	0.903	0.135
	1	4.01	0.846	0.073
pH	0	7.36	0.17	**0.000**
	1	7.32	0.54	**0.010**
Bicarbonate mmol/L	0	23.87	4.187	0.624
	1	22.31	5.963	0.513
Lactate mmol/L	0	1.36	1.090	0.163
	1	2.60	3.384	0.291

BUN: Blood urea nitrogen; NLR: Neutrophil lymphocyte rate

The mean BUN of the survivor group was 21.93±11.963, and the mean BUN of the non-survivor group was 35.68±21.682. In this comparison, a statistically significant relationship was found between the groups in terms of BUN ($p<0.05$). On the other hand, patients were also compared in terms of creatinine values. The mean creatinine of the survivor group was 0.71±1.854, and the mean creatinine of the non-survivor group was 0.90±1.309. There was no statistically significant relationship between the groups in terms of creatinine ($p>0.05$). The mean lactate of the survivor group was 1.36±1.090, and the mean lactate of the non-survivor group was 2.60±3.384. There was a statistically significant relationship between the two groups in terms of lactate ($p<0.05$).

DISCUSSION

In our study, we aimed to evaluate the efficacy of the sub-findings in the APACHE 2 scoring system and neutrophil lymphocyte ratio in predicting mortality in oncology patients. No difference was observed between the mortal and non-mortal groups in terms of findings such as age and gender. No difference was observed in terms of fever, mean arterial pressure, heart rate, respiratory rate, alveolar arterial oxygen gradients, pH, serum sodium, serum potassium, serum creatinine, and Glasgow coma scores.

Elevated white blood cell values, neutrophil counts, hematocrit values, BUN values, lactate values, and neutrophil-to-lymphocyte ratios were statistically significant. In addition, the patient's emergency admission secondary to colon cancer and hospitalization in the intensive care unit were also observed as predictors of mortality. At the same time, surgical operations for cancer were also observed as a predictor of mortality in our study.

White blood cell elevation is a parameter that is also present in APACHE 2 scoring and was found to be a predictor of mortality as an independent variable in our study group. White blood cell elevation is also present as a parameter in APACHE 2, which Knaus et al.[9] used in the APACHE 2 classification and is in routine use as a disease severity classification system. Our study is also compatible with this.

An elevated neutrophil count was found to be a predictor of mortality in our study and is usually associated with infections. It is also included in the total white blood cell count. Therefore, it may be considered secondary in the APACHE 2 scoring system. Therefore, as in this classification system indicating disease severity, neutrophil count was found to be a predictor of mortality in cancer patients in our study.

Low hemoglobin and hematocrit values were included in the APACHE 2 scoring system by Knaus et al.[9] In our study, low hemoglobin and hematocrit values were observed as predictors of mortality in cancer patients.

In our study, a high BUN value at the time of arrival to the emergency department was also observed as a predictor of mortality in cancer patients. The APACHE 2 scoring system includes creatinine elevation. However, APACHE 2 is a disease severity classification system. Our study, on the other hand, aimed to observe the mortality predictors of oncologic patients, which is a single disease group. Some differences between the two studies can be expected. Although the serum creatinine value was not significant in our study, it is part of the APACHE 2 scoring system. The elevated BUN value was significant in our study. Unfortunately, the fact that our study group was limited to 145 patients, i.e., a small niche-specific study group, does not allow us to determine every parameter that may be significant. The development of acute renal failure is a factor that increases mortality. It is plausible that increased BUN and creatinine, which are parameters of this picture, are predictors of mortality.

Lactate is used as a predictor of mortality through lactate clearance, especially in sepsis patients. It is even used to evaluate the effectiveness of early goal-directed therapy in sepsis patients. In our study, lactate was observed as a predictor of mortality in oncology patients. Husain et al.[10] examined lactate levels at baseline and 24 hours in their study of surgical intensive care unit patients and found a significant relationship between high serum lactate levels and mortality. Holtfreter et al.[11] found a statistically significant high lactate level in patients with exitus in their study conducted in an intensive care unit. Brain et al.[12] found that a high lactate level was associated with mortality in patients with infection. In our study, a statistically significant relationship was found between high serum lactate levels and mortality in cancer patients admitted to the emergency department, and a high serum lactate level was observed as a predictor of mortality.

The neutrophil-lymphocyte ratio, which is another significant finding, has been investigated in many studies in terms of the evaluation of disease severity. The physiologic response of circulating leukocytes to stress is an increase in neutrophils and a decrease in lymphocytes, and the ratio of these two values is used as a marker of inflammation.[13-16]

During inflammation, changes occur in the proportion of circulating leukocytes. The increase in neutrophils is accompanied by a finding of relative lymphopenia. Therefore, the neutrophil-lymphocyte ratio has been proposed as a simply calculable marker of inflammatory response. As stated in the study in the literature, neutrophil lymphocyte ratio was found to be compatible with prognosis when evaluated with sepsis scores such as APACHE 2 and SOFA. The neutrophil lymphocyte ratio is also called the neutrophil lymphocyte stress factor. There is an increasing number of studies showing that an increased neutrophil/lymphocyte ratio is associated with a poor prognosis in various diseases. For example, some studies have reported that the mortality rate in acute coronary syndrome is related to the neutrophil-lymphocyte ratio.[17-18]

The presence of T lymphocytes in a tumor is an indicator of the presence of an immune response against the mass. One study stated that a low lymphocyte count in colorectal tumors is a predictor of a poor prognosis. In studies by Blake-Mortimer et al.[20], the neutrophil-to-lymphocyte ratio was observed as a prognostic factor in colorectal and ovarian cancers.[19]

The peripheral blood neutrophil-to-lymphocyte ratio has been used as a parameter associated with physiologic stress and inflammation. Several studies have been used to evaluate its effect on mortality in oncologic errors. Öztürk et al.[21] reported a significant increase in the neutrophil-lymphocyte ratio in young patients with acute coronary syndrome. Studies by Kapçı et al.[22] and Kahramanca et al.[23] emphasized the importance of an increased neutrophil lymphocyte ratio in the diagnosis of acute appendicitis.

The prognostic importance of the neutrophil-lymphocyte ratio before treatment in various tumors has been investigated in many studies. The presence of systemic inflammatory reactions is used as a poor prognostic marker in various types of cancer.[24,25] In studies, the neutrophil-lymphocyte ratio was found to be high in patients with advanced ovarian cancer.[26-29] Furthermore, it is essential to develop novel methodologies and approaches, similar to those used in other medical conditions, to accurately identify cancer patients who are in a critical condition.[30]

CONCLUSION

In our study, high white blood cell count, high neutrophil count, decreased hemoglobin and hematocrit, and increased BUN and lactate levels seem to be predictors of mortality during emergency admissions in cancer patients.

ETHICAL DECLARATIONS

Ethics Committee Approval: This study is a specialty thesis in the field of emergency medicine. Before 2020, institutional approval was obtained, and ethics committee decisions were not taken for that period. All procedures performed in studies involving human participants were in accordance with the ethical standarts of the institutional and/or national research committee and with 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

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Comparison of Canadian and San Francisco syncope rules in patients admitted to emergency department with syncope

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ABSTRACT

Aims: Syncope is the totality of symptoms in which consciousness is temporarily lost and postural tonus cannot be maintained, which resolves spontaneously and completely without any medical intervention. Although syncope has an important place among the reasons for admission to the emergency department, the diagnostic approach and what should be done in terms of discharge have not yet been fully systematized. In this study, a comparison was made according to age, gender, known diseases, and San Francisco and Canadian syncope rules.

Methods: This is a single-center, retrospective cohort study. During the study period, the vital parameters, ECG, blood tests, and physical examination findings of the patients who presented to the emergency department with the complaint of fainting were evaluated. The number of points scored by the San Francisco and Canadian syncope criteria was determined for each patient. It was stated which of the discharge, hospitalization in the ward, intensive care unit, and ex results each patient ended with. Each patient was investigated after 30 days, and it was investigated whether there were any of the negative results we wrote above within 30 days. At the end of all these, the San Francisco and Canadian syncope criteria were compared with the analysis method.

Results: The study included 449 patients, of whom 52.1% were male and 47.9% were female, with a serious outcome rate of 10%, a readmission rate of 11.4%, and a mortality rate of 1.1%.

Conclusion: In this study, it was found that the rate of no adverse events was significantly higher when the San Francisco Syncope Rule were negative; the San Francisco Syncope Criteria and the Canadian Syncope Rule gave similar results in predicting mortality and morbidity; the Canadian Syncope Rule were slightly more effective in predicting morbidity and mortality.

Keywords: Clinical prediction rules, prognosis, risk stratification, syncope

INTRODUCTION

Syncope is defined as a sudden, transient loss of consciousness with an inability to maintain postural tone, followed by spontaneous recovery and a return to pre-existing neurologic function. It is a common clinical problem, accounting for 1-3% of emergency department (ED) admissions.[1]

The overall distribution of syncope is equal between men and women; however, women are more likely to experience syncope at older ages. Compared with people aged 50 to 59 years, the incidence increases two- and threefold in people aged 70 to 79 years and people aged 80 years and older, respectively. Older adults are more likely to have orthostatic, carotid sinus hypersensitivity, or cardiac syncope, whereas younger adults are more likely to have vasovagal syncope.[2] A significant proportion of patients with benign causes of syncope are admitted for inpatient evaluation. Therefore, risk stratification, which ensures safe discharge of patients with a low risk of serious outcomes, is important for effective management of patients in emergency departments and the reduction of costs associated with unnecessary diagnostic investigations.[1]

Patients with cardiovascular disease, an abnormal electrocardiogram, or a family history of sudden death who present with unexplained syncope should be hospitalized for further diagnostic evaluation. Patients with neural-mediated or orthostatic syncope usually do not require additional testing. Although a cohort of patients will have unexplained syncope despite undergoing a comprehensive evaluation, patients with multiple episodes are more likely to have a serious underlying disorder.[3] 3–5% of all syncope patients evaluated in the emergency department have been found to have a serious condition after emergency department admission.[4] Death, myocardial infarction, arrhythmia, pulmonary embolism, stroke, severe bleeding, or any condition that causes or may cause readmission to the emergency department and hospitalization for a related event is considered a serious outcome.[5-8]

The San Francisco Syncope Rule was created to predict adverse outcomes at 7 and 30 days.[9] Five risk factors, denoted

by 'CHESS' in the San Francisco Syncope Rule, history of congestive heart failure, hematocrit <30%, abnormal findings on the ECG, shortness of breath, and systolic blood pressure <90 mmHg, were identified to predict patients at high risk of serious outcomes.[10] The Canadian Syncope Risk Score was developed as a clinical decision tool to identify adult patients with syncope at risk of a serious adverse event within 30 days of discharge from the emergency department. The Canadian Syncope Risk Score is calculated based on the presence of vasovagal symptoms, a history of heart disease, systolic blood pressure <90 or >180 mmHg, elevated troponin, an abnormal QRS axis, a corrected QT interval >480 ms, and a QRS duration >130 ms.[11-13] The aim of this study was to evaluate the San Francisco and Canadian Rules in terms of predicting poor outcomes in patients presenting to the ED with syncope. Also this study aims to not only compare the Canadian and San Francisco Syncope Rules but also to delve into their practical implications in clinical settings.

METHODS

This study is a single-center retrospective case study. The study was carried out with the permission of Clinical Research Ethical Committe of Kartal Dr. Lütfi Kırdar State Hospital (Date:30.06.2022, Decision No: 2022/514/228/7). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Patients over the age of 18 years who were admitted to the ED with loss of consciousness and fainting during the specified periods, after excluding the causes of loss of consciousness such as hypoglycemia, trauma, seizure, alcohol or substance intake, stroke, and the rest of the patients, were included in the study together with their findings in the Hospital Information Management System and the results of tests and examinations.

Study Inclusion Criteria

Patients over the age of 18 years who presented to the ED with fainting and blackout, whose tests and findings were registered in the system, and who did not meet the exclusion criteria, were included in the study.

Study Exclusion Criteria

Patients admitted to the ED with loss of consciousness but epilepsy, hypoglycemia, patients with ongoing neurological deficits suggestive of stroke, patients with CO intoxication, patients with high dose alcohol intake or any other suspected signs of intoxication, patients who refused to participate in the study, patients who could not be reached afterwards, and patients with missing data were excluded from the study.

Collection of Cases

We conducted a detailed analysis considering patient characteristics like age, gender, and known diseases to understand the effectiveness of these rules. Between 01.05.2022-01.09.2022, patients who presented to ED with the complaint of fainting and fainting were carefully selected. Patients with missing findings, documents, tests, and examinations from the past system were eliminated. The remaining patients were analyzed for age, gender, history of heart failure, hematocrit value, presence of abnormal ECG, presence of shortness of breath, systolic and diastolic blood pressure values; cardiac diseases such as atrial fibrillation, heart valve replacement, and history of coronary artery disease; whether the type of syncope described was vasovagal, cardiac, or neurological syncope; whether the troponin value was elevated or not; whether there was an abnormal QRS axis on the ECG; QRS duration; and corrected QT interval.

Abnormal ECG findings included ST segment elevation in the anterior (V1,V2,V3,V4) and inferior (D2,D3,AVF) leads, right and/or left bundle branch block, AF, Brugada pattern, T wave negativity, aneurysmatic changes, AV block, ventricular tachycardia (VT), pathologic Q wave, and sinus tachycardia.

Patients' diagnoses, inpatients ward/intensive care unit (ICU), or discharge information were also noted in the relevant field on the second page of the form. Patients' scores from the San Francisco Syncope Rules and Canadian Syncope Rules were marked in the relevant section of the form.

Patients and their relatives were contacted after 1 month if the patient was discharged, and it was learned whether the patient was readmitted, hospitalized in the ward, hospitalized in the intensive care unit, died, or had other serious conditions developed within 1 month, and it was written in the relevant section of the form.

Calculation of San Francisco and Canada Scores

SFSK consists of five parameters: HF history, abnormal ECG findings, Htc <30%, dyspnea, and SDB <90 mm Hg. Each parameter is 1 point, and patients with any of these parameters are classified as high-risk.

The Canadian Syncope Rule consist of 8 parameters: vasovagal symptoms, history of heart disease, HR >180 or <90, troponin value elevated or elevated during follow-up, QRS axis abnormal, QRS duration longer than 130 ms, corrected QT interval longer than 480 ms, and diagnosis of vasovagal or cardiac syncope. Each parameter has its own score, and -3,-2 points were considered very low risk, -1.0 points as low risk, 1,2,3 points as moderate risk, 4,5 points as high risk, and above 5 points as very high risk.

The history of heart failure was determined by asking the patient/relative whether they had previously been diagnosed with HF and whether they were taking medication for it.

Abnormal ECGs were evaluated. Abnormal ECGs were defined as ST segment elevation in anterior and inferior leads, right and/or left bundle branch block, AF, Brugada pattern, T wave negativity, aneurysmatic changes, AV block, VT, pathologic Q wave, and sinus tachycardia.

Shortness of breath: the presence of shortness of breath before syncope and/or at presentation was questioned. Since the assessment of dyspnea was subjective, care was taken to evaluate it meticulously in relation to the prodromal symptoms described by the patient and serious events such as chest pain. It was not associated with respiratory rate or oxygen saturation.

Systolic blood pressure: blood pressure was taken as the value measured by the triage nurse or nurses in the yellow and red area at the time of admission and recorded in the file.

Age: Official age records at the time of admission to our hospital were taken.

Hematocrit was taken as the Htc value in the complete blood count measured by the device in the biochemistry laboratory of our hospital from the blood sample taken at the time of admission.

Troponin elevation was based on the troponin hs value obtained from the blood sample taken at the time of admission

by the devices in the biochemistry laboratory of our hospital. A troponin hs value that was higher than normal or had a tendency to increase was considered positive.

Statistical Analysis

The SPSS version 25 statistical package program was used for statistical analysis. Descriptive statistical methods (mean, standard deviation, frequency, minimum-maximum, percentage) were used to summarize the data. The Shapiro-Wilk test was used for normality tests of continuous variables, and the Mann-Whitney U test was applied for the difference between all two group averages since the normal distribution condition was not met. Fisher's exact test, which is used for two-group variables, was used for tests of independence between two categorical variables. ROC analysis was applied to reveal the power of the scores used in the study to determine the serious outcome of the patients. The significance level was taken as 0.05 for all tests performed.

RESULTS

The data of 449 patients admitted to ED with the complaint of 'fainting' were analyzed. Upon a more detailed evaluation, we observed distinct patterns in the performance of the Canadian and San Francisco Syncope Rules, especially when considering patient-specific factors such as underlying medical conditions and demographic variables. **Table 1** shows the characteristics of the 449 patients included in the study and the number and percentage distributions of the factors belonging to the two scores. The mean age of the patients was 51.46 years, and there was a balanced distribution of patients in terms of gender. It is understood that ECG abnormality is the most common factor in the San Francisco Syncope Score, while troponin elevation or increase, cardiac syncope diagnosis, and vasovagal symptoms are more common in the Canadian Syncope Risk Score. In addition, after these factors, a history of cardiac diseases was also found to be more common in some patients than others. The rate of serious outcomes was approximately 10%, readmission was 11.4%, and mortality was 1.1%.

In **Table 2**, the risk distribution of the patients as a result of the classification of the patients according to the San Francisco Syncope Score and the Canadian Syncope Risk Score is given with numbers and ratios. According to the results, it is seen that some of the patients classified as low risk according to the San Francisco Syncope Score were classified as moderate risk according to the Canadian Syncope Risk Score, and some of the patients classified as non-low risk were in the moderate risk group. It is understood that more detailed risk grading can be made according to the Canadian Syncope Risk Score.

