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Management of Arrhythmias in COVID-19

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Abstract

Coronavirus disease-2019 (COVID-19) disease is caused by severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) virus infection and firstly appeared in China and then became a pandemic. The leading cause of mortality is respiratory failure in COVID-19; however, cardiovascular manifestations are frequent and also important causes of death in COVID-19. The incidence of arrhythmia is increased in patients with COVID-19 due to increased systemic inflammatory response, hypoxia, and administered drugs. All kinds of arrhythmias, including bradyarrhythmias, supraventricular and ventricular arrhythmias, may develop during COVID-19 course. QT prolongation plays a central role in COVID-19 related arrhythmias. Therefore, QT duration should be strictly followed. All the clinicians should know the management of arrhythmias that they might face with frequently during the pandemic.

Keywords: COVID-19, cardiac arrhythmia, QT prolongation

Introduction

Coronavirus disease-2019 (COVID-19), firstly appeared in China and led to the pandemic. There is a significantly increased risk of the development of arrhythmias in COVID-19 due to increased inflammatory response, direct myocardial viral infection, and administered drugs (1). Cardiac arrhythmias are one of the leading causes of mortality in COVID-19. The incidence of cardiac arrhythmias is reported as 19.6 % in hospitalized patients, while it rises to 44.4 % in patients who needed intensive care unit (ICU) admission. Palpitation was the first symptom of COVID-19 in 7.3% of the patients (2). Cardiac arrhythmias were reported in 25.9% of the patients, and most of them were supraventricular arrhythmias in a single-center retrospective study from China (3). Another study from the USA said that; cardiac arrhythmias developed in 7.5% of the cases, and the most common arrhythmia was atrial fibrillation (3.5%). Bradyarrhythmias occurred in 1.2% of the patients and ventricular arrhythmias developed in 1.4% of the patients with COVID-19 (4).

Several mechanisms are responsible for arrhythmia development in COVID-19. Direct viral infection and inflammatory response cause myocardial damage, which may present with chest pain and myocarditis or detected by increased cardiac biomarkers in asymptomatic cases. COVID-19 related lung involvement leads to hypoxemia. Additionally, COVID-19 may cause gastroenteritis and diarrhea, which may result in electrolyte imbalance such as hypokalemia. Drugs used to treat COVID-19 may induce arrhythmogenesis via both causing prolongation of QT duration and affecting microsomal liver enzymes, which play the primary role in the metabolism of certain medications that may affect QT interval (2). Increased inflammatory response changes the configuration and distribution of ion channels located on the myocardial cell membranes and lead to increased action potential duration (5). To summarize, the incidence of cardiac arrhythmias is increased in COVID-19 due to several mechanisms.

Management of Atrial Arrhythmias in COVID-19

In a study with 115 COVID-19 patients in the United Kingdom (6), atrial arrhythmias developed in 19 (16.5%) patients. Twelve patients had atrial fibrillation (AF), six patients had atrial flutter, and one patient had focal atrial tachycardia. It is expressed that all of the patients with atrial arrhythmias were ICU admission requiring patients. Increased age, higher C-reactive protein (CRP), and D-dimer values were defined as risk factors for the development of atrial arrhythmias. BNP and troponin levels were similar between patients with and without atrial arrhythmias.

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The need for mechanical ventilation was established as a strong predictor of atrial arrhythmia development possibly due to hypoxia driven arrhythmogenesis. It has been reported that the use of hydroxychloroquine, azithromycin, and remdesivir were similar between cases with and without atrial arrhythmias. Intravenous amiodarone was administered in nine patients, and conversion to sinus rhythm was achieved in seven patients. Electrical cardioversion was applied to one patient. Five cases with atrial arrhythmias have died during treatment (6).

Thromboembolic events are frightening manifestations of atrial fibrillation. Therefore, the need for anticoagulation should be evaluated in patients with AF. The SARS-CoV-2 virus infects endothelial cells and induces thrombogenesis, so thromboembolic event risk is increased in patients with COVID-19. CHADS-VASc score is developed to estimate thromboembolic risk in AF, and CHADS-VASc score ≥2 in males and ≥3 in females is an indication for anticoagulation. However, due to an increased tendency to thrombosis in COVID-19, the administration of anticoagulant treatment should be considered in males with CHADS-VASc score ≥1 and in females with CHADS-VASc score ≥2 (7). Possible drug interactions should be assessed before the choice of anticoagulant drugs. Direct-acting oral anticoagulants can be used, and the dose of drugs should be accommodated by age, weight, and glomerular filtration rate. Parenteral anticoagulation should be administered in intubated patients. It should be kept in mind that unfractionated heparin should not be used with azithromycin due to drug interaction (7). Administration in a crushed form (e.g., via a nasogastric tube) does not alter the bioavailability of apixaban, edoxaban, and rivaroxaban while dabigatran capsules must not be opened, as it would result in a 75% increase in the drug bioavailability (8,9).

Rate control should be the preferred strategy instead of rhythm control in patients with COVID-19 due to increased arrhythmia recurrence rates unless the patient's hemodynamic parameters are unstable. Antiarrhythmic drugs should be discontinued because of the potential adverse effects, including QT prolongation. If the patient is hypotensive or in cardiogenic shock, electrical cardioversion should be performed urgently. Beta blocking agents should be preferred rather than digoxin or calcium channel blockers in rate control due to having less potential for drug interactions. After the completion of COVID-19 treatment; patients should be re-assessed for rhythm control (7).