Table 2. Risk distribution of the patients according to the classification of the San Francisco Syncope Score and the Canadian Syncope Risk Score

San Francisco Syncope Score	Low risk	Not low risk			
Number (percentage)	313 (69.7)	136 (30.3)			
Canadian Syncope Risk Score	**Very low risk**	**Low risk**	**Moderate risk**	**High risk**	**Very high risk**
Number (percentage)	84 (18.7)	190 (42.3)	101 (22.5)	46 (10.2)	28 (6.2)

Table 3 shows the number and percentages of outcomes according to the factors and other characteristics of the scores obtained from the patients. The percentages given are based on the number of patients belonging to the respective outcome. For example, out of a total of 5 patients who died, 2 and 40%, had heart failure. According to the percentages, it is clear that a high proportion of patients, especially those admitted to intensive care, had serious problems with heart disease.

Table 1. Characteristics of the patients and distribution of the factors of the two scores

Patient Characteristics	Patient count (n=449)
Demographics	
Age, mean (SD)	51.46 (0.96)
Min-max	0-92
Gender, number (percentage)	
Female	264 (52.1)
Male	215 (47.9)
SAN FRANCISCO SYNCOPE FACTORS, number (percent)	
Heart failure	35 (7.8)
Hematocrit <30	24 (5.3)
ECG Abnormality	90 (20)
Systolic blood pressure <90 mmHg	13 (2.9)
Shortness of breath	5 (1.1)
CANADA SYNCOPE FACTORS, number (percentage)	
Vasovagal symptoms	96 (21.4)
History of heart disease	83 (18.5)
Systolic blood pressure <90 mmHg or >180 mmHg	31 (6.9)
Troponin elevation or increase	100 (22.3)
Qrs axis <-30 or >100	52 (11.6)
Qrs duration of more than 130 ms	26 (5.8)
Qt distance greater than 480 ms	47 (10.5)
Diagnosis of vasovagal syncope	74 (16.5)
Diagnosis of cardiac syncope	98 (21.8)
Medical condition	
Atrial fibrillation	33 (7.3)
History of heart valve replacement	10 (2.2)
History of coronary artery disease	81 (18)
Termination or reapplication	
Serious outcome	46 (10.2)
Outcome	
Discharged	405 (90.2)
Inpatients ward	24 (5.3)
Intensive care	6 (1.3)
Mortality	5 (1.1)
Readdmission	51 (11.4)

Associations between the San Francisco Syncope Score and its factors

The relationships between the San Francisco Syncope Score and its factors were investigated by applying Fisher's Exact Tests. According to the p values given in **Table 4**, which are less than 0.05, the relationships between the San Francisco Syncope Score and its factors are significant. For each factor, it is understood that if the factor is present in the patient, the score indicates a non-low risk. In shortness of breath, this rate is slightly lower than the others.

Table 3. Distribution of outcomes according to factors related to scores and other characteristics

Variables	Outcome, number (percentage)					
	Discharged (n=405)	Inpatients Ward (n=24)	Intensive care (n=6)	Mortality (n=5)	Other (n=9)	Total (n=449)
Heart failure	29 (7.16)	2 (8.33)	2 (33.33)	2 (40.00)	0 (0)	35 (7.80)
Hematocrit <30	15 (3.70)	4 (16.70)	2 (33.33)	3 (60.00)	0 (0)	24 (5.35)
ECG abnormality	68 (16.79)	10 (41.67)	6 (100)	3 (60.00)	3 (33.33)	90 (20.04)
Systolic blood pressure <90 mmHg	10 (2.47)	1 (4.17)	0 (0)	2 (40.00)	0 (0)	13 (2.90)
Shortness of breath	5 (1.23)	0 (0)	0 (0)	0 (0)	0 (0)	5 (1.11)
Vasovagal symptoms	92 (22.72)	0 (0)	0 (0)	1 (20.00)	3 (33.33)	96 (21.38)
History of heart disease	72 (17.18)	6 (25.00)	3 (50.00)	2 (40.00)	0 (0)	83 (18.49)
Systolic blood pressure <90 mmHg or >180 mmHg	26 (6.42)	4 (16.67)	0 (0)	1 (20.00)	0 (0)	31 (6.90)
Troponin elevation or increase	76 (18.77)	12 (50.00)	5 (83.33)	5 (100)	2 (22.22)	100 (22.27)
Qrs axis <-30 or >100	38 (9.38)	6 (25.00)	3 (50.00)	2 (40.00)	3 (33.33)	52 (11.58)
Qrs duration of more than 130 ms	20 (4.94)	3 (12.50)	2 (33.33)	0 (0)	1 (11.11)	26 (5.79)
Qt distance greater than 480 ms	38 (9.38)	4 (16.67)	3 (50.00)	1 (20.00)	1 (11.11)	47 (10.47)
Diagnosis of vasovagal syncope	71 (17.53)	0 (0)	0 (0)	0 (0)	3 (33.33)	74 (16.48)
Diagnosis of cardiac syncope	77 (19.01)	12 (50.00)	4 (66.67)	3 (60.00)	2 (22.22)	98 (21.83)
Atrial fibrillation	25 (6.17)	2 (8.33)	4 (66.67)	2 (40.00)	0 (0)	33 (7.35)
History of heart valve replacement	8 (1.98)	1 (4.17)	1 (16.67)	0 (0)	0 (0)	10 (2.23)
History of coronary artery disease	67 (16.54)	6 (25.00)	4 (66.67)	1 (20.00)	3 (33.33)	81 (18.04)
Termination or reapplication	20 (4.94)	23 (95.83)	6 (100)	1 (20.00)	1 (11.11)	51 (11.36)
Serious outcome	10 (2.47)	22 (91.67)	6 (100)	5 (100)	3 (33.33)	46 (10.24)

Table 4. Results of association tests between the San Francisco Syncope Score and its factors

Factors	Group	San Francisco Syncope Rule		
		Low risk, number (percentage)	Non-low risk number (percentage)	p value
Heart failure	No	312 (75.4)	102 (24.6)	0.000
	Yes	1 (2.9)	34 (97.1)	
Hematocrit <30	No	312 (73.4)	113 (26.6)	0.000
	Yes	1 (4.2)	23 (95.8)	
ECG Abnormality	No	309 (86.1)	50 (13.9)	0.000
	Yes	4 (4.4)	86 (95.6)	
Systolic blood pressure <90 mmHg	No	313 (71.8)	123 (28.2)	0.000
	Yes	0 (0)	13 (100)	
Shortness of breath	No	312 (70.3)	132 (29.7)	0.031
	Yes	1 (20.0)	4 (80.0)	

Associations between the Canadian Syncope Risk Score and factors

Table 5. Results of tests of association between the Canadian Syncope Risk Score and factors

Factors	Group	Canadian Syncope Risk Score, mean (SD)	p value
Vasovagal symptoms	No	1.62 (2.28)	0.000
	Yes	-1.84 (1.77)	
History of heart disease	No	0.27 (2.16)	0.000
	Yes	3.59 (2.64)	
Systolic blood pressure <90 mmhg or >180 mmgh	No	0.62 (2.42)	0.000
	Yes	4.35 (2.47)	
Troponin elevation or increase	No	-0.08 (1.82)	0.000
	Yes	4.24 (2.06)	
Qrs axis <-30 or >100	No	0.43 (2.25)	0.000
	Yes	4.33 (2.53)	
Qrs duration of more than 130 ms	No	0.60 (2.33)	0.000
	Yes	4.33 (2.53)	
Qt distance greater than 480 ms	No	0.45 (2.24)	0.000
	Yes	4.55 (2.58)	
Diagnosis of vasovagal syncope	No	1.53 (2.28)	0.000
	Yes	-2.42 (1.33)	
Diagnosis of cardiac syncope	No	-0.07 (1.77)	0.000
	Yes	4.27 (2.25)	

The relationships between the Canadian Syncope Risk Score and its factors were investigated by applying Mann-Whitney tests due to the lack of normality. According to the p values given in **Table 5**, which are less than 0.05, the relationships between the Canadian Syncope Risk Score and its factors are significant. It is understood that when vasovagal symptoms and vasovagal syncope diagnosis are "present" among the factors, the score is smaller than those who are not present, and when other factors are "present," the score has a larger mean.

Comparison of the San Francisco Syncope Score and the Canadian Syncope Risk Score

According to the cross-tabulation of the classes of the San Francisco Syncope Score and the Canadian Syncope Risk Score (**Table 6**), most of the patients in the low-risk group, according to the San Francisco Syncope Score, were classified as very low, low, and moderate risk by the Canadian Syncope Risk Score, while those in the non-low-risk group were classified as moderate, high, and very high risk by the Canadian Syncope Risk Score. It is seen that 45.54% of the patients classified as moderate risk with the Canadian Syncope Risk Score were classified as low risk with the San Francisco Syncope Score, and 54.56% were classified as non-low risk.

Table 6. Cross-tabulation of the San Francisco Syncope Score and the Canadian Syncope Risk Score by class

		Canadian Syncope Risk Score, number (percent)					
		Very low risk	Low risk	Moderate risk	High risk	Very high risk	Total
San Francisco Syncope Score	Low risk	76 (24.3)	171 (54.6)	46 (14.7)	18 (5.8)	2 (0.6)	313 (100)
	Not low risk	8 (5.9)	19 (14.0)	55 (40.4)	28 (20.6)	26 (19.1)	136 (100)
	Total	84	190	101	46	28	449

Table 7. Results of the ROC Curve Analysis of the San Francisco Syncope Score and the Canadian Syncope Risk Score

Score	Criteria	AUC	p value	AUC 95% Confidence Interval	Sensitivity (95% Confidence Interval)	Specificity (95% Confidence Interval)
San Francisco Syncope Score	>0	0.720	0.0001	0.675-0.760	69.57 (54.2 – 82.3)	74.19 (69.6 – 78.4)
Canadian Syncope Risk Score	>10	0.728	0.0001	0.638-0.794	67.39 (52-80.5)	72.95 (68.3-77.2)

ROC Curve Analysis

A ROC curve analysis was performed to investigate the extent to which the San Francisco Syncope Score and the Canadian Syncope Risk Score determine the serious outcome of patients. The size of the areas under the ROC curve for the San Francisco Syncope Score and the ROC curve for the Canadian Syncope Risk Score are 72.0% and 72.8%, respectively, and p values less than 0.05 indicate that both scores effectively determine serious outcomes. (**Table 7**) If the San Francisco Syncope Score is greater than zero, i.e., 1, and the Canadian Syncope Risk score is greater than 10, the patient is expected to have a serious outcome.

The sensitivity, which is the percentage of correctly identifying the patient with a serious outcome, and the specificity, which is the percentage of correctly identifying the patient without a serious outcome, are close to each other for the two scores.

According to the p values, the San Francisco Syncope Rule and the Canadian Syncope Risk Score are significantly associated with serious outcome and readmission (p values<0.05). When the San Francisco Syncope Rule indicates low risk, the rates of serious outcomes and no readmission are quite high. If the rule shows a non-low risk, the rates of serious outcomes and readmissions are higher compared to the low-risk status.

As the risk indicated by the Canadian Syncope Risk Score increases from very low to very high, the rates of serious outcomes and readmissions become progressively higher. Conversely, as the risk indicated by the score decreases, the rates of serious outcomes and no readmission increase.

The changes in gender with readmission, atrial fibrillation with serious outcome and readmission, coronary artery disease with serious outcome and readmission, and age with serious outcome and readmission were significant (p values <0.05).

Accordingly, it is seen that males readmitted at a higher rate than females, but gender did not affect the serious outcome. It is understood that the presence of atrial fibrillation increases both serious outcomes and readmission rates. Heart valve replacement was not a factor in increasing serious outcomes or readmissions. The presence of coronary artery disease increased both serious outcomes and readmission rates. Patients who had a serious outcome and readmission had a higher mean age than those who did not.

Gender, atrial fibrillation, heart valve replacement, and coronary artery disease were significantly associated with the risks indicated by the San Francisco Syncope Rule (p value<0.05). Accordingly, it is seen that men have a higher non-low risk rate than women. If patients have atrial fibrillation, heart valve replacement, and coronary artery disease, the rule shows a higher non-low risk. It is understood that gender, atrial fibrillation, heart valve replacement, and coronary artery disease are significantly associated with the risks shown by the Canadian Syncope Risk Score (p value<0.05).

Accordingly, it is seen that men are in higher risk groups than women. If patients have atrial fibrillation and coronary artery disease, the score indicates higher risk groups. In the presence of valvular heart valve replacement, the moderate and very high-risk ratios of the score increased, while the high-risk ratio remained almost the same.

DISCUSSION

In this study, we evaluated the San Francisco and Canada scores in order to safely discharge patients with syncope during the follow-up of patients with a prediagnosis of syncope. Our findings reveal notable differences in the effectiveness of the Canadian and San Francisco Syncope Rules, which could have significant implications for patient care. While our results align with some of the existing literature, they also highlight unique aspects of syncope management in emergency settings. This comprehensive analysis of both scoring systems reveals nuanced differences in their applicability to diverse patient groups, highlighting the need for a more personalized approach in syncope management. The detailed comparison of these rules in our study sheds light on their relative strengths and weaknesses, offering valuable insights for emergency physicians in choosing the most appropriate evaluation method. We investigated whether the patients encountered a serious outcome and whether the patients we discharged safely were readmitted and their mortal course was missed. 449 patients were included in the study. In this study, 52.1% of the patients were male and 47.9% were female. The rate of serious outcomes was 10%, readmission was 11.4%, and mortality was 1.1%.

In a survey conducted among physicians in North America, syncope was found to be the second most problematic problem in decision making.[14] It was found that the cause could not be determined in approximately half of the patients admitted to AS for syncope, and mortality was as high as 30% in this group.

In a study by Quinn et al. in which 684 syncope patients were evaluated, 59% of the patients were women, and the mean age was 62.1±22.3.[15] In a study involving 270 patients for the validation of risk scores in syncope patients, 54% of the patients were women, and the mean age was 59.5±24.3.[16] In our study, the mean age of the patients was 51.46 years, and 52% of the patients were women. Although the female-to-male ratio was close to each other in all three studies, the female ratio was higher.

Electrocardiography (ECG) is the gold standard in the diagnosis of syncope due to arrhythmias. Although its diagnostic value in patients with syncope is low (2-9%), it is recommended to be performed on every patient considering cost-effectiveness.[17] Almost all of the scoring systems used for risk classification include abnormal ECG findings (SFSR, CSRS, OESIL, EGSYS, and ROSE).

In our study, males were found to be in higher risk groups than females. If the patients had atrial fibrillation and coronary artery disease, the score indicated higher risk groups. In the presence of valvular heart valve replacement, the score increased in the moderate and very high-risk groups, while the high-risk group remained almost the same.

In our study, it was understood that ECG abnormality is the most common factor in the San Francisco Syncope Score, while troponin elevation or increase, cardiac syncope diagnosis, and vasovagal symptoms are more common in the Canadian Syncope Risk Score. In addition, after these factors,

a history of cardiac diseases was also seen more frequently in patients than others.

Among the risk classification scores available in the literature for predicting adverse outcomes in patients presenting to the emergency department with syncope, the SFSK is the only score that includes all short-term adverse outcomes, has been prospectively created according to the methodological standards of clinical prediction rules, and has been validated in more than one study (circumstantial evidence), so it has been stated that its use in AS is appropriate.[18-20] However, it has also been stated that validation studies conducted later did not obtain as good results as in previous studies.[21,22]

In a study applying the San Francisco Syncope Rule, 791 patients presenting to the emergency department with syncope were followed up for 30 days. Serious outcomes occurred in 6.7% of patients (n=53) during follow-up. As a result of this study, the sensitivity and specificity of the San Francisco Syncope Rules were found to be 98% and 56%, respectively.[12] In our study, the sensitivity and specificity of the San Francisco Syncope Rules were found to be 69.7% and 74.19%, respectively. Although the sensitivity was significantly lower, 95.5% of patients who received low risk from the San Francisco Syncope Rules had no serious outcome, and 92.8% were not readmitted to the hospital.

In our study, when the San Francisco Syncope Rule shows low risk, the rates of serious outcomes and readmissions are quite high. If the rule shows non-low risk, it is understood that the rates of serious outcomes and readmissions are higher than the low-risk status. Our study underscores the importance of tailored approaches in syncope management, considering patient-specific factors.

In a very large series study (4033 patients), Canadian syncope risk scores showed a 30-day serious outcome. About 1% or less of very low-risk and low-risk Canadian Syncope Risk Score patients, about 20% of high-risk Canadian Syncope Risk Score patients, and about 50% of very high-risk Canadian Syncope Risk Score patients experienced serious 30-day outcomes.[13] In our study, 2.4% of very low-risk patients and 6.3% of low-risk patients experienced serious outcomes from the Canadian Syncope Risk Score; 21.7% of high-risk patients and 35.7% of very high-risk patients experienced serious outcomes. The limitations of our study point to the need for further research in diverse patient populations and over extended periods.

CONCLUSION

This study contributes to a more nuanced understanding of syncope management, emphasizing the need for adaptable diagnostic strategies in emergency departments. It is understood that as the risk indicated by the Canadian Syncope Risk Score increases from very low to very high, the rates of serious outcomes and readmission gradually increase. Conversely, as the risk indicated by the score decreases, the rates of serious outcomes and no readmission increase.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Clinical Researches Ethical Committe of Kartal Dr. Lütfi Kırdar State Hospital (Date:30.06.2022, Decision No: 2022/514/228/7). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Types of wounds on those rescued from the avalanche disaster

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ABSTRACT

Aims: The most crucial step in rescue operations is the safety of rescuers. Two critical points were addressed to contribute to the literature. The first point is that the intervention of the rescuers together with the local people before ensuring the safety may result in more catastrophic disasters, and the second point is the course of avalanche victims after being rescued.

Methods: After the avalanche disaster that occurred in February 2020, the team, who went to help, was exposed to the avalanche disaster that happened again. A total of 65 people were rescued with injuries in both disasters. Data of patients admitted to neighboring hospitals (secondary and tertiary healthcare facilities) in Van province and 112 Emergency Health Services data were recorded.

Results: 41 avalanche victims died, 40 were out of the hospital and one victim in a local secondary healthcare facility. Among the 65 rescued people, one was admitted to the intensive care unit, 8 underwent emergency surgery, 40 were admitted to the hospital for follow-up purposes, and 16 were discharged after initial treatment in the emergency department. Of the patients, 63 were male, one was female, and the mean age was 36.39 years.

Conclusion: The primary strategy in an avalanche disaster is to stay in the safe zone. As with all major disasters, various types of injuries can occur. Although the priority is to reduce deaths, determining the most common injury areas of individuals exposed to disasters will help prevent possible deaths and disabilities.

Keywords: Avalanche, emergency, rescue

INTRODUCTION

Avalanche is defined as the swift motion of a mass of snow down a mountainside with an approximate speed of 90-120 km after a trigger.[1]

Avalanche is a significant problem in cold and snowy countries.[2] The frequency of avalanche disaster varies depending on the climatic and geographic characteristics of countries.[3] Although the avalanche mortality rate ranges between 6% and 43%, it is estimated that the exact figures are much higher.[4,5] The popularity of winter tourism and mountain climbing has gradually increased worldwide.[3] Outdoor activities in mountainsides covered with a snow mass pose severe risks for the participants.[4]

It is known that humans trigger approximately 90% of avalanche disasters in Europe and North America.[3] The avalanche victims would die of asphyxia and hypothermia approximately within 15-20 minutes even if they survived the initial trauma.[2] In various studies, asphyxia has been ranked first among other causes of death in avalanche victims, with a reported rate of 75% to 91.7% whereas the second most common cause of death is trauma.[6-8] Despite these reports, the cause of death remains unknown in some cases.[5]

The most crucial step in rescue operations is the safety of rescuers. The present study evaluates cumulative injuries in the rescuers buried under avalanche during a rescue operation for two avalanche victims to emphasize the safety of rescuers. The present study addresses two critical points to contribute to the literature. The first point is that the intervention of the rescuers together with the local people before ensuring the safety may result in more catastrophic disasters, and the second point is the course of avalanche victims after being rescued.

METHODS

The data of the patients admitted to the surrounding hospitals (secondary and tertiary healthcare facilities) in the Van province after the avalanche disaster in February 2020, and the data of 112 Emergency Health Services were recorded retrospectively. Demographic data, injury site, first interventions, initial vital signs, and blood parameters were recorded.

The study was carried out with the permission of the Van Yüzüncü Yıl University Hospital Scientific Researches Evaluation and Ethics Committee (Date:22.05.2020, Decision No: 2020/03-60). We obtained an informed consent form all patients for procedure. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Statistical Analysis

Among the studied parameters, the descriptive statistics for continuous variables were expressed as mean and standard deviation, and the categorical variables were expressed as number and percentage. SPSS 20 statistical software package was used in statistical analysis.

RESULTS

In the avalanche disaster, a total of 41 victims died and 65 victims were rescued. Of those rescued with injuries, 64 were men and 1 was a woman and the mean age was 36.39 years.

A total of 41 avalanche victims died, 40 out of the hospital and one victim in a local secondary healthcare facility (**Figure 1**).

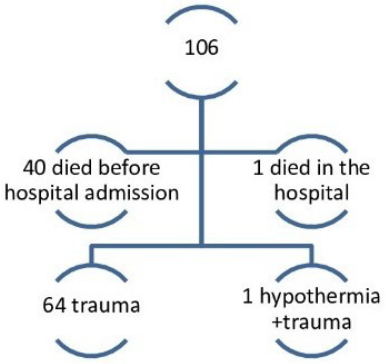

Figure 1. Distribution of the aftermath in avalanche victims

Among the 65 rescued people, one was admitted to the intensive care unit, 8 underwent emergency surgery, 40 were admitted to the hospital for follow-up purposes, and 16 were discharged after initial treatment in the emergency department (**Figure 2**).

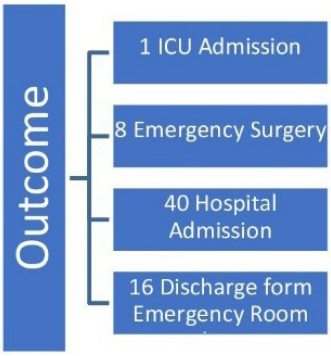

Figure 2. Distribution of the hospital course in the avalanche victims

The patients with an injury affecting only one organ and system were considered to have sustained isolated trauma, and those with multiple injuries were considered to have sustained multiple trauma (**Figure 3**).

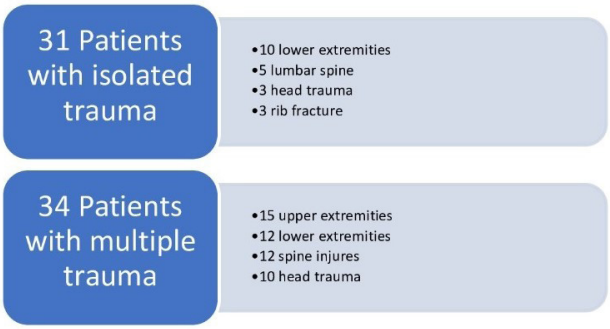

Figure 3. Type of injuries

Since almost all avalanche victims had muscle injuries, WBC and CK were elevated as shown in **Table 1**.

Table 1. Mean blood parameters of the casualties

Parameter	Average/Reference Value
White blood cell (WBC)	16.11 x 10^3uL (4.5-11 x 10^3uL)
Hemoglobin (Hgb)	15.5g/dL (male: 14-16.5; female 12-15 g/dL)
Hematocrit (Htc)	%44.6 (male: 42-52%; 35-47%)
Potassium (K)	4.2mmol/L (3.5-5 mEq/L)
Calcium (Ca)	8.6mmol/L (8.5-10.5 mg/dL)
Urea	24 mg/dL (8-25 mg/dL)
Creatinine (Cr)	0.82 mg/dL (0.6-1.3 mg/dL)
Alanine aminotransferase (ALT)	32u/L (male: 10-55; female 7-30 u/L)
Aspartate aminotransferase (ALT)	32u/L (male: 10-40; female 9-25 u/L)
Creatine kinase (CK)	674u/L (male: 38-174; female 26-140 u/L)
Creatine kinase MB (CK-MB)	33u/L (CK*0-0.05)
Troponin I	0.09um/L (<0.6 ng/mL)

The patients who underwent emergency surgery after being admitted to the emergency department had thoracic spine fracture (T10) with compression to the medulla spinalis, extremity, and forearm injuries with damage to the vessel-nerve package, intracranial hemorrhage, comminuted knee fracture, shoulder and leg injury with comminuted fracture, shoulder-leg-thoracic spine injury, eye-upper extremity and leg injuries.

The patients discharged from the emergency department had forearm fracture, rib fracture, foot fracture, fracture of the lateral process of the lumbar vertebra, knee injury, facial injury, superficial head injury, neck injury without a fracture, hand and leg injury, hand and lumbar injury, knee injury, and thoracic injury.

One patient admitted to the intensive care unit had facial, shoulder, lung, and thoracic vertebra injury.

DISCUSSION

Although the avalanche is a fatal natural disaster, educating and informing the people may reduce unjust suffering.[4,6,9] The number of avalanche victims increases gradually due to people's engagement in mountain climbing sports, transportation, military operations, rescue operations, and dense residential areas in mountainsides at high altitude.[6]

The reported mortality rate associated with the avalanche disaster varies between 4% and 50%.[7,10] The mortality rate associated with trauma in avalanche victims was reported to be 24% in Canada and 5.6% in Europe.[6,7]

The knowledge of the causes of death and injuries in avalanche victims would guide rescue and resuscitation guidelines.[8] The people buried under a mass of snow in an avalanche disaster may come across rocks, trees, and palisades.8 The cause of death should not be related to only one factor. Asphyxia, trauma, and hypothermia can be observed in all cases at different severity levels.[6] In an avalanche in Utah, the cause of death was considered to be asphyxia in 72%, trauma in 19%, and the combination of asphyxia, hypothermia, and trauma in 9% of the victims.[4]

The overall mortality rate varies depending on the activity engaged, time spent under the snow mass, the physical status of the victim, and the equipment.[6] The death rate is approximately 50% in the victims buried entirely under the snow mass and 3-4% in those who were not completely buried.[11] Ninety percent of the victims completely buried in avalanches survive if they are rescued within 15 minutes.[10] The victims killed by nontraumatic causes gradually experience hypoxia, hypercapnia, and hypothermia.[12] Of the victims presented in the study, 40 were found dead after the incidence, and one casualty died after an admission to a secondary care hospital. The rate of mortality per total number of victims was 33.06%.

The avalanche victims are often healthy and young males. The mean age ranges between 25 and 33 years.[4,6,8] The mean age in the present study was 36.39 years. The high mean age can be explained by the fact that a considerable number of victims were from the local people. Males are the predominant gender in previous studies. The rate of female victims ranges from 5.3% to 6%.[4,8] The number of female victims was 2 in the present study, comprising 3.1% of all victims.

Trauma is the most common cause of death after asphyxia.[8] This rate varies depending on the geographic characteristics of the incident site. The data dramatically vary depending on the area's topographic structure, the composite structure of snow, and the incident site being a forested or rocky terrain.[12] The avalanche victim can hit trees and rocks and fall down a cliff while rolling in a large mass of snow.[6,8] Of avalanche deaths, 57% are caused by internal and 43% are caused by external injuries.[4] Sixty-five casualties in the present study had signs of trauma at various degrees. When the number of injured organs was evaluated, 31 out of 65 casualties had isolated trauma while 34 casualties with multiple trauma had injuries in different organs and systems.

Some authors argue that trauma is the cause of death in one-third of the victims.[4,6] It was reported that approximately 43% of the deaths during a 10-year period in Switzerland were caused by trauma.[13] The leading cause of death in trauma cases is reported to be the brain injury.[13] Head injury has been observed in 42% of deaths caused by trauma.[6] Therefore, wearing a helmet will reduce the risk of head trauma. According to the results of clinical and autopsy studies, trauma most commonly affects the head, spine, chest, and extremities.[7,8,12] According to the Canadian data, the injury site is the chest in 46% and head in 42% of the victims.[6] The extremities, spine, and head were the most commonly affected body sites in the present study. The casualty admitted to the intensive care unit had facial, shoulder, thoracic, and vertebral injuries.

The rescue team must be complete and ready before starting the rescue operation.[14] The intervention to avalanche disaster must begin with the safety of the medical management team.[12]

The primary strategy in avalanche disaster is the stay in the safe zone. Rescue training must have been received, and the essential equipment must be carried.[2] The rescue operation must be delayed or stopped in hazardous areas, severe weather conditions, and if there is a risk of new avalanche.[12,15] The victims in the present study were composed of the rescue team and the local people who dispatched to the area to rescue two people buried in a previous avalanche. Despite severe weather and the occurrence of a second avalanche disaster, running the rescue mission, increased the number of victims to 106. Thus, rescue operations must be delayed until favorable conditions have been achieved.

Taking fast and effective actions increases the chance of survival.4 The involvement of the people in the neighborhood until the professional rescue team has arrived increases survival.[3] The access to the disaster site is sometimes challenging.[16] The terrain is screened for evidence when the rescue operation has been initiated. A connection line is tested if the rescuer is using a receiver device. The strategic area is determined, and the search and rescue operation is started with a scoop.[14] Resuscitation must be performed within 35 minutes after the victims buried under snow have been recovered.[17]

Rescue strategies along with appropriate rescue equipment increase the chance of survival.[4,8] It is stated that avalanche airbags reduce mortality.[18] Therefore, it is suggested that people who may be exposed to avalanche travel with at least one partner, an airbag, and a walkie-talkie.[4]

The use of helicopters is effective in areas with limited ground access; however, it must be realized that the helicopter's sound and vibration waves may trigger a second avalanche.[16] Air rescue teams among the avalanche rescue teams must be specialized.[16] The triggering of a new avalanche during the operation can be attributed to heavy snow and steep and rocky geographic features of the terrain.

A rapid assessment must be performed, and the vital functions must be analyzed upon reaching the victim. It must be realized that the heart rate may be weak, slow, and irregular due to hypothermia.[19] Only one hypothermic casualty was admitted to the hospital as the first intervention to the immersed victims was made at the incident site. The body temperature in the hospitalized patient returned to normal by passive warming techniques.

The possibility of bodily trauma must not be overlooked in avalanche victims, and the rescuers must implement multiple trauma protocols.[20,21] A proper body position must be given due to the possibility of spinal trauma after recovering avalanche victims. If resuscitation attempts have been initiated, minimum intervals must be given between chest compressions. A resuscitation procedure must be performed because the victim may also have hypothermia and asphyxia.[3,6] Because the most commonly affected body site is the spine in the casualties with isolated and multiple injuries, a cervical collar and spine support must be used until it is proven otherwise.

In the present study, the patients who underwent emergency surgery after being admitted to the emergency room had thoracic spine fracture (T10) with compression to the medulla spinalis, extremity, and forearm injuries with damage to the vessel-nerve package, intracranial hemorrhage, comminuted knee fracture, shoulder and leg injury with comminuted fracture, shoulder-leg-thoracic spine injury,

eye-upper extremity and leg injuries. Sixteen patients were discharged after the treatment and follow-up in the emergency department.

Resuscitation may not be performed when the victim has fatal injuries, or the body has been frozen so that chest compression becomes impossible. Resuscitation must be continued regardless of the duration in cases with a patent airway.[17] The rescued victims must be transported initially to the nearest healthcare facility or trauma facility by helicopter or ground ambulance, or snow bike if possible.[11,12] All casualties reported in the present study were transported to the hospital by a ground ambulance.

Limitations

The present study's limitations are that different rescue teams intervened the avalanche victims, the casualties were treated in different hospitals, and some data were not appropriately kept.

CONCLUSION

It is of particular importance to reduce deaths by increasing avalanche awareness and educations in the terrain. The time to intervention is critical as death and injuries suddenly occur in avalanche disaster. The dispatch of the rescue teams to the incident site should be rapid and appropriate. No intervention should be made until safety measures have been taken. The rescue plan should be made as per the geographic characteristics of the terrain and weather conditions, and the victims should be transported to the treatment facilities in the shortest time possible. Regardless of the effectiveness of the intervention to avalanche disaster, the most important protection method is to stay away from risky areas.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of the Van Yüzüncü Yıl University Hospital Scientific Researches Evaluation and Ethics Committee (Date:22.05.2020, Decision No: 2020/03-60). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Informed Consent: All patients signed and free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declared that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Evaluation of the effectiveness of transthoracic echocardiography and compression ultrasonography (echo-cus) in the diagnosis of pulmonary embolism in the emergency department

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ABSTRACT

Aims: The aim of this study was to evaluate the effectiveness of echocardiography and compression ultrasonography in the diagnosis of pulmonary embolism and to investigate the diagnostic power of echocardiography and compression ultrasonography in patients with suspected pulmonary embolism.

Methods: The cross-sectional study was conducted on patients who were admitted to the emergency department between 01.10.2020 and 30.09.2021 with complaints of shortness of breath, chest pain, palpitations, bloody cough, fainting and who were recommended to undergo pulmonary computed tomography angiography according to the YEARS protocol. The study included 52 patients according to power analysis. The patients included in our study were evaluated at the bedside with the ultrasound of the emergency department. The main echocardiographic findings and compression ultrasonography findings of the deep veins of the lower extremities were evaluated. Then pulmonary computed tomography angiography was performed to patients. The right ventricle/left ventricle diameter ratio was recorded from the computed tomography images of the patients. The patients were divided into 2 groups according to pulmonary computed tomography angiography report: pulmonary embolism and non-pulmonary embolism. To see whether pulmonary embolism could be diagnosed, the main echocardiographic findings of the criteria we defined and compression ultrasonography of the deep veins of the lower extremities were evaluated. Statistical analysis of the data was performed in IBM SPSS Statics Version 26 program.

Results: There were 52 patients and 20 (38.5%) patients diagnosed with pulmonary embolism according to computed tomography. Fifty percent of the patients included in the study were male and fifty percent were female. The symptom distribution of the cases according to the diagnosis of pulmonary embolism was examined and no significant difference was found between the symptoms ($p>0.05$). When the distribution of echocardiography and compression ultrasonography findings of the patients according to pulmonary embolism diagnosis was analyzed, a statistically significant difference was found between the groups in terms of tricuspid regurgitation jet flow velocity, right ventricle/left ventricle diameter ratio, D-sign, McConnell's sign and deep vein thrombosis findings ($p<0.05$). When the results of the receiver operating characteristic curve analysis for the power of Wells and Geneva scores, echocardiography, compression ultrasonography and computed tomography findings to diagnose pulmonary embolism were analyzed; the cut-off values calculated for Wells and Geneva scores; the area under curve values calculated for the power of current echocardiography findings of tricuspid regurgitation jet flow velocity, right ventricle/left ventricle diameter ratio, D-sign, McConnell's sign findings and computed tomography right ventricle/left ventricle diameter ratio findings to diagnose pulmonary embolism were found to be statistically significant ($p<0.05$).

Conclusion: The results of our study showed that in patients diagnosed with pulmonary embolism, echocardiography is easily available and can help diagnose pulmonary embolism by showing right ventricular dysfunction. The results suggest that bedside echocardiography may help emergency physicians to make faster decisions in pulmonary embolism by increasing the provider's index of suspicion.

Keywords: Critical care, emergency medicine, echocardiography, ultrasonography, pulmonary embolism, thrombosis

INTRODUCTION

Pulmonary embolism (PE) is a clinical, pathologic and physiologic syndrome in which the pulmonary arteries are blocked by various endogenous or exogenous emboli and in most cases manifests as pulmonary circulatory dysfunction. It is a difficult diagnosis that may be overlooked due to its nonspecific clinical appearance. A 2005 study by Calder et al.[1] showed that the diagnosis is missed in 400000 people each year, of whom 100000 to 120000 die. However, early diagnosis is essential as emergency treatment is highly effective. Evaluation of patients in the emergency department should be prompted to reduce associated morbidity and mortality.