Management of Ventricular Arrhythmias in COVID-19

The incidence of ventricular arrhythmias is reported as 5.9% in patients with COVID-19. Ventricular arrhythmias mainly occur in patients with higher troponin levels, and inflammatory biomarkers (10). The prolongation of QT interval plays a significant role in the development of ventricular arrhythmias (11). All of the reversible conditions that facilitate arrhythmogenesis should be corrected. Hypoxemia, acid-base, and electrolyte disorders should be treated. Potassium levels should be kept over 4.5 mEq/L (7). The dose of parenteral vasopressors should be minimized. Fever should be treated with paracetamol.

Defibrillation should be performed emergently in ventricular fibrillation, and direct current cardioversion (DCCV) should be done in unstable sustained ventricular tachycardia (VT).

Treatment algorithm in patients with sustained monomorphic VT;

- If the patient is intubated and under sedation, DCCV should be considered.
- If the patient is hemodynamically unstable, DCCV should be considered.
- In hemodynamically stable patients;
- Intravenous (IV) procainamide or lidocaine should be preferred if the patient is under treatment with drugs which may cause QT prolongation.
- IV amiodarone should be considered if any of the following conditions present; ongoing VT despite IV procainamide or lidocaine, underlying structural heart disease, or decreased left ventricular systolic functions. It should not be forgotten that amiodarone has a QT-prolonging effect itself.
- Amiodarone should be the preferred agent in critically ill patients and cases with recurrent VT/ventricular fibrillation (VF). QT interval must be strictly controlled during the treatment to prevent from QT prolongation. Lidocaine can be an alternative in suspicion of underlying myocardial ischemia.
- IV beta-blocker (esmolol), general anesthesia or overdrive pacing with a temporary transvenous pacemaker should be considered in patients unresponsive to antiarrhythmic drugs (7).

Torsades de Pointes (TdP) is defined as polymorphic VT that develops on the underlying prolonged QT. Drugs used in the treatment of COVID-19 may cause QT prolongation. Therefore, other conditions that lead to QT prolongation, such as bradycardia, deteriorated kidney functions, and electrolyte disorders, should be evaluated and treated. QT interval should be followed strictly (7).

D2 or V5-6 derivations should be preferred for measuring the QT interval. Consequent QT intervals should be measured, and the longest measurement should be recorded. QT interval should

be corrected according to the heart rate. The Bazzett formula is the most commonly used correction formula, and it estimates corrected QT via dividing QT duration (millisecond) to the root mean square of the RR interval duration (second). Normal values of corrected QT (QTc) is <440 msec for men and <460 msec for women. Values of >500 msec are associated with an increased risk of TdP development. Bigger U waves (>1 mV) or U waves adjacent to T waves should be added to the QTc measurement while small U waves or u waves separate from the T wave should not be added in the analysis (12). QTc interval is prolonged in patients with a cardiac pacemaker and pace rhythm or patients with bundle blocks; therefore, 50 msec should be subtracted from the measured QTc value in these cases. One previous study recommended that, in the presence of a left bundle branch block, 70-ms subtraction rule may be employed for QTc estimation, respectively, though 40-ms subtraction may be used in the presence of a right bundle branch block (13). The measurement of QTc is summarized in Figure 1.

Baseline electrocardiography (ECG) should be performed before starting treatment. If baseline QTc interval <480 msec, control ECG should be performed three days later. If the QTc interval is approximately 480-499 msec, ECG should be performed daily, and telemetric follow-up might be considered in conditions that either the patient is bradycardic or ventricular premature beats develop. A combination of azithromycin and hydroxychloroquine should be avoided if baseline QTc >500 msec. If QTc duration prolongs for more than 60 msec during follow-up, dose and combination of the drugs used for COVID-19 should be checked and rearranged. QTc measurement and follow-up are demonstrated in Figure 2.

Before the starting treatment, all of the medications that prolong QTc should be reassessed and discontinued if they are not indispensable. Drugs causing QTc prolongation and useful website addresses were listed in Figure 3. The potassium level should be kept above 4.5 mEq/L, and the magnesium level should be kept between 3-4 mg/L. Drugs that cause bradycardia should be stopped, and the heart rate should be kept between 90 and 110 bpm. Catecholamines such as dopamine and isoproterenol or transvenous pacing can be used to increase heart rate in patients with lower heart rates (7).

Hemodynamic stability determines the treatment algorithm in TdP. If the patient is hemodynamically unstable or TdP is sustained, defibrillation should be performed urgently. Magnesium should be replaced, and electrolyte abnormalities should be corrected. Magnesium and potassium levels should be kept in targeted ranges (3-4 mg/dL for magnesium and >4.5 mEq/L for potassium). Magnesium may reduce the amplitude of early after depolarizations (EADs) by inhibiting the late calcium influx via L-type calcium channels which related to delayed ventricular repolarization. Therefore, EADs are less likely to reach threshold potential and provoke TdP. Magnesium therapy is simple and relatively safe to administer. The recommended dose of intravenous magnesium is 2 gr in adults and it should be given in 10-15 minutes (14). If refractory or recurrent TdP develops, magnesium replacement should be repeated. Heart rate should be increased by catecholamine infusion or overdrive pacing with a transvenous pacemaker. If polymorphic VT is under normal QTc interval, ischemia may play a role in arrhythmogenesis, and lidocaine may be tried terminating VT (7). Approach to polymorphic VT is summarized in Figure 4.