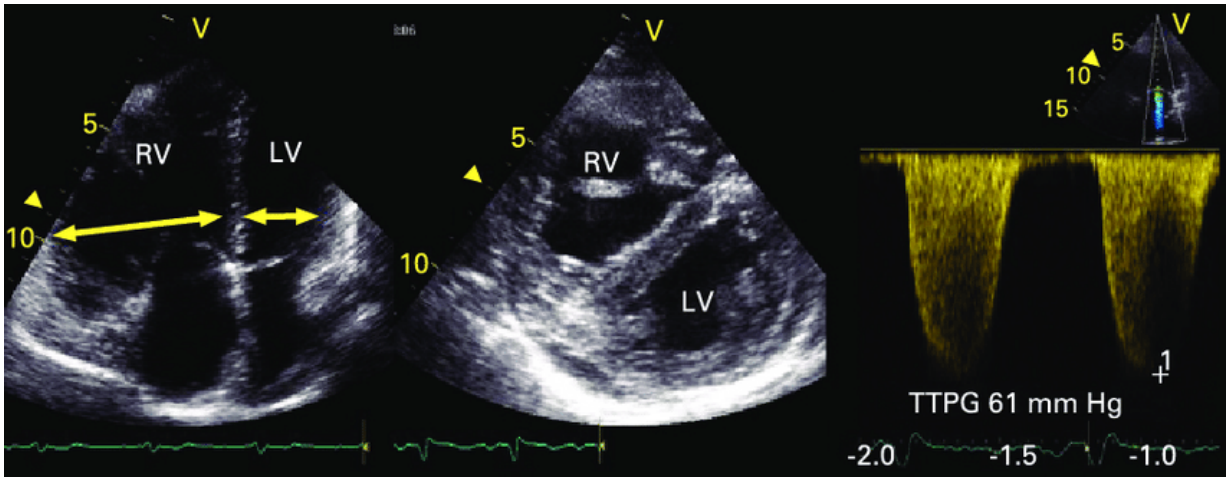

Figure 1. *Images of Right Ventricle Expansion in Pulmonary Embolism from A4 and PSSA view. A: The increase in the diameter of the RV compared to the LV in terms of A4 view. B: The increase in the diameter of the RV compared to the LV in terms of PSSA view. RV: right ventricle, LV: left ventricle, A4: apical four chamber, PSSA: parasternal short axis*

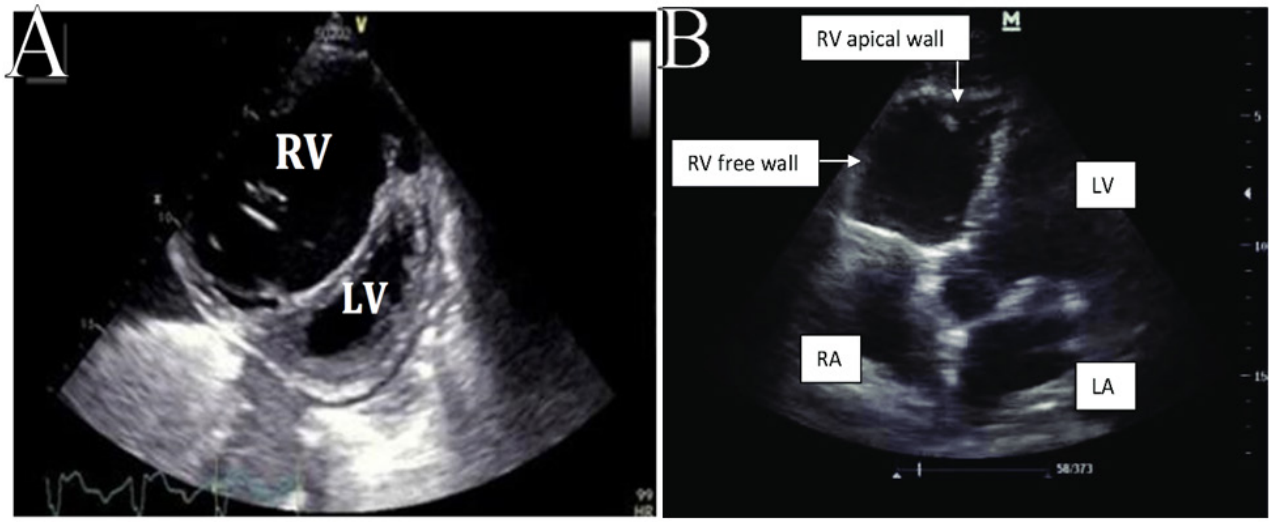

Figure 2*. Images of D-sign and McConnell's sign in PSSA and A4 view. A: D-sign in terms of PSSA view B: McConnell's sign in terms of A4 view RV: right ventricle, LV: left ventricle, RA: right atrium, LA: left atrium, A4: apical four chamber, PSSA: parasternal short axis*

Echocardiography (ECHO) is a rapid, bedside imaging modality in the emergency department. Bedside ECHO is used for emergency management decisions in high-risk patients with suspected PE. Acute PE is defined as high-risk PE when there is hemodynamic instability. According to the 2019 "European Society of Cardiology" (ESC) guideline, hemodynamic instability is characterized by cardiac arrest, obstructive shock or persistent hypotension. Hemodynamically unstable patients show signs of end-organ hypoperfusion such as hypoxia, low GCS, and confusion.[2] In a high-risk patient with suspected PE, echocardiographic evidence of right ventricle (RV) overload and dysfunction is diagnostic and recommends initiation of treatment. PE is caused by deep vein thrombosis (DVT) in the majority of cases and another bedside test recommended by the ESC guidelines for the diagnosis of PE is compression ultrasonography (CUS).[2] DVT is present in 70% of cases with PE.[3] CUS has 90% sensitivity and 95% specificity for DVT. The ESC guidelines state that a simple 4-point (both femoral veins and both popliteal veins) compression test is sufficient for CUS.[2] PE, ECHO and CUS findings were stated in the **Table 1**.[4-11]

In **Figure 1**, the increase in the diameter of the RV compared to the left ventricle (LV) is shown in terms of A4 (apical four chamber) view shown in A. The same finding shown in B is shown from the PSSA (parasternal short axis) view. In **Figure 2**, the D-sign shown in A and McConnell's sign in B are shown from A4 view.[12]

PE is one of the diseases that emergency clinics deal with intensively. It has high mortality and morbidity. In addition to this high frequency and high risk, it is an extremely difficult and challenging pathology to diagnose. Bedside ECHO and CUS methods are used for the diagnosis of PE and are recommended by guidelines. There are not many studies on the extent to which the combined use of these methods (ECHO-CUS) can diagnose PE. We aimed to evaluate the diagnostic power of these bedside methods when used together in our study.

Table 1. Pulmonary Embolism Echocardiographic and Compression Ultrasound Findings

Right Ventricle/Left Ventricle ratio	Pulmonary embolism blocks the right ventricular outflow and increases the right ventricular pressure. As a result, the right ventricle expands and the right ventricle/left ventricle ratio, which is normally <1/1, increases with right ventricular expansion and becomes >1/1.
D-sign	It is a finding that occurs when the septal wall, which is normally curved to the right due to increased right ventricular pressure, curves towards the left ventricle and takes a "D" shape in the left ventricle.
McConnell sign	Due to increased right ventricular pressure in pulmonary embolism; the outward bulging of the right ventricular wall from the apical 4-chamber view is a finding resulting from normal right ventricular apex wall movement.
Vena Cava Inferior collapsibility index	Increasing right ventricular pressure increases the pressure of the vena cava inferior, one of the vessels entering the right ventricle, and prevents its collapsibility. Physiologically, vena cava inferior collapsibility is >50%.
High tricuspid jet flow velocity	The value considered elevated is ≥2.5 m/sec. Increasing right ventricular pressure causes insufficiency in the tricuspid valve, and the peak velocity of the flow escaping into the right atrium provides information about the right ventricular pressure.
Right ventricle wall thickness	Normal wall thickness is between 3-5 mm. Increased right ventricular wall thickness is an indicator of increased right ventricular work force. Pulmonary embolism may cause an increase in right ventricular wall thickness as it increases the right ventricular afterload by increasing the pulmonary artery pressure. Echocardiography can indirectly provide information about the presence of pulmonary embolism.
Deep Vein Thrombosis	Deep vein thrombosis and pulmonary embolism are part of the venous thromboembolism spectrum. Half of the thrombi in the proximal deep veins of the leg cause pulmonary embolism. Compression ultrasonography is a method of imaging the leg veins and applying pressure to check whether there are clots in them.

METHODS

The study was conducted with the approval of Aydın Adnan Menderes University School of Medicine Scientific Researches Evaluation and Ethics Committee (Date: 01/10/2020, Decision No: 2020/200). We obtained an informed consent form from all patients for the procedure. The procedures were performed in line with ethical rules and the Declaration of Helsinki principles. The cross-sectional study was conducted on patients who were admitted to the emergency department between 01.10.2020 and 30.09.2021 with complaints of shortness of breath, chest pain, palpitations, bloody cough, fainting, and who were recommended to undergo pulmonary computed tomography (CT) angiography according to the YEARS protocol, the criteria of which were specified in the study published by van der Hulle et al.[13] The YEARS protocol includes the criteria for evidence of DVT signs, hemoptysis, and the most likely diagnosis being PE, and helps the clinician to decide on pulmonary CT angiography according to the criteria.[13] The research was conducted in a single center. Patients over the age of 18, who were not pregnant, who were stable in the emergency department and who were subsequently able to undergo pulmonary CT angiography were included in our study. Patients under 18 years of age, pregnant women, and patients who could not undergo pulmonary CT angiography were excluded from the study. In a study conducted by Stefano Grifoni et al.[14] in 1998, the effect size calculated from the table related to PE was calculated as 0.640 and a large effect size of 0.5 was taken for the sample size calculation of our study. With an effect size of 0.5, the sample size was found to be 52 at 95% power with a 5% margin of error and 52 patients were included in the study. Patients were informed about their inclusion in the study and their informed written consent was obtained.

While the patient's examination and treatment for PE was continued by his regular physician without delay, the co-executive of the study evaluated him with ECHO and the necessary data was collected. The patients included in our study were examined by a researcher with a basic and advanced ultrasonography (USG) course certificate given by the Emergency Association of Türkiye, using a Samsung H60 model USG device with doppler features such as pulse wave and continuous wave. Echocardiographic findings of PE were evaluated with the cardiac probe of ultrasound. While the patient was evaluated with a cardiac probe, peak velocity was measured using continuous wave doppler mode on the tricuspid valve from the A4 view in the supine position. Afterwards, RV free wall thickness, McConnell's sign, and the ratio of RV/LV diameters were measured with a cardiac probe. The D-sign and the RV/LV diameter ratio were measured from the PSSA view with the cardiac probe of the ultrasound. The probe was taken to the epigastric area and inferior vena cava (VCI) diameters and collapsibility index were recorded. Then, the linear probe was used and DVT was searched for by compression from 3 different points in both groin and legs, from the femoral vein to the popliteal vein. Afterwards, the patient's regular physician intervened, stabilized him, and pulmonary CT angiography was performed. The RV/LV diameter ratio was recorded from the CT images of the patients. It was recorded whether the patients were diagnosed with PE in their CT angiography reports, and accordingly, the patients were split into 2 groups: PE and non-PE. To see whether PE could be diagnosed, the main echocardiographic findings of the criteria we defined and CUS of the deep veins of the lower extremities were evaluated.

Statistical Analysis

Data were statistically analyzed using IBM SPSS Statistics Version 26 program. For the comparison of categorical data between groups, Pearson Chi-Square statistical analysis was used, and for the comparison of continuous data not conforming to normal distribution between two groups, Mann Whitney U statistical analysis was used. Receiver operating characteristic (ROC) analysis was used to estimate the predictive power of positive pulmonary CT Angiography and $p<0.05$ was considered statistically significant.

RESULTS

The flowchart of the study is presented in **Figure 3**. There were 52 patients and 20 (%38.5) patients diagnosed with PE according to CT. Fifty percent of the patients included in the study were male and fifty percent were female. The median age of the subjects diagnosed with PE was 56 years (18-90) and the median age of the subjects not diagnosed with PE was 64 years (30-91). There was no statistically significant difference between the median ages of male and female patients

Table 4. Results of ROC Analysis for the Power of Wells and Geneva Scores, ECHO, CUS and CT findings to diagnose PE

Cut-off	Sensitivity	95% CI	Specificity	95% CI	AUC	95% CI	p
Wells score	45.0	23.1- 68.5	93.8	79.2- 99.2	0.755	0.616-0.863	**<0.001**
Geneva score	75.0	50.9- 91.3	56.3	37.7- 73.6	0.705	0.563-0.824	**0.004**
High tricuspid jet flow velocity (≥2.5m/s)	60.0	36.1- 80.9	81.3	63.6- 92.8	0.706	0.564-0.824	**0.008**
VCI Collapsibility index (<%50)	90.0	68.3- 98.8	21.9	9.3- 40.0	0.559	0.415-0.697	0.463
RV/LV (PSSA)	75.0	50.9- 91.3	90.6	75.0- 98.0	0.828	0.698-0.919	**<0.0001**
D-shape sign	60.0	36.1- 80.9	96.9	83.8- 99.9	0.784	0.648-0.886	**<0.001**
McConnel sign	35.0	15.4- 59.2	100.0	89.1- 100.0	0.675	0.531-0.798	**0.033**
DVT+ (CUS)	30.0	11.9- 54.3	93.8	79.2- 99.2	0.619	0.474-0.750	0.155
CT RV/LV	70.0	45.7- 88.1	90.6	75.0- 98.0	0.803	0.669-0.900	**<0.0001**

ROC: receiver operating characteristic, ECHO: echocardiography, CUS: compression ultrasonography, CT: computed tomography, VCI: vena cava inferior, RV: right ventricle, LV: left ventricle,
PSSA: parasternal short axis view, DVT: deep vein thrombosis, PE: pulmonary embolism, CI: confidence interval, AUC: area under curve

(p>0.05). When the distribution of ECHO and CUS findings of the patients according to PE diagnosis was analyzed, a statistically significant difference was found between the groups in terms of high tricuspid regurgitation jet flow velocity, RV/LV diameter ratio (PSSA), RV/LV diameter ratio (A4), D-sign, McConnell's sign and DVT (CUS) findings (p<0.05). There was no statistically significant difference between the groups in terms of other variables (>0.05). The distribution of gender, age, ECHO and CUS findings according to the diagnosis of PE is summarized in **Table 2**. When the distribution of symptoms according to the PE diagnosis of the cases was examined in **Table 3**, no significant difference was found between the symptoms (p>0.05).

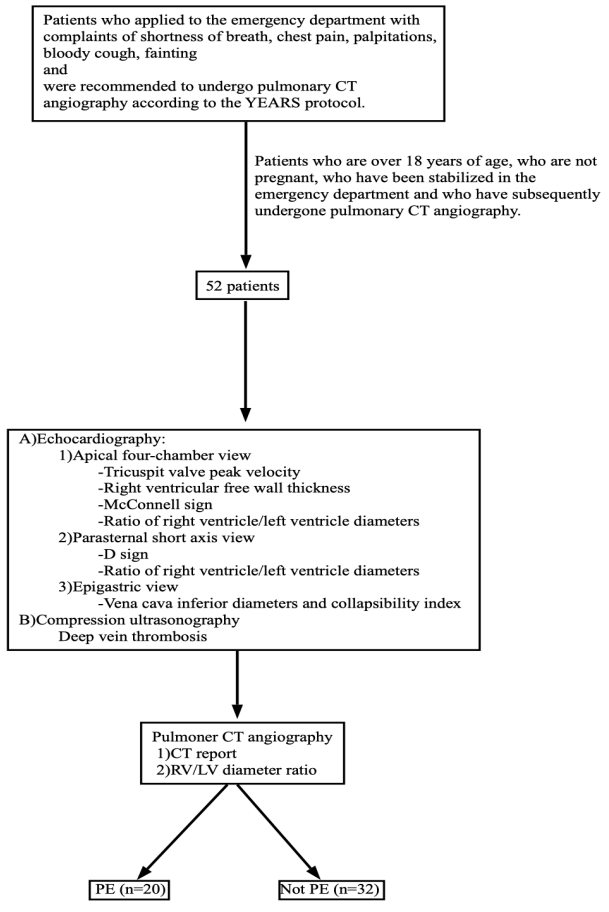

Figure 3. *The flow chart of the study*
CT: computed tomography, PE: pulmonary embolism

Table 2. Distribution of Gender, Age, ECHO and CUS findings according to the diagnosis of PE

		PE(n=20)	Not PE (n=32)	Total(n=52)	p
Age (year)		56(18-90)	64(30-91)	63,5(18-91)	0.257#
Sex	Female, n (%)	11(55.0)	15(46,9)	26(50)	0.569*
	Male, n (%)	9(45.0)	17(53,1)	26(50)	
High tricuspid jet flow velocity (≥2.5m/s), n (%)		12 (60)	6 (18.8)	18 (34.6)	0.002*
VCI Collapsibility index (<%50), n (%)		18 (90)	25 (78.1)	43 (82.7)	0.454*
RV/LV (PSSA) (>0,90), n (%)		15 (75)	3 (9.4)	18 (34.6)	**<0.001***
RV/LV (A4) (>0,90), n (%)		15 (75)	3 (9.4)	18 (34.6)	**<0.001***
D-sign, n (%)		12 (60)	1 (3.1)	13 (25)	**<0.001***
McConnel sign, n (%)		7 (35)	0 (0)	7 (13.5)	**0.001***
RV thickness (>5mm), n (%)		12 (60)	10 (31.3)	22 (42.3)	**0.041***
DVT+ (CUS), n (%)		6 (30)	2 (6.3)	8 (15.4)	**0.043***

* p value for Pearson Chi-Square test, # p value Mann Whitney U analysis
ECHO: echocardiography, CUS: compression ultrasonography, PE: pulmonary embolism, VCI: vena cava inferior, RV: right ventricle, LV: left ventricle, PSSA: parasternal short axis view, A4: apical four chamber view, DVT: deep vein thrombosis

Table 3. Distribution of Symptoms According to Diagnosis of PE

	PE		Not PE		Total		X^2	p
	n	%	n	%	n	%		
Shortness of breath	15	75.0	24	75.0	39	75.0	0.000	1.000
Chest pain	6	30.0	6	18.8	12	23.1	0.878	0.500
Palpitation	4	20.0	3	9.4	7	13.5	1.193	0.408
Bloody cough	1	5.0	2	6.3	3	5.8	0.035	1.000
Fainting	1	5.0	1	3.1	2	3.8	0.117	1.000

Pearson Chi-Square, Fisher's Exact test, PE: pulmonary embolism

When the results of the ROC analysis for the power of Wells and Geneva scores, ECHO, CUS and CT findings to diagnose PE were analyzed; the cut-off values calculated for Wells and Geneva scores; the Area Under Curve (AUC) values calculated for the power of current ECHO findings of high tricuspid regurgitation jet flow velocity, RV/LV diameter ratio (PSSA), D-Sign, McConnell's sign findings and CT RV/LV diameter ratio findings to diagnose PE were found to be statistically significant (p<0.05). AUC values calculated for other variables were not statistically significant (p>0.05). The results of ROC analysis for the power of Wells and Geneva scores, ECHO, CUS and CT findings to diagnose PE are summarized in **Table 4**. The ROC analysis curves of the data

with significant AUC values are shown in **Figure 4**. As can be seen in the graph and table, the parameter with the highest specificity was found to be RV/LV diameter ratio.