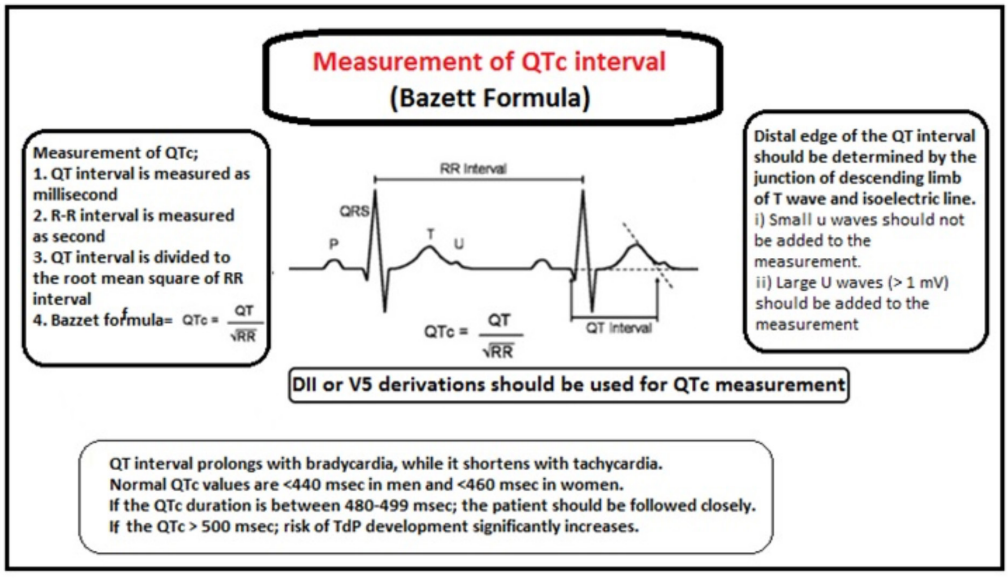

Figure 1. Measurement of corrected QT (QTc) interval

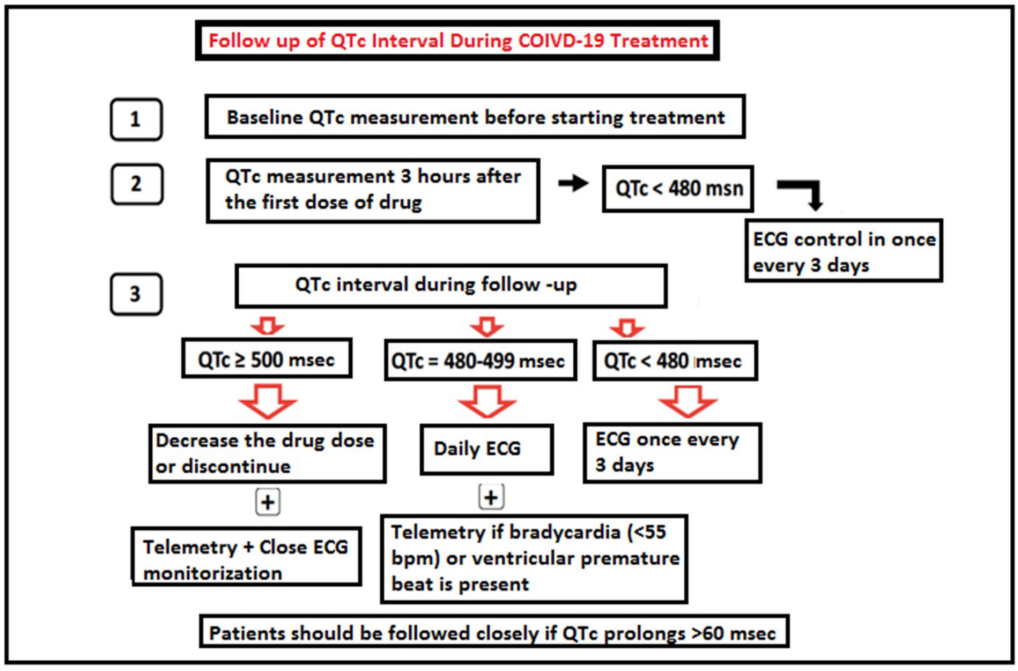

Figure 2. Follow-up of QTc during COVID-19

COVID-19: Coronavirus disease-2019

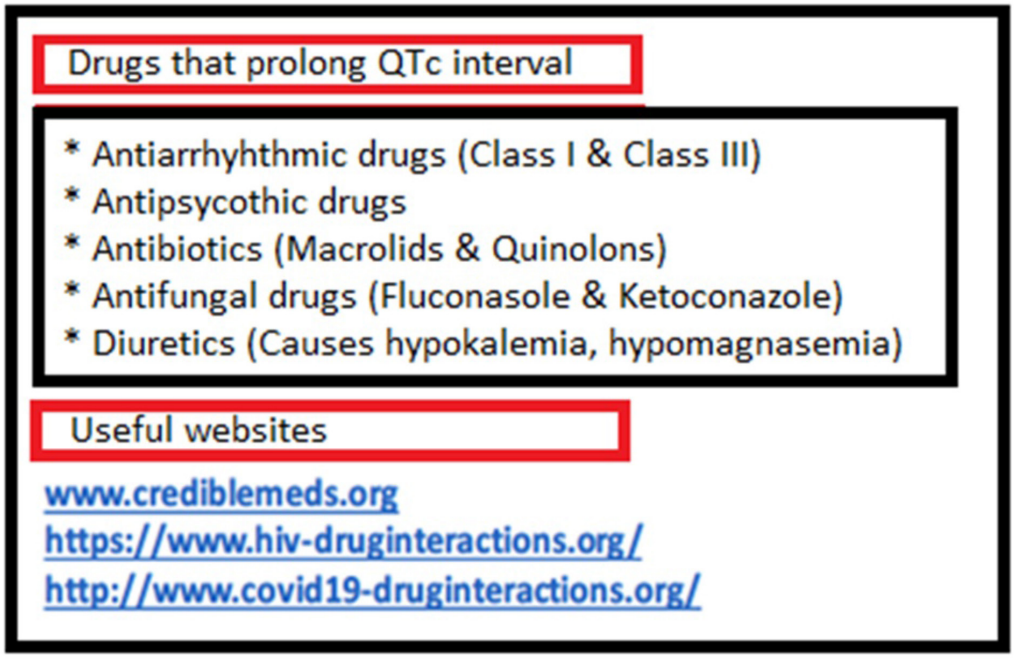

Figure 3. Drugs which prolong QTc interval and useful websites for drug interactions

Management of Bradayarrhythmias During COVID-19

Conduction defects, sinus node dysfunction, and atrioventricular (AV) block might develop during COVID-19. Bradyarrhythmias generally occur in patients with myocardial damage. Hypoxia and neural invasion caused by the SARS-CoV-2 virus lead to increased vagal tone and facilitates bradyarrhythmias. It is demonstrated in animal studies that the AV block develops in coronavirus infection due to myocarditis (15). Intubation, tracheal aspiration, and prone positioning of the patient causes increased vagal activity and bradyarrhythmias (16). Another interesting finding is detected lower heart rates in COVID-19 patients than expected heart rates according to their body temperature values, as seen in typhoid fever (17).

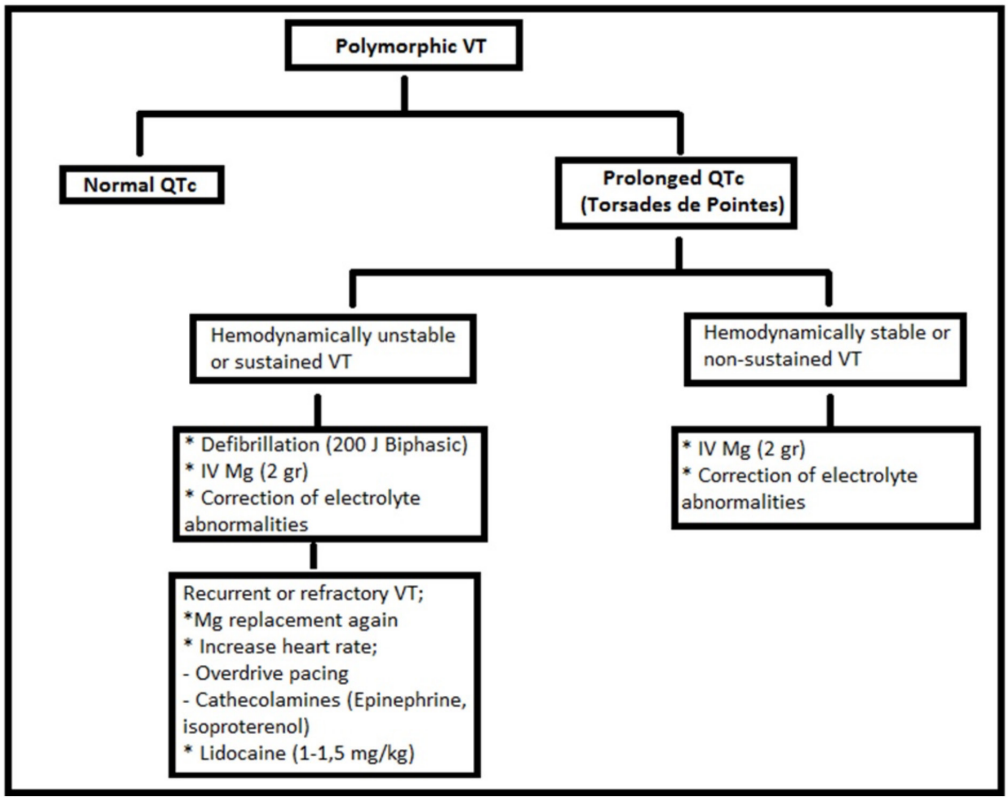

Figure 4. Approach to polymorphic VT during COVID-19

VT: Ventricular tachycardia, COVID-19: Coronavirus disease-2019, IV: Intravenous

Treatment of bradyarrhythmias depends on the hemodynamic parameters of the patients. All of the drugs that may cause bradycardia should be stopped. Atropin may be tried to increase heart rate. A temporary transvenous pacemaker should be implanted if the patient is symptomatic. Permanent pacemaker implantation should be avoided during active disease, and the need for a pacemaker should be re-evaluated after completion of COVID-19 treatment. It should be kept in mind that fingolimod and hydroxychloroquine may cause bradyarrhythmias weeks after the drug cessation (7).