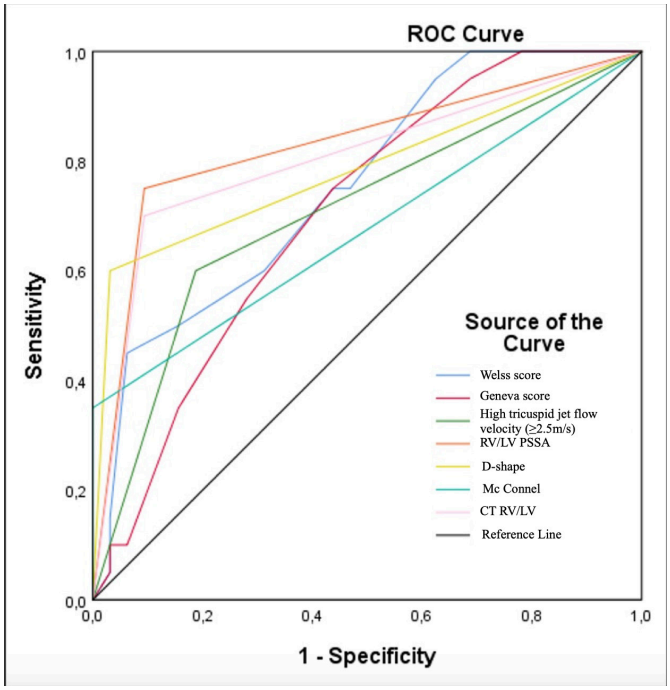

Figure 4. *ROC Curves Plotted for Variables Found Significant in ROC Analysis for the Power of Wells and Geneva Scores, ECHO, CUS and CT findings to diagnose PE*
ROC: receiver operating characteristic, ECHO: echocardiography, CUS: compression ultrasonography, CT: computed tomography, PE: pulmonary embolism, RV: right ventricle, LV: left ventricle, PSSA: parasternal short axis

DISCUSSION

RV function is an important determinant of long-term outcome in patients with acute PE. In these conditions, the RV is subjected to abnormal and increased loading that varies in timing, magnitude and duration. Consequently, RV dysfunction is variably present in the initial presentation of acute PE. Pruszczyk, P. et al.[15] found that the RV/LV diameter ratio was significantly elevated on ECHO. Akhoundi et al.[16] found a significantly higher CT RV/LV diameter ratio in their study. In our study, when the distribution of ECHO, CUS, and CT findings of the patients according to PE diagnosis was examined, a statistically significant difference was found between the groups in terms of RV/LV diameter ratio (PSSA), RV/LV diameter ratio (A4), and CT RV/LV diameter ratio findings. These results indicate that there is a significant clinical need for a simple, reproducible and reliable parameter of RV function in patients with right heart disease. ECHO has an important role in the diagnosis of PE because it is non-invasive, easily accessible, without radiation hazard and without the use of contrast agents.

D-sign is a finding seen in PE, because PE increases RV pressure. In the normal heart, the septum bends towards the RV because the LV pressure is higher. If the pressure in the RV increases as a result of conditions such as PE, the septum bends towards the LV and gives the LV a "D" shaped appearance. This ultrasonographic finding is called "D-sign".[17] In our study, a statistically significant difference was found between the groups in terms of D-sign finding; and the D-sign finding is consistent with the literature.

PE causes morbidity and mortality through RV outflow obstruction, which can lead to increased pulmonary artery pressure, RV failure, LV failure and circulatory collapse. RV dysfunction has been found on ECHO in 27% to 40% of normotensive patients with PE and can predict circulatory collapse.[4] Dresden et al.[4] found that RV dilatation on bedside ECHO is highly specific for PE (98%) but has a low sensitivity (50%). There are also studies proving that the most prominent ECHO finding detected in patients with PE is McConnell's sign.[18,19] The results of our study are consistent with the literature.

The definitive diagnosis of pulmonary hypertension is made by cardiac catheterization, but echocardiographic measurement of tricuspid regurgitation jet stream velocity height can be used to estimate pulmonary artery systolic pressures. Pulmonary hypertension is described as a tricuspid regurgitant jet flow velocity ≥2.5 m/s.[20] Increased jet flow velocity in tricuspid valve regurgitation (≥2.5 m/sec) is one of the echocardiographic findings that lead the clinician to PE in studies. In a study conducted on patients diagnosed with PE, it was found to be elevated in 44 of 46 patients.[21] RV dysfunction may be diagnosed by measuring the peak velocity of the regurgitant jet of the tricuspid valve. Nazeyrollas et al.[22] included a total of 132 cases and showed that peak velocity of the tricuspid valve regurgitant flow ≥2.5 m/s and RV/LV diameter ratio >0.5 were 93% sensitive and 81% specific for the diagnosis of PE. In our study, tricuspid regurgitation jet flow velocity elevation (≥2.5 m/s) and RV/LV diameter ratio elevation was significant and consistent with the literature.

DVT and PE are related diseases covered under the heading of venous thromboembolism. Half of the thrombi that form in the proximal deep leg veins cause PE and DVT is a risk factor for PE. The diagnosis of PE is usually confirmed by pulmonary CT angiography in patients with DVT after CUS.[23] In our study, DVT results were significant and consistent with the literature.

Bedside ECHO is the most popular diagnostic tool in patients with suspected PE, and as the number of PE attending the emergency department rises, the role of ECHO and its results becomes more significant. In a meta-analysis of 24 articles, only RV end-diastolic diameter was found to have a sensitivity of more than 80% for detecting PE, although this is still a low value for a finding to be used in sensitivity. None of the USG findings in this meta-analysis had a specificity lower than 80%. In the studies included in this meta-analysis, the VCI collapsibility index, which was the only finding that was not significant in our study, was not examined and the VCI collapsibility index was not mentioned in the meta-analysis.[24] Yamanoğlu A. et al.[25] grouped the etiologies of patients presenting to the emergency department with dyspnea into cardiac and pulmonary etiologies and examined PE in the pulmonary origin group. They performed ECHO and evaluated the VCI and collapsibility index. The findings of their study have shown that the VCI collapsibility index was normal in pulmonary-induced dyspnea compared to cardiac-induced dyspnea. As a result of our study, we found that the VCI collapsibility index has no place in the diagnosis of PE. Based on these findings, the results of our study are consistent with the literature.

Normal limits of RV wall thickness are 3-5 mm. Exceeding this value indicates thickening of the RV wall, which may indicate RV hypertrophy. The main mechanism of ventricular hypertrophy is increased hemodynamic workload. As a result,

increased RV wall thickness is an indicator of increased RV workload. PE may cause increased RV wall thickness because it increases RV afterload by increasing pulmonary artery pressure. In our study, increased RV wall thickness was detected and found to be consistent with the literature.

Limitations

In our study, our results are regional in nature due to the fact that the hospital where the study was conducted was a single center. Larger multicenter studies will be able to provide more objective information. Repeated measurements were not performed in our study, the treatment response of patients can be followed up by performing repeated measurements. The person-dependent nature of the USG performed is also among the limitations of the study.

CONCLUSION

Acute PE is an emergency requiring rapid diagnosis and treatment. ECHO and CUS is a non-invasive, easily accessible, non-radiation hazardous diagnostic tool and were found to be effective in diagnosing PE in our study. Results from our study showed that bedside ECHO and CUS can help emergency physicians to make faster decisions in PE by increasing the provider's index of suspicion.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Scientific Researches Evaluation and Ethics Committee of Aydın Adnan Menderes University (Date: 01/10/2020, Decision No: 2020/200). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Informed Consent: All patients signed and free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declared that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Occupational accidents and injuries: clinical experiences of a tertiary hospital

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ABSTRACT

Aims: Occupational accidents are a significant public health problem due to mortality and morbidity. This study aims to examine the patients who present to the emergency department due to occupational accidents and their clinical outcomes.

Methods: In this retrospective, descriptive, and cross-sectional study, patients older than 18 who present to the emergency department of Samsun University Samsun Training and Research Hospital due to a work accident between January 1, 2020, and January 1, 2023, were included.

Data such as the sociodemographic characteristics of the patients, the mechanisms of the accidents, the season of the occupational accident, the injured anatomical regions of the patients, the clinical conditions requiring hospitalization, the hospitalized clinic, and whether mortality has developed or not recorded.

Results: Two hundred seventy patients were included in the study. 94.1% of the patients were male. There was no difference in age between men and women. Falling was the most common injury mechanism (49.3%). Extremity injuries were the most frequently injured anatomical location (51.8%). It was observed that occupational accidents occurred most frequently in summer (33.7%). Mortality developed in 2.6% (n=7) of the patients. It was determined that mortality did not develop in any of the patients admitted to the service, and the mortality rate was 13.6 % (6/44) among the patients who required intensive care treatment.

Conclusion: In this study, we determined that the injuries due to occupational accidents are primarily male and occur during the summer and fall seasons, orthopedic injuries occur more frequently, and the clinical follow-up style is essential in the outcome.

The data obtained will guide the determination of the measures that can be taken to improve occupational safety.

Keywords: Occupational injuries, emergency medicine, tertiary hospital

INTRODUCTION

Occupational accidents are a significant public health problem due to mortality and morbidity.[1] The low number of occupational accidents measures a country's development. In addition, it is noteworthy that occupational accidents have increased in our country (in Samsun/Turkiye), similar to the world, in periods other than the COVID-19 Pandemic.[2] Although there are many definitions for work accidents, there has yet to be a definite consensus on this issue. Certain conditions must be met for an event to be considered an accident at work. These are that the person is working as an insured person, the incident is related to the work and takes place in the workplace or within the period worked by the employer, the incident occurs suddenly and involuntarily, a material or moral damage occurs as a result of the incident, and there is a connection between the incident and the result.[3]

According to the 2017 data from the Center for Labor and Social Security Training and Research (CASGEM), 88% of work accidents occur due to dangerous actions, 10% due to dangerous situations, and 2% due to unavoidable situations.[4] It is known that injuries due to occupational accidents differ in terms of gender. In addition, the incidence of occupational accidents varies over periods throughout the year, and patients often suffer extremity injuries.[4]

This study aimed to obtain detailed information about the sociodemographic characteristics of patients admitted to the emergency department due to occupational accidents, the temporal characteristics of the occupational accidents, the mechanisms of injury, and the outcomes of the patients. The data obtained will guide us in determining the measures that can be taken to improve occupational safety.

METHODS

Center and Methodology of The Study

In this retrospective, descriptive, and cross-sectional study, the data of patients admitted to the emergency department of Samsun University Samsun Training and Research Hospital due to occupational accidents between January 1, 2020, and January 1, 2023. The study was carried out with the permission of the Ethics Committee of the Samsun Training and Research Hospital of Samsun University (Date: 08.02.2023, Decision No: 2023/2/3). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Formation of The Study Group

It was planned to include all patients older than 18 who presented to the emergency department due to occupational accidents. Patients younger than 18 with incomplete data were excluded from the study.

Study Protocol

Data such as mode of presentation (outpatient, ambulance, etc.), sociodemographic characteristics, mechanisms of occupational accidents, season, month and time of day of the occupational accident, anatomical regions of the patients injured, clinical conditions requiring hospitalization, duration of hospitalization, hospitalized clinic and whether mortality developed were obtained from the hospital information system and recorded.

Endpoint of The Study

The primary endpoint of our study was to identify occupational accidents presented to the emergency department and to determine the time of occurrence, mechanisms of occurrence, and outcomes.

Statistical Analysis

Obtained data were analyzed using the IBM SPSS Statistics 25 package program. Categorical variables are expressed as frequency and percentage. The mean ± standard deviation for the numerical variables that fit the normal distribution, the median (minimum-maximum) for the variables that did not fit the normal distribution; Student's t-test was used to compare numerical data with the normal distribution, the Mann-Whitney U test was used to compare data that did not fit. The Chi-square or Fisher's exact test was used to compare categorical data. All statistical tests were two-tailed, and the statistical significance level was accepted as $p<0.05$ for all analyses.

RESULTS

The study included 270 patients who met the criteria and whose information was available. Of the patients included in the study, 94.1% were male and 5.9% were female. The mean age of all patients was 40.56±11.77 years. There was no statistically significant difference between male and female patients regarding mean age (Table 1).

Table 1. Comparison of demographic data of patients

Gender, n (%)	Age (year) (mean ± SD)	p value
Male, n=254 (94.1)	40.37 ± 11.75	0.275
Female, n=16 (5.9)	43.69 ± 12.09	

The mechanism of injury and anatomical classification of the injured sites of the patients included in the study are presented in Table 2. In our study, 49.3% (n=133) of the patients were injured as a result of falls, 12.2% (n=33) as a result of sharps injuries and 10.4% (n=28) as a result of traffic accidents, resulting in 28.9% (n=78) upper extremity injuries, 21.9% (n=59) lower extremity injuries and 13% (n=35) neurosurgical injuries.

Table 2. Mechanism of injury and evaluation of injured anatomical regions

Site of injury	n (%)	Injury mechanism	n (%)
Head-neck	35 (13)	Penetrating object injury	33 (12.2)
Face	2 (0.7)	Blunt object injury	11 (4.1)
Thorax	35 (13)	Fall	133 (49.3)
Abdomen	3 (1.1)	Caught-in-machinery	12 (4.4)
Spine	10 (3.7)	Burn	22 (8.1)
Pelvis	9 (3.3)	Intoxication	5 (1.9)
Upper extremity	78 (28.9)	Lifting heavy weight	1 (0.4)
Lower extremity	59 (21.9)	Electric	9 (3.3)
Skin	8 (2.9)	Car traffic accident	28 (10.4)
Multiorgan injury	16 (5.9)	Non-vehicle traffic accident	9 (3.3)
Other	15 (5.6)	Other	7 (2.6)
Total	**n=270**	**Total**	**n=270**

Table 3 provides an analysis of the time-related factors influencing occupational accidents. Accordingly, it was observed that occupational accidents occurred most frequently in summer (33.7%), most frequently in August (11.5%), and most frequently in the evening period after 16:00 (69.6%).

Table 3. Occupational Accident Patterns Over Time

	Time of day, n (%)		
	Morning, 08:00-16:00		21 (7.8)
	Evening, 16:00-00:00		188 (69.6)
	Night, 00:00-08:00		61 (22.6)
Season	**n (%)**	**Month**	**n (%)**
Winter	61 (22.6)	December	12 (4.4)
		January	25 (9.3)
		February	24 (8.9)
Spring	52 (19.3)	March	14 (5.2)
		April	21 (7.8)
		May	17 (6.3)
Summer	91 (33.7)	June	30 (11.1)
		July	30 (11.1)
		August	31 (11.5)
Autumn	66 (24.4)	September	19 (7)
		October	26 (9.6)
		November	21 (7.8)

The follow-up patterns and outcomes of patients with occupational accidents are given in Table 4. It was seen that 9.3% of the patients who had occupational accidents were discharged from the emergency department, 74.4% were

hospitalized in the ward, and 16.3% were hospitalized in the intensive care unit. It was determined that the orthopedics branch most frequently performed ward and intensive care unit hospitalizations. In this regard, orthopedics was followed by plastic surgery. None of the patients required intensive care after hospitalization in the ward.

Table 4. Follow-up patterns and outcomes of patients in the study

Follow-up of patients (n=270)		n (%)
Discharged		**25 (9.3)**
Admitted to the service	General surgery	2 (1)
	Thoracic surgery	1 (0.5)
	Ophthalmology	2 (1)
	Otorhinolaryngology (ENT)	1 (0.5)
	Neurosurgery	5 (2.5)
	Orthopedics	149 (74.1)
	Plastic surgery	39 (19.4)
	Cardiovascular surgery	2 (1)
	Total	**201 (74.4)**
Admitted to the ICU	Neurosurgery	1 (2.3)
	Orthopedics	27 (61.4)
	Plastic surgery	15 (34.1)
	Total	**44 (16.3)**
Mortality	Mortality (-)	263 (97.5)
	Mortality in the ICU (+)	6 (2.1)
	Mortality in the ED (+)	1 (0.3)

ICU: Intensive Care Unit, ED: Emergency Department

Gender, age, length of hospitalization, and outcome characteristics of the patients according to the hospitalization location are presented in **Table 5**.