Approach to Patients with Hereditary Arrhythmia Syndromes and COVID-19

Long QT syndromes (LQTs) develop due to ion channel mutations, and KCNQ1, KCNH2, and SCN5A are the most common detected mutations. It is believed that ion channel mutations play a significant role in patients prone to acquired QT prolongation (18). QTc interval should be strictly followed in patients with LQTs, and drug change or cessation should be considered in patients with QTc interval >500 msec or QTc prolongation more than 60 msec. Potassium level should be kept at the level of 5 mEq/L (19). Fever is the trigger of VT, especially in type 2 LQTs. Therefore, fever should be reduced strictly (20).

Brugada syndrome (Brs) develops due to sodium channel mutation (SCN5A) and is associated with sudden cardiac death (SCD). The precise diagnosis of BrS is confirmed by demonstrating type 1 Brugada ECG pattern either spontaneously or induced with conditions such as fever and drugs (21). Fever is the main trigger of VT/VF in patients with BrS. It is reported that fever-induced BrS cases have higher sudden cardiac death risk than cases induced with drugs (22). Patients with established sodium channel mutation or spontaneous type 1 Brugada ECG pattern, patients under 26 years old or older than 70 years old, patients with syncope and patients with fever-induced BrS have a high risk for sudden cardiac death. Therefore, patients with high SCD risk should be hospitalized during COVID-19. Patients with lower SCD risk might be followed without hospitalization. Fever should be treated aggressively in BrS patients, and paracetamol should be the preferred agent (23).

Catecholaminergic polymorphic VT (CPVT) develops due to ryanodine receptor mutation, and it is associated with malign ventricular arrhythmias, especially after sympathetic nervous system activation by exercise or emotional stress. Beta-blockers are gold standard treatment in CPVT, and flecainide is the second-line treatment in refractory cases (24). Fever alone is not the trigger of VT/VF in CPVT. The main possible trigger of VT/VF

in patients with CPVT and COVID-19 is catecholamines used for hemodynamic support. Therefore, catecholamine use should be avoided as much as possible. A combination of beta-blockers and milrinone can be a safe option in patients with CPVT who needs hemodynamic support. Beta-blockers should not be stopped in CPVT patients (25).

Conclusion

Both COVID-19 itself and drugs used for the treatment of the disease are responsible for increased incidence of arrhythmia in patients with COVID-19. QTc prolongation plays a central role in COVID-19 related ventricular arrhythmias. Therefore, the QTc interval should be followed strictly according to the recommendations. Drugs reducing heart rate should be discontinued in patients with bradyarrhythmias, and patients should be reassessed for the need for a permanent pacemaker after completion of the COVID-19 treatment. Fever should be reduced in patients with BrS, and catecholamines should be avoided in patients with CPVT. Clinicians should be aware of the increased risk of arrhythmia during COVID-19.

Ethics

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: Y.Z.Ş., H.Y., K.A., Design: U.C., H.Y., K.A., Data Collection and/or Processing: Y.Z.Ş., Analysis and/or Interpretation: U.C., Literature Search: H.Y., K.A., Writing: Y.Z.Ş., U.C.

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Investigation of the Usability of Serum Phospholipase A2, Neutrophil/Lymphocyte Ratio, Red Cell Distribution Width and Mean Platelet Volume Levels in the Grading of Scorpion Envenomation

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Abstract

Aim: This study aimed to compare the serum phospholipase A2, neutrophil/lymphocyte ratio (NLR), red cell distribution width (RDW), and mean platelet volume (MPV) levels of patients who presented to our emergency department due to scorpion stings and to determine a laboratory parameter that could assist in clinical grading.

Materials and Methods: Sixty-three patients presenting to the emergency department due to scorpion stings and 33 volunteers presenting for other reasons between May and October 2018 were included in the study. The serum phospholipase A2, NRL, RDW and MPV levels of the patients were determined and compared with the control group.

Results: In the evaluation performed in the patient group, the mean serum leukocyte and serum lymphocytes were higher and the RDW mean was statistically significantly lower compared to the control group, ($p=0.001$, 0.003, and 0.004, respectively). There was no significant difference between the patient and control groups in terms of the serum MPV, platelet and serum phospholipase levels ($p>0.05$). When the patients' serum MPV values were compared according to their clinical grade, a statistically significant correlation was found (rho: - 0.432, $p<0.001$).

Conclusion: In scorpion stings, as the clinical grade progresses, the MPV rate decreases. Therefore, the MPV level can be used as an auxiliary parameter to show the severity of scorpion stings.

Keywords: Scorpion sting, phospholipase A2, mean platelet volumes

Introduction

There are many types of scorpions worldwide, some of which can cause severe or deadly envenomation. Since ancient times, the existence and toxicity of scorpions have been known, but this species does not carry disease factors; however, in order to protect themselves, they can cause envenomation and death by stinging people and animals (1).

Scorpion stings can cause severe skin reactions, neurological and respiratory problems, and severe systemic manifestations that can lead to cardiovascular collapse. In terms of their geographical location in Turkey, scorpions are particularly common in Southeast Anatolia due to the climate and socio-economic structure. There are 1,500 subspecies of scorpions worldwide and 50 subspecies are toxic to humans. In South America, North Africa, and Middle East, the subspecies of *Leiurusquinquestriatus*, *Androctonuscrassicauda* and *Buthusoccitonus* are dangerous. Turkey is estimated to be home to 13 subspecies of scorpions. In East and Southeast Anatolia Regions of the country, *A. crassicauda* (Figure 1) and *L. quinquestriatus* (Figure 2) are relatively common and constitute the most causes of stings (2).