Table 5. Evaluation of patient characteristics and outcomes by hospitalization location

			Service(n=201)	ICU (n=44)	p-value
Gender	Male	n (%)	188 (82.1)	41 (17.9)	0.574
	Female	n (%)	13 (81.2)	3 (18.8)	
Age		(mean ± SD)	39.94 ± 11.46	43.39±12.58	0.077
Length of stay in hospital		Median(min-max)	3 (1-29)	3.5 (0-93)	0.173
Mortality	Mortality (+)	n (%)	0 (0)	7 (15.9)	**<0.001**
	Mortality (-)	n (%)	201 (100)	37 (84.1)	

ICU: Intensive Care Unit

Patients admitted to the emergency department due to occupational accidents were treated for 3 (1-29) days in inpatient wards and 3.5 (0-93) days in intensive care units. Mortality occurred in 2.6% (n=7) of the 270 patients in the study, one of which occurred in the emergency department and the remaining six after hospitalization in the intensive care unit. No mortality occurred in any patient hospitalized in the ward. The mortality rate among patients requiring intensive care treatment was 13.6% (6/44). The patient who died in the emergency department was a patient with multiple trauma who was brought to the emergency department with cardiac arrest. Of the 263 patients who did not develop mortality, 201 were hospitalized in the ward and 37 in intensive care unit. 25 patients were discharged after follow-up in the emergency department. There was no difference between the hospitalized patients according to the place of hospitalization (ward/intensive care unit) in terms of gender, age, duration of hospitalization and mechanism of injury (p=0.574, p=0.077, p=0.173; respectively). There was a statistically significant difference in mortality between patients hospitalized in the ward and intensive care unit (p<0.001). It was also found that all of the patients with mortality were male. Of the 22 burn patients included in the study, 45.5% (n=10) were hospitalized in the intensive care unit. Mortality occurred in 13.6% (n=3) of all burn patients and this rate was 42.8% (3/7) of all patients with mortality.

DISCUSSION

In our study, 94.1% of the participants were male, while 5.9% were female. According to SSI (Social Security Institution) data, it was reported that 588,823 people had work accidents in 2022, of which 465,769 (73.6%) were male and 123,054 (26.4%) were female. Of those injured, 1.517 (0.2%) died, 1,478 (97.4%) were male, and 39 (2.6%) were female.[5] According to NSC (National Safety Council) data, it was determined that 1,176,340 people had work accidents in the USA in 2020, and 577,990 (49.1%) of these cases were male and 585,540 (49.7%) were female.[6] According to the NSC, 103,020 people died in work-related accidents across the country.[7] In a study by Anderson et al.[8] involving 9187 patients with work accidents, 91.8% of the patients were male, and 8.2% were female. In a study by Tadros et al.[9] involving 377 work accidents in 2015, it was reported that approximately 80% were men. Although SSI data and Anderson's study show that men have more work accidents, similar to our study, NSC data show that men and women have similar rates of work accidents. 2022 According to SSI data, men who had work accidents were found to work in open areas more than women.[5] The reason for the gender difference among those who had occupational accidents in our study may be that men are more involved in business life than women, and men work in open areas relatively more. In addition, women are more likely to be unregistered workers, which may be another reason for this difference. Statistics show that men are exposed to non-fatal accidents at a higher rate than women and show that male patients are exposed to the majority of fatal occupational accidents.[5,10] There are also sources reporting that the primary explanation for this gender gap in occupational accidents in our country is gender discrimination in the labor market, as men and women usually work in different fields of work.[5,11,12]

We found that the mean age of the patients in our study was 40-45 years. In addition, we found that 53.7% of the occupational accidents in our study were in the age range of 25-44 years. Although the numerical values of the mean age were not reported in the study by Tadros et al.[9], the ages of the patients are similar to our study according to the data on the bar chart graph when the study details are examined. According to SSI and NSC data, the most common age range of occupational accidents is 25-44, and the frequency is found to be 55.3% 5, and 41,7, 6, and this information is consistent with our study. When evaluated with the current data, the age at the time of work accidents admitted to our hospital is similar to the literature data.

In the study by Tadros et al.[9], it was reported that 5 patients were referred to occupational medicine, but there was no information about hospitalization. In a study by Toolaroud et al.[13] involving 429 patients, the length of hospital stay was 10.38±10.37 days, and the length of hospital stay was longer than in our study. In the study by Nurczyk et al.[14], the duration of hospitalization was found to be 1.4 (0-203) days. Work accidents caused by burns were included in the studies by

Tollaroud et al.[13] and Nurczyk et al.[14] Burns are known to have a higher mortality and morbidity rate. Similar to the literature, in our study, almost half of all patients with mortality were burn patients.[13-15] However, the small number of patients and the number of patients with mortality prevented us from making strong comments on this subject. However, the difference in trauma mechanisms between the patients included in our study and the patient groups in the literature data may have caused this difference between our study and the literature data. In our study, there was no statistically significant difference between the length of hospitalization of the hospitalized patients and the ward in which they were treated (p=0.173). This may be attributed to the fact that patients whose intensive care treatment was completed were included in the ward hospitalization. As a matter of fact, in our study, the maximum length of stay of patients hospitalized in the intensive care unit was longer than that of ward patients.

Toolaroud et al.[13] found that 28.7% (n=123) of the patients had upper extremity injuries, 21% (n=90) had lower extremity injuries, and 19.3% (n=3) had head and neck injuries. In the Tadros et al.[9] study, 78.2% of the patients were discharged, and only 5 patients were referred to occupational medicine still, more information needed to be provided on the follow-up of patients in inpatient wards. According to SSI data, the most common mechanisms of injury were falls, slips, and loss of control of the tool used, and the most common injury sites were the upper and lower extremities (54.1%) and the head and neck region.[5] According to NSC data, it was determined that injuries occurred due to exposure to harmful substances or environments, overexertion, bodily reactions, and falls.[6] The study by Anderson et al.[8] found that musculoskeletal disorders were the most common reasons after accidents. The available data differ between studies. This is due to the differences in the fields of work between countries, sample sizes, the location of the hospital where the study was conducted, and the fact that repeating the study with a multi-center and larger sample would allow for more precise data. Our study found that patients were most frequently consulted with orthopedics and traumatology, followed by plastic surgery and neurosurgery. The fact that orthopedics, trauma, and plastic surgery departments were the most frequently consulted departments in the study by Tadros et al.[9] involving 377 patients is similar to our study. Considering the regions injured as a result of occupational accidents, it is seen that the number of consultations requested and the hospitalization data are in line with this.

Similar to our study, SSI data showed that injuries occurred most frequently in August, June and September. According to SSI data, 60.2% of injuries and according to NSC data, 35.1% of injuries occurred between 08-16:00 hours.[5,6] Anderson et al.[8] found that the most common injuries occurred in the summer and fall seasons, and the most common time of day for injuries was during working hours. There is a difference between the SSI and NSC data in the percentage of the time of day when work accidents occur. This is because 42.8% of work accidents in NSC data are not reported.[6] There is a difference between the data we obtained in our study, SSI data and NSC data in the time of day of work accidents. We believe that this is due to the fact that the time of 42.8% of work accidents in NSC data is not clearly reported, the time of presentation of the patient to the emergency room is recorded as the time of the incident, and people with minor injuries present to the emergency room after completing their working hours during the day. In addition, there are publications that fatigue and carelessness, which increase as a result of prolonged working hours during the day, increase work accidents and support our study. In addition, we think that the increase in work accidents in our country in the summer and autumn months is due to the increasing labor shortage in the construction and agricultural areas in these seasons and the employment of seasonal workers who have not received the necessary and sufficient training about the work areas.[16,17] In addition, the increase in air temperature in the summer months causes a slowdown in people's physical functions and this situation creates a ground for work accidents.[16]

In contrast to the data, we obtained in our study, mortality was found to occur in 0.2% of work accident victims according to SSI data and in 0.9% according to NSC data.[5,7] The mortality rate was 11.2% in a study of 429 patients by Toolaroud et al.[13] and 0.47% in a study of 641 patients by Nurczyk et al.[14] It is seen that the mortality data obtained in our study is higher than that of Nurczyk et al.[14] and lower than that of Toolaroud et al.[13] We can say that the mortality rate is higher than in Nurczyk et al.[14] study because the hospital where we conducted the study is a tertiary hospital, the patients admitted are complicated cases and also patients with poor general conditions who could not be solved in other hospitals are referred to our hospital. In addition, due to the small number of patients included in our study and the fact that the injuries were usually extremity-related, we may think that the mortality rate was lower than the Toolaroud et al.[13] study. We also think that this difference may be due to the sample size from which the data were obtained.

It is known that burn patients have high mortality rates. The mortality of the burn patients included in our study supports the literature.[13-15] In addition, all patients with mortality were followed up in intensive care units. However, since the statistically significant difference found in the endpoint may be due to the numerical difference between the groups, we believe that re-evaluation with more appropriate data would be beneficial.

Limitations

Since our study was retrospective, we could not obtain sufficient information about the workplaces where the accidents occurred. In addition, since our study was planned as a single-center study, the small number of patients is noteworthy. For this reason, prospective, multicenter studies with more patients will contribute more to clinicians and occupational safety specialists.

CONCLUSION

We believe that the data we obtained from this study will contribute to the prevention of occupational accidents, which is a public health and emergency department problem, and to all health professionals, especially health managers, in the clinical management of patients.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of the Ethics Committee of the Samsun Training and Research Hospital of Samsun University (Date: 08.02.2023, Decision No: 2023/2/3). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Informed Consent: All patients signed and free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declared that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Case Report

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Synchronized AVNRT attack of mother and daughter: case report

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ABSTRACT

Atrioventricular nodal reentrant tachycardia (AVNRT) is a common arrhythmia and accounts for approximately 45-65% of paroxysmal supraventricular tachycardias. Patients may present with palpitations, syncope, dizziness, nausea, or sudden cardiac arrest. Although a few studies and case reports investigate the familial and genetic features of AVNRT, these mechanisms are unclear. This report aims to present the cases of a mother and her daughter who contributed to the emergency department with simultaneous AVNRT attacks and draw attention to the familial nature of AVNRT.

Keywords: Atrioventricular nodal reentrant tachycardia, arrhythmia, supraventricular tachycardia, familial

INTRODUCTION

Atrioventricular nodal reentrant tachycardia (AVNRT) is a common arrhythmia and accounts for approximately 45-65% of paroxysmal supraventricular tachycardias.[1] The average adult heart rate is 60-100 beats/min. However, in AVNRT, this rate is usually higher than 150/min. Patients may experience palpitations, dizziness, nausea and syncope. This can even lead to a sudden cardiac arrest.[2] While the frequency of AVNRT in the general population is estimated to be 1 in 1,000 people, the probability of occurrence in 2 family members reaches approximately 1 in 1,000,000 people.[3] It is known that fast and slow nodal reentry circles play a role in the mechanism of AVNRT and can be treated with radiofrequency ablation.[4] Many previous studies have reported that familial predisposition and genetic factors are effective in many structural heart diseases and supraventricular tachycardias such as wolf parkinson white (WPW) syndrome.[2,5]

However, few studies and case reports investigate the familial and genetic features of AVNRT.[1-6] This report aims to present the cases of a mother and her daughter who contributed to the emergency department with simultaneous AVNRT attacks and draw attention to the familial nature of AVNRT.

CASE

Case 1 - Mother

A 54-year-old female patient presented to the emergency department with a sudden onset of palpitations, dizziness and nausea. In the patient's medical history, it was found that she had had similar complaints on 3 or 4 previous occasions. However, she was not diagnosed with these conditions. The patient's vital signs were blood pressure: 130/80 mmHg, pulse rate 180/min, respiratory rate: 14/min and saturation: 97%. Other system examinations were normal. The patient's 12-lead electrocardiography (ECG) showed tachycardia, a narrow QRS complex, and a standard, rapid ventricular response. This ECG was evaluated as AVNRT (**Figure 1a**).

The patient was diagnosed with AVNRT with the electrophysiological study performed later. The patient was given 6 mg adenosine intravenously. The patient, who returned to sinus rhythm and no pathology was observed during follow-up, was discharged with recommendations (**Figure 1b**).

Case 2 - Daughter

A 19-year-old female patient came to the emergency department with her mother. She had no active complaints when she arrived. During the follow-up (probably due to emotional stress), palpitations, dizziness and weakness occurred. It was learned that the patient had previously received radiofrequency ablation treatment for AVNRT but had fewer attacks after treatment. Vital signs of the patient were blood pressure: 120/70 mmHg, pulse: 175/min, respiratory rate: 13/min, saturation: 97% was measured. Other system examinations were normal. ECG showed regular tachycardia with narrow QRS and rapid ventricular response. The patient's history and ECG findings were evaluated as AVNRT (**Figure 2a**).

The patient was given 6 mg adenosine intravenously. Sinus rhythm was obtained, no additional pathology was found during follow-up, and the patient was discharged with her mother with recommendations (**Figure 2b**).

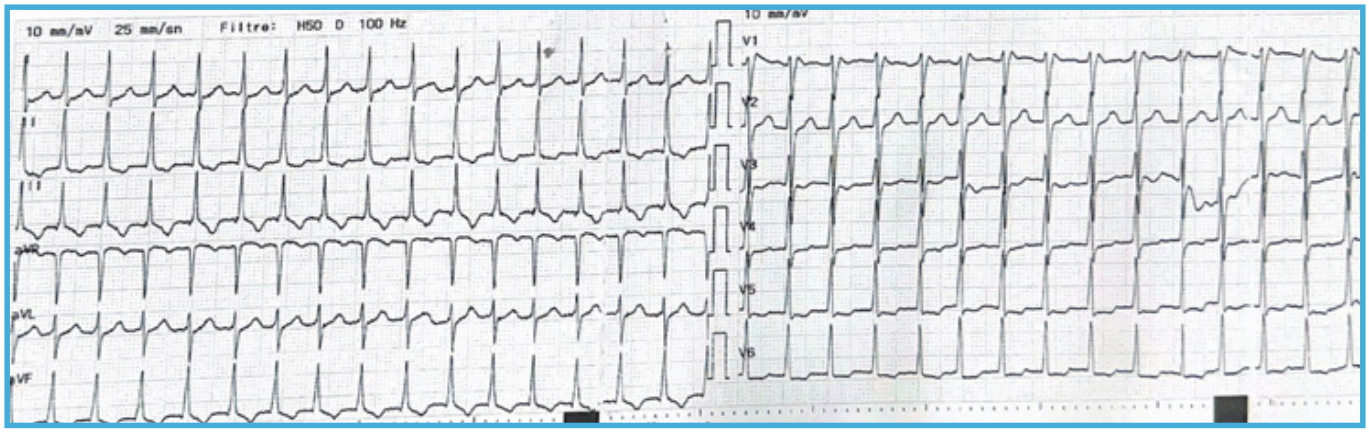

Figure 1a. Mother's 12 lead ECG: supraventricular tachycardia (probably AVNRT). Narrow rhytmic QRS complexes. Rate about 180. There is no P wave before QRS. There are P waves after QRS complexes at V1-3 leads

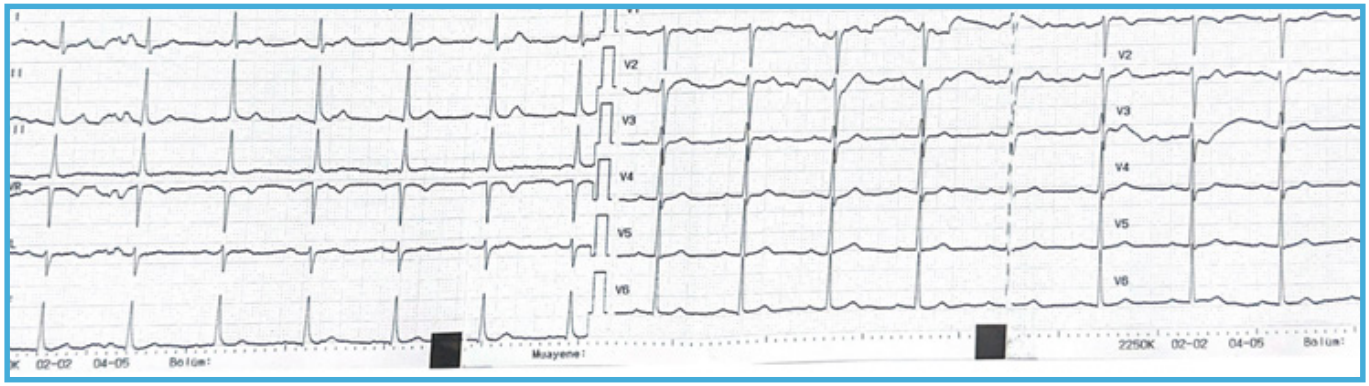

Figure 1b. Mother's second ECG after adenosine administration. It shows normal sinus ryhthm