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Figure 1. *A. crassicauda*

Figure 2. *L. quinquestriatus*

Scorpion venom is a water-soluble, antigenic and heterogeneous mixture. The venom is formed by the release of neurotoxin, cardiotoxin, nephrotoxin, hemolytic toxin, phosphodiesterase, phospholipase, hyaluronidase, glycosaminoglycan, histamine, serotonin, tryptophan, and cytokine at different concentrations. However, the strongest toxin is neurotoxin (3).

In this study, the serum phospholipase A2, neutrophil/lymphocyte ratio (NRL), red cell distribution width (RDW), and mean platelet volume (MPV) levels of patients presenting to the emergency department after scorpion stings were compared to a control group. Additionally, clinical grading was performed in the patient group, and by comparing the A2, NRL, RDW and MPV levels between the grades, the parameters that could determine the severity of envenomation was investigated.

Materials and Methods

This prospective case-control study was conducted in the emergency department of a tertiary hospital. Our emergency department serves approximately 25,000 patients monthly with two attending physicians and three general practitioners. The study began after the approval of the local ethics committee (number: 2017/9-26).

Sixty-three patients who presented to the emergency department due to scorpion stings and 33 volunteers presenting with other complaints between May and October 2018 were included in the study. The patients included in the study were graded according to their clinical features as follows: Grade 1, local pain and paresthesia; Grade 2, spread of local pain and paresthesia toward the proximal; Grade 3, central pain and paresthesia findings in addition to central nervous system findings (increased oral secretion, nystagmus, blurred vision, and rapid tongue movements); and Grade 4, in addition to central nervous system findings, other system findings (rhabdomyolysis, multiple organ failure, etc.) (4). The blood samples obtained from the patients were analyzed in terms of the serum white blood cell count (WBC) (normal range: 4.5-10x10^3/uL), phospholipase A2 (normal range: 86.4-167.6 nmol/min/mL), NRL (normal range: 1.65), RDW (normal range: 11.6%-15.8%), and MPV normal range, 6.8-10.8 fL) and compared to the control group. All cases presenting to the emergency room were treated according to the standard protocol. Patients under the age of 18 years, pregnant women, and individuals who did not agree to participate in the study were excluded.

Laboratory Analysis

Blood samples were obtained by venipuncture from both groups and stored at -80 °C after centrifugation at 1,000 g for 20 min and separation. The serum levels of the PLA2 protein were analyzed using ELISA kits supplied by Shanghai Sunred Biological Technology Co. Ltd. (Shanghai, China) according to the manufacturer's recommended protocol. Along with the serum PLA2 levels, selected clinical and sociodemographic variables, namely affected body region, number of antivenoms, electrocardiogram tracing analysis, WBC, NRL, RDW, and MPV were recorded and analyzed.

Statistical Analysis

SPSS v.15.0 for Windows was used for the statistical analysis. Descriptive statistics were expressed as number and percentages for categorical variables, and mean, standard deviation, minimum, maximum and median values for numerical variables. The comparison of two independent groups of numerical variables was performed using the Mann-Whitney U test since the data did not meet the normal distribution condition. The ratios in the groups were determined by the chi-square analysis. The relationship of the ranks in the groups were examined by linear-by-linear association, and the relationship between ordinal and

numerical variables was examined by the Spearman correlation analysis. The alpha significance level was set as $p<0.05$.

Results

The study included 63 patients, 27 males and 36 females, with a mean age of 43.71±18.63 years, and 33 controls, 12 males and 21 females, with a mean age of 41.06±16.07 years. There was no statistically significant difference between the patient and control groups in terms of age and gender (Table 1, p=0.560 and p=0.538, respectively).

When the patient group was classified according to the clinical grade of envenomation, it was determined that most of them were in Grade 1 and least were in Grade 4. Concerning antivenom use, only nine (14.3%) patients received an antivenom and most were advanced-grade. The right upper extremity was the most affected body area (Table 2).

The mean serum leukocyte and serum lymphocytes were statistically significantly higher and the RDW mean was statistically significantly lower in the patient group compared to the control group (p=0.001, p=0.003, and p=0.004, respectively). A statistically significant difference was also observed in the RDW levels of the patient and control groups (p=0.045). However, no significant difference was found between the two groups in terms of the serum MPV, platelet and serum phospholipase levels (Table 3, p>0.05).

In the patient group, the leukocyte, neutrophil, lymphocyte, NLR, phospholipase, D-dimer and RDW levels did not significantly differ according to the clinical grade (p>0.05) (Table 4). However, it was determined that the MPV level was significantly decreased as the grade progressed (rho: -0.432, p<0.001) (Table 5, Figure 3).