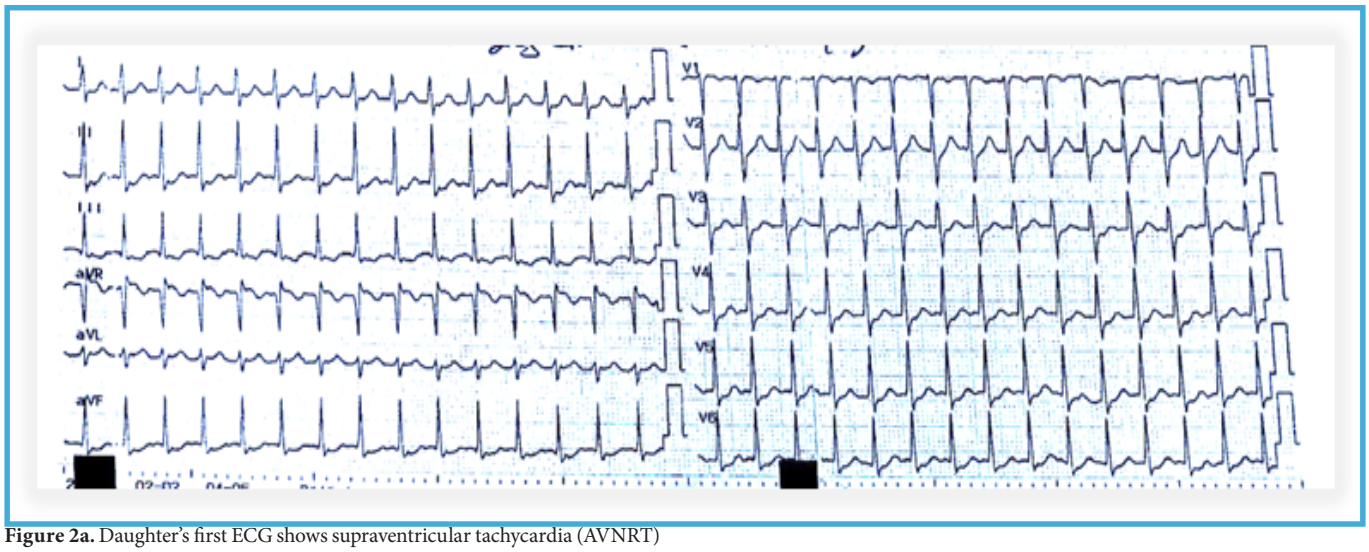

Figure 2a. Daughter's first ECG shows supraventricular tachycardia (AVNRT)

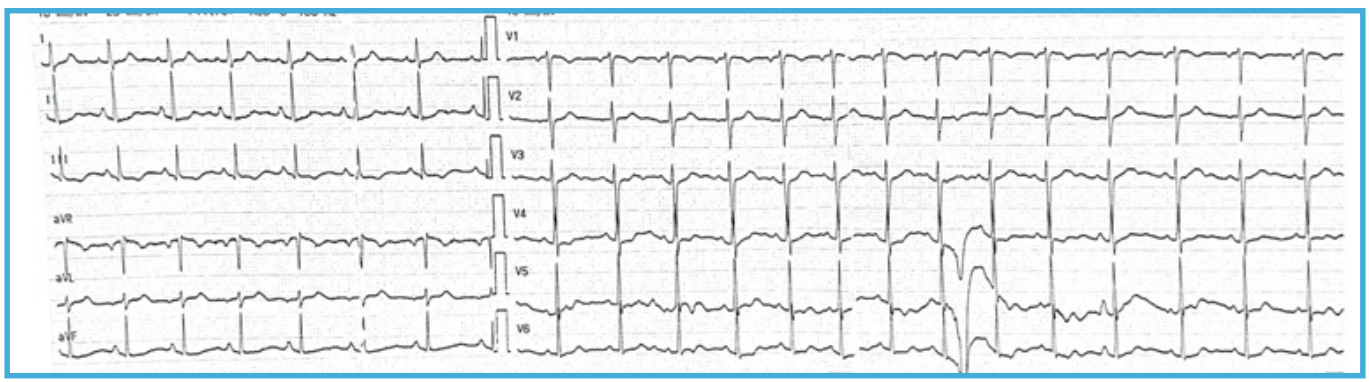

Figure 2b. Daughter's second ECG after adenosine administration

DISCUSSION

Until recently, paroxysmal supraventricular tachycardia caused by AV accessory pathways or dual AV node physiology was attributed to randomly occurring congenital anomalies of pathological substrates from birth.[7] Various responsible mutations in the autosomal dominant PRKAG2 gene have been identified for WPW syndrome, a common cause of supraventricular tachycardia.[8] However, the genetic and familial characteristics of AVNRT are not precise. There are limited studies and case reports on this subject in the literature.

A previous study conducted in Poland reported a familial relationship in 2.91%-4.02% of patients with AVNRT.[1] In another study conducted in 2022, the pathological gene was tried to be identified in sporadic and familial AVNRT cases. This article reports that three possible pathological genes (TRDN, CASQ2 and WNK1) may be responsible for domestic AVNRT cases.[2] Another study said that genes such as SCN1A, PRKAG2, RYR2, CFTR, NOS1, PIK3CB, GAD2 and HIP1R are probably responsible for AVNRT.[4] Further studies are needed to elucidate the genetic pathologies and familial characteristics responsible for AVNRT.

When the literature is reviewed, few case reports are related to familial AVNRT. The mother and son presented in 2012[6] who were diagnosed with ANVRT, and the father and two sons gave in 2017[7] can be shown among these. This case report mentioned a mother and her daughter diagnosed with AVNRT and presented to the emergency department with a simultaneous attack. This is the first case of familial AVNRT presenting with simultaneous attacks in the literature.

CONCLUSION

Although familial and genetic aspects are unapparent, this case report supports that AVNRT may be familial and genetic. It is important to remember that relatives of patients who present to the emergency department with an AVNRT attack may also have an AVNRT attack, which may be triggered by emotional stress. Additionally, genetic studies are needed to clarify the genetic and familial features of AVNRT.

ETHICAL DECLARATIONS

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Case Report

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Treatment with direct thrombolytic infusion via mesenteric catheter and thrombectomy in superior mesenteric vein thrombosis due to synthetic drug use

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ABSTRACT

Mesenteric vein thrombosis (MVT) is a rare cause of acute abdomen and accounts for only 5-15% of all acute mesenteric ischemia cases. Symptoms usually begin with nonspecific abdominal pain. Progressively increasing abdominal pain is often accompanied by nausea, vomiting and bloody diarrhea. As the cases usually present with nonspecific symptoms, diagnosis and treatment may be delayed. Anticoagulation, hydration, use of antibiotics, thrombolysis, thrombectomy, and bowel resection are included in the treatment of MVT. We aimed to present a case with a complaint of abdominal pain who underwent interventional thrombectomy and thrombolysis with the diagnosis of superior MVT.

Keywords: Mesenteric vein, venous thrombosis, intervetioanal radiology

INTRODUCTION

Mesenteric vein thrombosis (MVT) is a rare cause of acute abdomen and accounts for only 5-15% of all acute mesenteric ischaemia cases. MVTs are classified as either primary MVT, in which the underlying cause can not be determined, or secondary MVT, in which the etiology can be determined. Symptoms usually begin with nonspecific abdominal pain. Progressively increasing abdominal pain is often accompanied by nausea, vomiting and bloody diarrhea. In severe cases, sepsis and septic shock are seen. As the cases usually present with nonspecific symptoms, diagnosis and treatment may be delayed. Despite advanced diagnostic techniques, high mortality rates are seen. We aimed to present a case with a complaint of abdominal pain who underwent interventional thrombectomy and thrombolysis with the diagnosis of superior MVT.

CASE

A 24-year-old male patient was admitted to the emergency room with severe abdominal pain in September 2022. The patient who had no comorbidities in his anamnesis and used different types of oral synthetic drug tablets, frequently methamphetamine. But he had not used drugs for about 1 month and his abdominal pain had increased in the last few months. In addition to the pain, there was diarrhea that had been going on for a while. The patient was referred to the Interventional Radiology Department following detection of thrombus in the superior mesenteric vein (SMV) and bowel loop edema by Doppler ultrasonography. On physical examination, rebound and defense were not detected, but bowel sounds were hypoactive. He had no gas or feces output in the last 24 hours. Body temperature was 37.2˚C. Laboratory findings were: leukocyte: 8000/mm3 (neutrophil 67%), hemoglobin:11.4g/dL, CRP: 176mg/L, D-Dimer:37.86, APTT:25.2, INR:1.18, prothrombin time:14.3. The patient's hematological tests performed during hospitalization were negative for thrombophilia which may predispose the patient to thrombosis. Contrast-enhanced triphasic computed tomography (CT) was performed and no serious necrosis was observed in the intestines (**Figure 1**).

Lack of enhancement outside the bowel wall suggests venous thrombosis rather than arterial thrombosis. There was no obvious bowel necrosis in the CT images and no rebound or defense was detected in the physical examination.

He was transferred to the Interventional Radiology Unit for transhepatic pharmacomechanical mesenteric vein thrombectomy. A portal vein puncture was carried out on the patient's liver via a 21G needle under local anesthesia, ultrasonography, and scopy. The main portal vein was successfully accessed using a cruiser set and an infusion catheter was inserted (**Figure 2**).

Despite infusion of 0.5 mg/hour tissue plasminogen activator (tPA) for 24 hours, there was still abundant thrombus on venography which showed that the thrombus was chronic (**Figure 3**). Later, mechanical thrombectomy was performed to remove chronic thrombi. Mechanical thromboaspiration was performed using an 8F catheter for approximately two hours, followed by an additional eight hours of thrombolysis and thrombectomy. This led to opening of the trunk portion of the SMV, but the majority of the side branches remained occluded (**Figure 4,5**). The portal vein of the patient was occluded using a coil to avoid complications arising from the administered anticoagulants and medical thrombolysis agents.

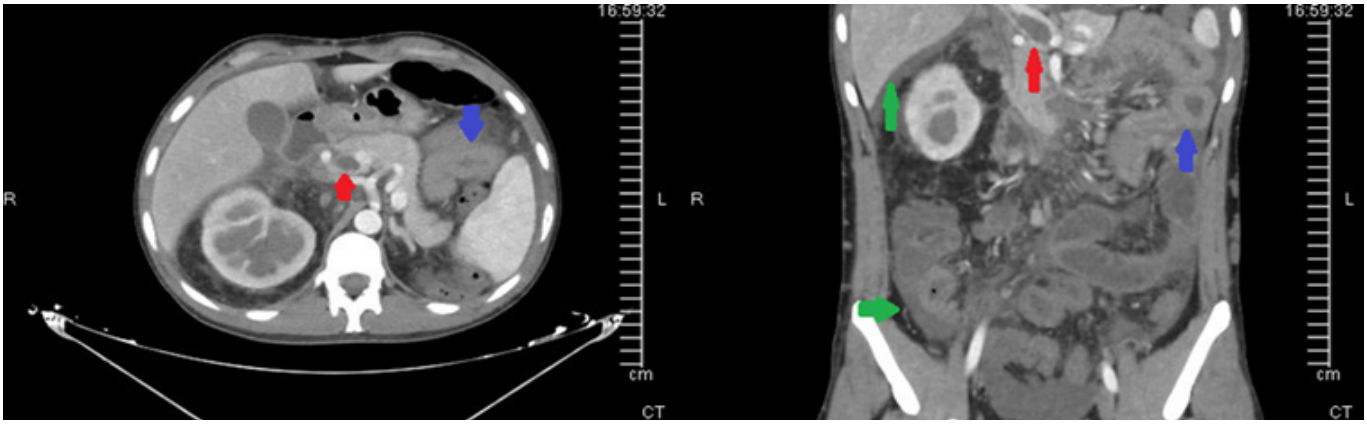

Figure 1. Portal venous phase CT shows thrombus in the SMV truncal segment (red arrow), edema and contrast uptake in the intestinal wall (blue arrow), minimal free fluid (green arrow)

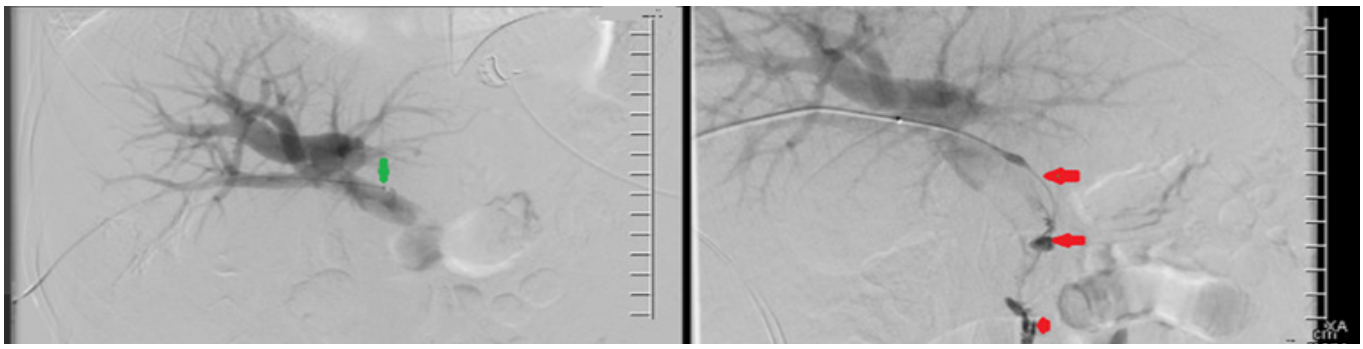

Figure 2. Portal vein is not thrombosed (green arrow). Thrombosed SMV visualized with contrast administered through the inserted infusion catheter (red arrow)

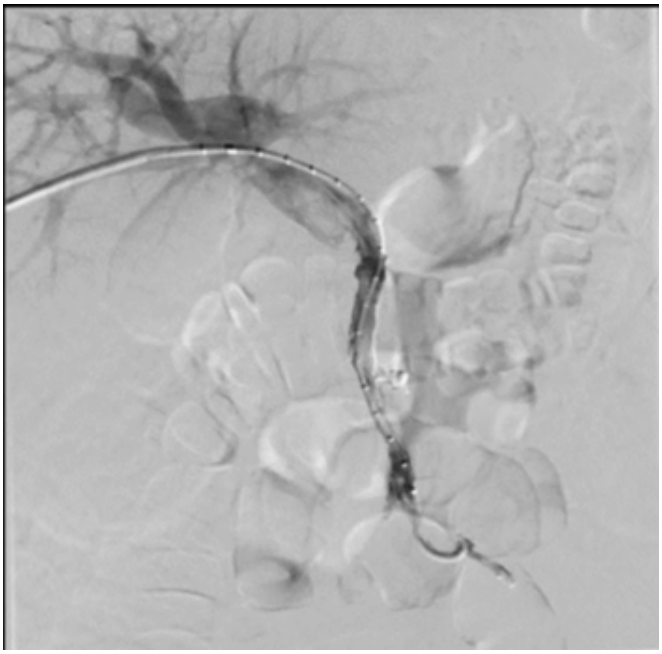

Figure 3. Imaging after 24 hours of tPA infusion shows thrombus in the SMV

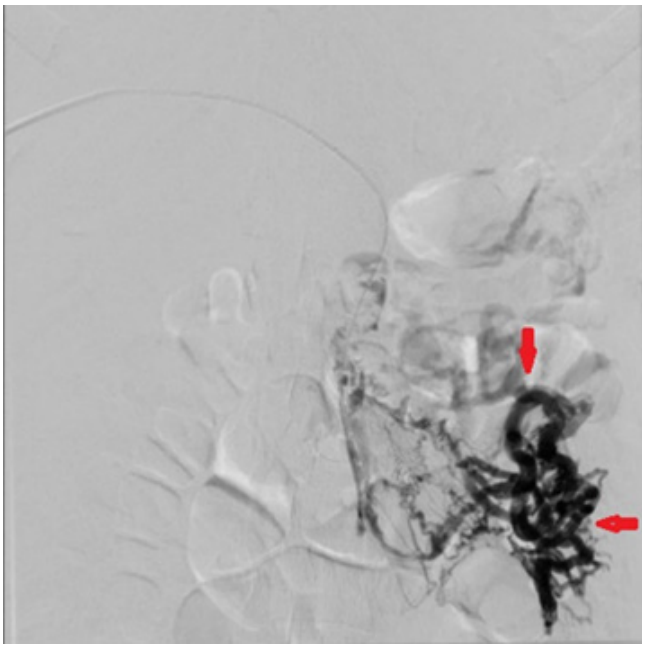

Figure 4. Patency of distal mesenteric vein branches on venography

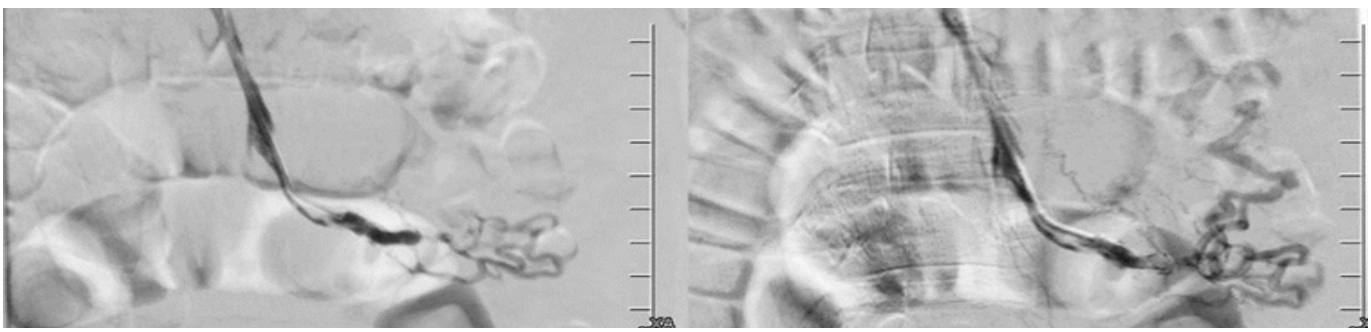

Figure 5. SMV venography after 2nd thrombectomy

In the follow-up of the patient, 2x8000 IU Enoxaparin was used daily. In abdominal CT, chronic thrombus was still observed in the SMV, but partial passage was achieved. The patient's gas and fecal output began. It was ordered to give oral anticoagulants for at least 6 months.

DISCUSSION

The incidence of MVT is approximately 2.0-2.7 per 100,000 people per year and the 5-year survival rate is 70-82%.[1] It is divided into two: idiopathic (primary MVT) and secondary MVT. MVT can occur acute, subacute or chronically. Acute mesenteric vein thrombosis (MVT) is a severe clinical condition where thrombosis occurs in the mesenteric veins along with bowel ischemia. It was initially reported in 1935 in a patient who underwent surgery for acute intestinal ischaemia.[2] Acute MVT, responsible for approximately 5-15% of acute mesenteric ischemia, has a better clinical course than arterial occlusions.[3] The average age of MVT patients is 45-62 years. There is no difference in the incidence between men and women.[1] Our patient was 24 years old, which is considerably younger than the average age reported in the literature.