Discussion

Scorpion envenomation, widely seen, especially in South-eastern Turkey, is one of the frequent reasons for emergency presentations (5). Following a scorpion sting, certain anti-inflammatory and pro-inflammatory cytokines and mediators are released by the host depending on the scorpion subspecies. These released mediators and cytokines determine the degree of inflammation that can lead to major clinical effects, such as cardiac dysfunction, pulmonary edema, and shock (6). The MPV reveals the presence of inflammatory load and disease activity in many diseases (7). In a study conducted with 76 cases of scorpion

Table 1. Distribution of age and gender in the patient and control groups

		Patient group (n=63)	Control group (n=33)	p value
Age (mean ± SD, min-max)		43.7±18.6 (15-92)	41.1±16.1 (20-74)	0.560
Gender, n (%)	Male	27 (42.9)	12 (36.4)	0.538
	Female	36 (57.1)	21 (63.6)	

SD: Standard deviation, min: Minimum, max: Maximum, n: Number

Table 2. General characteristics of the patient group

Time to presentation (minutes), mean ± SD (min-max)		**101.0±121.9 (12-600)**
Grade, n (%)	1	35 (55.5)
	2	23 (36.5)
	3	3 (4.8)
	4	2 (3.2)
Electrocardiogram, n (%)	Normal sinus rhythm	63 (100)
Number of antivenoms used, n (%)	0	54 (85.7)
	1	8 (12.7)
	2	1 (1.6)
Affected body area, n (%)	Right upper extremity	23 (36.5)
	Left upper extremity	12 (19.0)
	Right lower extremity	12 (19.0)
	Left lower extremity	10 (15.9)
	Head-neck, trunk	6 (9.5)

SD: Standard deviation, min: Minimum, max: Maximum, n: Number

Table 3. Comparison of the patient and control groups in terms of laboratory parameters

Patient group			Control group		
	Mean ± SD	**Min-max (median)**	**Mean ± SD**	**Min-max (median)**	**p value**
Leukocyte (10^3/uL)	9.76±2.49	4.64-16.94 (9.41)	8.05±1.56	4.16-11.27 (8.13)	0.001
Neutrophil (10^3/uL)	5.40±1.92	1.97-11.37 (4.86)	4.72±1.45	2.05-7.53 (4.66)	0.104
Lymphocyte (10^3/uL)	3.28±1.20	1.46-7.45 (2.95)	2.54±0.66	0.87-3.79 (2.67)	0.003
NLR	1.83±0.91	0.65-5.71 (1.66)	2.12±1.49	0.91-8.62 (1.72)	0.471
RDW (%)	12.21±1.44	10.7-19.9 (11.83)	12.78±1.25	11.14-16.3 (12.55)	0.004
<11.6	23 (36.5)		5 (15.2)		0.045
11.6-15.8	39 (61.9)		26 (78.8)		
>15.8	1 (1.6)		2 (6.1)		
MPV (fL)	7.99±1.77	5.5-13.5 (7.487)	8.39±2.34	5.83-16.01 (7.63)	0.622
<6.8	17 (27.0)		9 (27.3)		0.697
6.8-10.8	40 (63.5)		19 (57.6)		
>10.8	6 (9.5)		5 (15.2)		
Platelet (10^3/uL)	268.14±80.57	135.8-486.6 (260.9)	235.68±64.48	130.5-373.8 (226.6)	0.053
Phospholipase (nmol/min/mL)	112.31±25.59	62.7-199.7 (111.2)	116.50±22.40	86.4-167.6 (114.4)	0.497

SD: Standard deviation, NLR: Neutrophil/lymphocyte ratio, RDW: Red cell distribution width, MPV: Mean platelet volume

envenomation in 2014, Capan et al. (8) reported that the patient group had significantly higher WBC and platelet distribution width values and were significantly lower mean MPV values compared to the healthy control group. In another study, Gokay et al. (9) evaluated 189 cases of scorpion stings and found that the serum MPV value was within normal limits and there was no difference between the patient groups according to clinical grades.

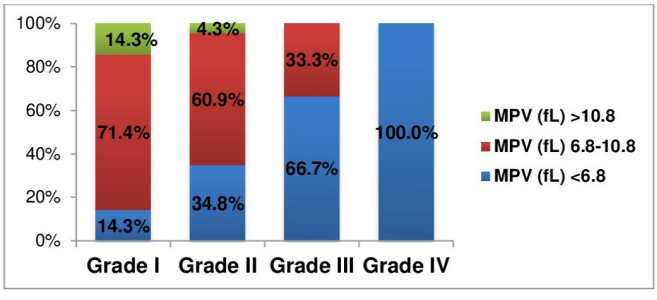

Figure 3. Mean platelet volume levels of the patient group according to clinical grade

MPV: Mean platelet volume

Song et al. (10) examined the impact of Buthusmartensii Karsch-type scorpion venom on rabbits and showed that it significantly inhibited platelet aggregation. They attributed this to the increase in the ratio of PGI2/TXA2, indicating an association with increased PGI2 concentration in plasma (10). In a study on mice with and without scorpion venom, Nasr et al. (11) found that the platelet parameters were generally unaffected in both groups, but the MPV levels were decreased over time in the mice that had been given the venom. Such a big decline in the MPV levels within four hours of the administration of the venom cannot be explained by the production of new and small platelets. However, scorpion venom is likely to have an anticoagulant effect on existing platelets. In our study, there was no significant difference between the serum MPV levels of the patient and control groups but a significant decrease was observed in the MPV level of the patients as their clinical grade increased. Therefore, further studies are needed to elucidate this mechanism.