Early diagnosis of MVT is difficult due to non-specific physical examination and laboratory findings. Clinical suspicion is necessary for rapid diagnosis. Progressive abdominal pain is the most common symptom of MVT. Other symptoms include nausea and vomiting, fever, hematochezia, hematemesis, lack of gas or stool passage, and diarrhea. The time to onset of symptoms in MVT is usually 24-72 hours, and subacute MVT symptoms continue for days or weeks.[4,5] On physical examination, abdominal tenderness is observed in 80% of the cases. Signs of peritonitis are observed in 10%, and blood is observed on rectal examination in 23%.[4-7]

Laboratory findings reveal metabolic acidosis, leukocytosis, elevated lactate levels and increased D-dimer values.[8] A progressive abdominal pain was seen over the months in our patient. At the time of admission to the hospital, there was no gas or fecal output for the 24 hours. In the physical examination, bowel sounds were hypoactive, and rebound or defense was not detected. There was no leukocytosis in laboratory results. However, CRP and D-dimer levels were high.

Imaging techniques are important in the diagnosis of MVT. Contrast-enhanced CT is the standard imaging method for identifying MVT. However, CT angiography is the most sensitive method.[9,10] The imaging protocol includes both arterial and portal venous phases. Administration of oral contrast should be avoided as it may mask the enhancement in the intestinal Wall. An occlusive embolism or thrombus occurs when an arterial vessel suddenly fails to opacify and is called a "vessel cut sign". Superior mesenteric artery (SMA) thrombosis or embolism is a highly specific finding in a patient with clinically suspected acute mesenteric ischemia (AMI). MVT, appears as no opacification or intraluminal filling defects in the mesenteric vessels. Non-occlusive thrombus typically presents as a filling defect.[11] While the sensitivity of CT in the diagnosis of acute MVT is 100%, it has been reported to be 93% in chronic MVT.[9] Non-vascular CT Finding; pneumatosis intestinalis and portomesenteric venous gas, changes in bowel wall thickness, decreased or absent bowel wall enhancement, bowel luminal dilation, mesenteric fat stranding and ascites, pneumoperitoneum.[11] Other imaging methods include abdominal Doppler ultrasonography and Magnetic Resonance Imaging, but they do not have any superiority over CT. In our patient, Doppler ultrasonography revealed SMV thrombus and edema in the bowel loops.

Despite advanced diagnostic methods, a mortality rate of 15-40% has been reported in the literature due to delays in diagnosis of MVT.[9,12] If MVT is not treated early, mortality and morbidity become greater.[13,14] Heparinization is the main treatment option for thrombolysis treatment, and early heparinization has been shown to delay disease progression and recurrence significantly.[15] In addition to anticoagulant treatment, tPA is also an option. Thrombolytic treatment can be lifesaving, especially in early diagnosed and symptomatic cases. It may obviate the requirement for bowel resection or facilitate treatment with a shorter segmental resection. Today, transcatheter tPA infusion is preferred instead of intravenous tPA infusion in mesenteric and portal vein thrombosis. Percutaneous or transhepatic thrombolytic therapy is suggested when anticoagulation therapy does not seem to be efficient or in cases where there is no evidence of intestinal ischemia. Slow tPA infusion directly into the thrombus, in combination with interventional radiology techniques, considerably enhances the treatment's efficacy.[3,7,16,17] Liu et al.[18] found that the effectiveness of direct injection of a thrombolytic agent into the catheter in 46 patients with portal vein and SMV thrombosis significantly improved the thrombolytic effect and reduced associated bleeding complications. In our case, tPA infusion was performed via the infusion catheter after the cruiser set was placed into the main portal vein. No complications, such as bleeding, hematoma, infection or embolism were observed.

Surgical complications include short bowel syndrome, wound infection, sepsis, pulmonary embolism and gastrointestinal bleeding. It has been reported that within 6 weeks after surgical resection, 14% of patients may experience a recurrence of MVT.[19] In our case, there were no signs of peritonitis on physical examination, and no non-contrast-enhancing area on the bowel wall that would suggest bowel ischemia was detected on CT images. Surgery was not considered because gas and feces passage began after thrombectomy. In recent years, interventional radiological treatment has been popular for MVT. With interventional treatment, the length of hospital stay can be considerably reduced, recovery can be accelerated and the vessels of the infarcted intestinal tract can be repaired within a short time.[20] The incidence of acute renal failure, lung failure and death is lower in interventional treatment compared to surgical treatment. As a result, prognosis improves significantly with radiological interventional treatment.[21] In our patient, the SMV occlusion was almost completely opened with interventional treatment and no surgery was required.

In our case, since the cause of thrombus could not be explained by laboratory markers, history of synthetic oral drug use was the most likely risk factor for SMV thrombus. It suggests that chronic MVT is caused by the prothrombogenic effect of the synthetic drug. Successful treatment was achieved without the need for surgery by rapid diagnosis and interventional methods, with serial tPA infusion through the catheter followed by thrombectomy.

CONCLUSION

Early diagnosis and rapid initiation of treatment are the main reasons affecting mortality and morbidity in MVT. Direct injection of a thrombolytic agent into the portal vein and SMV with a catheter significantly improves the thrombolytic effect and reduces associated bleeding complication. We recommend that early interventional treatment as it reduces mortality and morbidity in MVT cases.

ETHICAL DECLARATIONS

Informed Consent: The patient signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declared that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Case Report

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Rapidly developing massive thromboembolism and death due to anticoagulant dose reduction in a patient with atrial fibrillation: Case Report

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ABSTRACT

Atrial fibrillation is one of the cardiac arrhythmias that can cause fatal complications. Patients diagnosed with atrial fibrillation face complications such as ischemic stroke, peripheral vascular embolism and pulmonary embolism if they are not under regular and strict treatment follow-up. In this case, in a 73-year-old woman with atrial fibrillation who was not receiving regular treatment, sudden onset of leg pain followed by rapid onset of dyspnea was clinically suggestive of acute peripheral arterial embolism followed by massive pulmonary embolism. The patient was tachypneic and confused at the time of presentation to the emergency department. After intubation with sedation and analgesia, radiologic imaging was obtained for possible complications secondary to atrial fibrillation. As a result, the patient had an embolus starting from the level of the abdominal aorta, extending to the right renal artery and spreading to the entire right iliac artery. The lung tissue showed bilateral acute lung injury without pulmonary embolism. In this case, we wanted to emphasize the importance of the subject by sharing the rapidly developing embolism and death process with the reduction of the anticoagulant dose used in the treatment of atrial fibrillation.

Keywords: Warfarin, embolism and thrombosis, atrial fibrillation

INTRODUCTION

Clinically, atrial fibrillation is the most common type of arrhythmia to be treated. Diseases such as hypertension, diabetes mellitus, chronic obstructive pulmonary disease and chronic renal failure, especially coronary artery disease, valvular heart disease and heart failure may also lead to the development of atrial fibrillation.[1] Atrial fibrillation is one of the most important factors causing acute peripheral vascular embolism. Acute pulmonary thromboembolism, ischemic stroke and myocardial infarction are the most mortal complications of peripheral vascular embolism.[2] In this case report, we describe a patient with atrial fibrillation who developed sudden onset of leg pain followed by rapidly developing dyspnea and syncope days after the dose of warfarin was reduced, which resulted in death in a short period of time.

CASE

A 73-year-old woman was brought to the emergency department by ambulance with complaints of sudden onset of leg pain followed by shortness of breath and fainting. When the patient arrived, her general condition was assessed as moderate-poor, consciousness was confused and GCS (Glasgow Coma Scoring) score was 9. When the vital values of the patient were examined, fever was 36.7ºC, pulse rate was 140/minute, blood pressure was 90/50 mm/Hg, and oxygen saturation was 78. The patient's fingertips appeared cyanotic. There was no pulse in the right lower extremity and circulatory disturbance was observed. The patient was intubated with sedoanalgesia and connected to a mechanical ventilator. The patient's medical history included hypertension, diabetes mellitus, coronary artery disease and atrial fibrillation in the heart rhythm. The patient was diagnosed with atrial fibrillation five months ago. The patient was regularly taking a single daily dose of warfarin 5mg/day, but the dose was changed to 2.5 mg/day after the INR control value was 5.8 one week ago. According to the statement of the patient's relatives, the patient had been taking her medication regularly at a dose of 2.5 mg/day for one week. Approximately two hours before he was admitted to the emergency department, she suddenly developed pain in her leg and shortness of breath started in the following period. The ambulance was then called after he suddenly lost consciousness. Laboratory tests revealed white blood cell count: 17.99 x 10^3/mm^3, hemoglobin: 15.1 g/dl, platelets: 367 103/mm^3, blood glucose level:466 mg/dl, troponin T: 61.1 ng/dl, D-dimer: 19682 ng/dl, PT: 15.4, PTT: 39.3 and INR level 1.06. Other biochemical values were within normal range. In the arterial blood gas evaluation of the patient receiving oxygen support, pH: 6.76, pCO2: 55.4 mmHg, pO2: 74.1 mmHg, HC03: 5.9 mmol/L, lactate: 1.35 mmol/L and deep metabolic acidosis was observed.

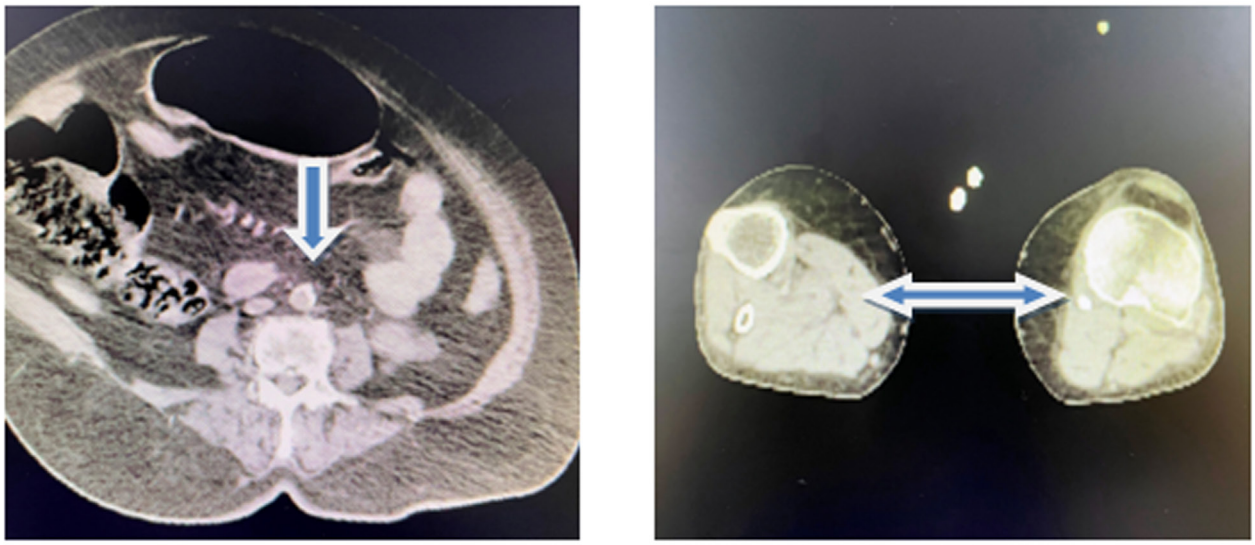

Figure 1. Embolism seen at the level of the abdominal aorta and the right lower extremity in the computed tomography angiography image

Computerized brain tomography image was first obtained from the patient. Subsequently, arterial phase imaging was performed in the computerized tomography (CT) scanner to visualize the pulmonary vessels, abdominal aorta and peripheral lower extremity arteries using contrast material. Diffusion MR imaging was also performed to rule out unconsciousness in the patient who had no pathologic findings on brain CT. As a result, the patient had embolism starting from the level of the abdominal aorta, extending to the right renal artery and extending to the entire right iliac artery (**Figure 1**). Posteroanterior chest radiography and computed tomography of the thorax showed diffuse ground-glass density in both lungs (**Figure 2**).

Echocardiography was performed and revealed biatrial dilatation and severe mitral and tricuspid valve insufficiency. There was no evidence of pulmonary embolism on echocardiography. The patient was admitted to the intensive care unit for follow-up and treatment. High dose positive inotropic support was given. In the following period, the patient was operated by the cardiovascular surgery clinic. After the operation, the patient's hypotension and respiratory failure symptoms deepened and the patient died. The patient's death occurred approximately 20 hours after the onset of clinical findings.

DISCUSSION

Acute peripheral arterial embolism has an important place in patient morbidity and mortality with complications that threaten limb survival and may also develop. Other accompanying comorbid diseases also affect the clinical course.[3] In this case, the INR value was 5.8 one week ago and decreased to 1.06 after halving the daily dose of warfarin. We found that warfarin use was not effective and the INR value was not in the therapeutic range (2.5-3.5). The patient's D-dimer level of 19682 ng/dl (200-400 ng/dl) was quite high, suggesting that massive thromboembolism might develop. According to the blood gas analysis obtained with oxygen support on admission, the patient had profound metabolic acidosis, suggesting that tissue breakdown was extremely rapid. In the light of the anamnesis, physical examination and laboratory findings, imaging studies were performed considering the possibility of massive thromboembolism. In this case, we first thought that it would be massive pulmonary embolism. However, we found that there was an embolism starting from the level of the abdominal aorta, extending to the right renal artery and extending to the entire right iliac artery, and bilateral tissue damage developed in the lung without pulmonary embolism.

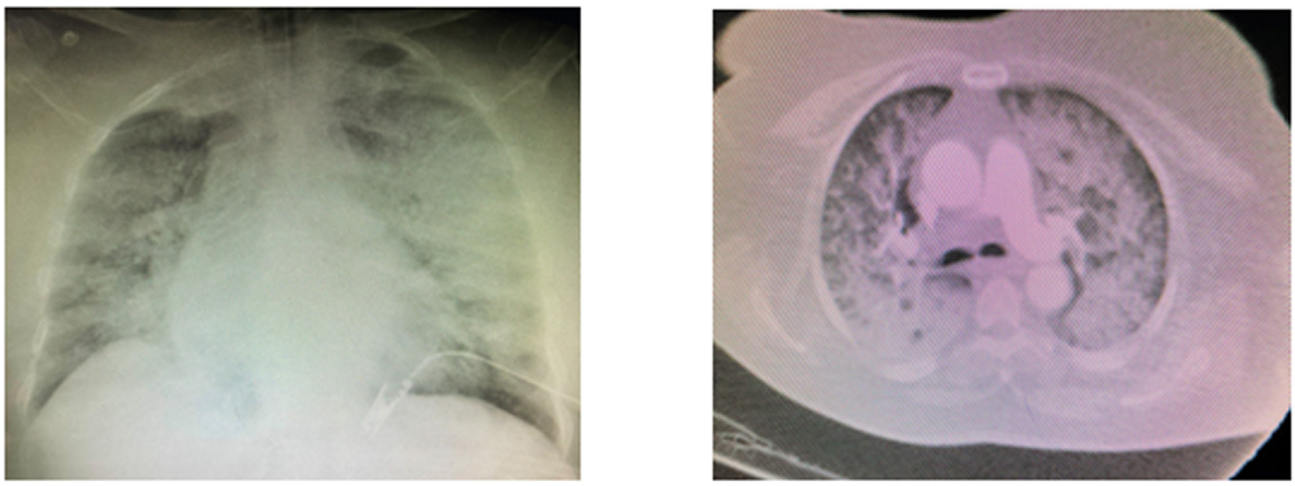

Figure 2. Diffuse ground-glass density image on posteroanterior chest radiography and computed tomography angiography

Surgical intervention within 8-12 hours from the onset of symptoms is an important part of arterial embolectomy and is defined as the ideal time for success.[4] In this case, although the patient's unstable vital signs prolonged the duration of the surgical operation, the patient was taken into operation approximately ten hours after arrival under supportive treatment.

Atrial fibrillation is the most common rhythm disorder that has been characterized as permanent in recent years.[5,6] Atrial fibrillation is a progressive disease and is often accompanied by other systemic diseases. Although there is no clear treatment protocol yet, the aim should be to reduce cardiovascular mortality and morbidity. In this regard, the main focus should be on preventing thromboembolic diseases and reducing hospitalizations. The two main elements in treatment are control of ventricular rate by ensuring sinus rhythm and prevention of thromboembolic events.[7]

Warfarin treatment is the most effective method to prevent thromboembolism. In a meta-analysis, the relative risk reduction in all ischemic stroke cases was found to be significant at 64%, corresponding to an absolute annual risk reduction of 2.7%.[8] Similar to our case, according to the case report of Coutrot et al.[9], in an elderly patient admitted to the hospital with epistaxis and on warfarin for atrial fibrillation, the INR level was measured as >10 and after repeated vitamin K treatment, the INR level was <2. Subsequently, it was observed that the patient suddenly developed massive pulmonary embolism.Similarly, in another case, a 56-year-old male patient presented to the emergency department with complaints of dyspnea and chest pain as well as pain and swelling in both legs. Although the patient was taking warfarin at a therapeutic dose since he had undergone aortic valve replacement, pulmonary embolism developed.[10]

CONCLUSION

As seen in the case examples and in our case, anticoagulant use and dose adjustment in patients with atrial fibrillation and risk of embolism is a very challenging task and fatal complications are inevitable. The dose of warfarin is extremely important and regular use and careful attention should be paid to the use of drugs and food consumption that may interact with it. We concluded from this case that the INR control period should be shorter and more controlled during the process of dose reduction.

ETHICAL DECLARATIONS

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declared that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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