Table 4. Rho and p values of the laboratory parameters according to clinical grades in the patient groups		
	Clinical grade	
	rho	p value
Leukocyte (10^3/uL)	0.131	0.307
Neutrophil (10^3/uL)	−0.005	0.967
Lymphocyte (10^3/uL)	0.162	0.206
NLR	−0.195	0.126
RDW (%)	−0.183	0.152
MPV (fL)	−0.432	<0.001
Platelet (10^3/uL)	0.164	0.199
Phospholipase (nmol/min/mL)	0.081	0.530
D-dimer (µg/L)	−0.001	0.996
NLR: Neutrophil/lymphocyte ratio, RDW: Red cell distribution width, MPV: Mean platelet volume		

Scorpion venom is a water-soluble, antigenic and heterogeneous mixture containing a large number of toxins and additional compounds, including various amounts of neurotoxin, cardiotoxin, nephrotoxin, hemolytic toxin, phosphodiesterase, phospholipase, hyaluronidase, glycosaminoglycan, histamine, serotonin, tryptophan, substances that increase cytokine release, and agglutinins. Any of these compounds can be dominant in the venom of scorpion species. Neuromuscular, neuroanatomic and local tissue effects are the most important clinical effects (12).

In our study, no significant difference was found in the serum phospholipase A2 level of the patients after a scorpion sting compared to that of the control group. In their 2019 study on *Centruroidesedwardsii*, which is the most common scorpion species in Costa Rica. Diaz et al. (13) found that the *C. edwardsii*venom was rich in peptides, proteolytic and hyaluronidase enzymes but it did not have any phospholipase A2 and fibrinogenolytic activity. Similarly, in our study, this enzyme may not have been present in scorpion venom, or a sufficient amount of poison may not have been transferred to the host. To clarify this issue, there is a need for further studies to determine the venom content of scorpions in our region.

RDW is a simple and inexpensive parameter reflecting the degree of heterogeneity (anisocytosis) of erythrocyte volume and is routinely used for the differential diagnosis of anemia. Increased RDW has been reported in various diseases and disorders, such as cardiovascular disease, venous thromboembolism, cancer, diabetes, community-acquired pneumonia, chronic obstructive pulmonary disease, liver and kidney failure, and other acute or chronic conditions (14). In our study, the amount of RDW was determined to be lower in the patient group compared to the control group.

Table 5. Comparison of the laboratory values of the patients according to clinical grades					
	Grade 1	**Grade 2**	**Grade 3***	**Grade 4***	**p#**
Leukocyte (10^3/uL)	9.56±2.50 (9.2)	9.73±2.39 (9.4)	11.29±3.09 (10.8)	11.22±3.73 (11.2)	0.709
Neutrophil (10^3/uL)	5.51±2.13 (4.9)	5.12±1.30 (4.8)	6.91±3.54 (5.4)	4.50±1.03 (4.5)	0.874
Lymphocyte (10^3/uL)	3.02±0.84 (2.9)	3.50±1.43 (3)	3.22±0.64 (3.4)	5.37±2.58 (5.4)	0.465
NLR	1.97±1.01 (1.7)	1.63±0.55 (1.7)	2.35±1.71 (1.4)	0.89±0.24 (0.9)	0.276
RDW (%)	12.27±1.19 (11.9)	12.32±1.85 (11.9)	11.30±0.14 (11.2)	11.32±0.58 (11.3)	0.715
MPV (fL)	8.53±1.76 (8.2)	7.54±1.61 (7)	6.43±0.89 (6.6)	6.11±0.35 (6.1)	0.016
Platelet (10^3/uL)	259.02±78.85 (242.4)	277.84±81.35 (272.1)	253.20±109.22 (272)	338.55±77.15 (338.6)	0.348
Phospholipase (nmol/min/mL)	112.48±20.23 (110)	110.04±34.02 (112.6)	121.13±17.75 (114.2)	122.15±7.99 (122.2)	0.805
D-dimer (µg/L)	737.66±1747.44 (304)	1606.39±5188.88 (354)	282.00±50.32 (256)	192.50±89.80 (192.5)	0.320

NLR: Neutrophil/lymphocyte ratio, RDW: Red cell distribution width, MPV: Mean platelet volume
Values given in mean ± standard deviation (median)
*not included in analysis
#Mann--Whitney U test

Study Limitations

This was a single-center study with a small number of patients. Additionally, only scorpion stings in our region were included in the study, and the species of scorpions that had stung the patients were not known. Therefore, the venom content of the scorpion species and how much venom the patients had been exposed to could not be determined. The blood samples were obtained from the patients only at the time of presentation, with no additional blood sample being taken during the follow-up. A study conducted in multiple centers to examine envenomation cases caused by different scorpion species can provide more comprehensive results.

Conclusion

We found that the serum leukocyte and lymphocyte levels were higher and the serum RDW level was lower in the patient group compared to the control group. Additionally, a significant relationship was observed between clinical grading and the serum MPV level. Therefore, it is concluded that the serum MPV level can be used as an auxiliary parameter in determining the severity of envenomation in patients presenting with a scorpion sting.

Ethics

Ethics Committee Approval: This study was approved by the Adıyaman University Faculty of Medicine Clinical Research Ethics Committee with the date of 19.12.2017 and number 2017-9-26.

Informed Consent: Patient consent has been received.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: İ.A., Design: İ.A., Data Collection or Processing: İ.A., M.K.P., K.T., A.A., N.A., Analysis or Interpretation: İ.A., M.K.P., K.T., A.A., N.A., Literature Search: İ.A., Writing: İ.A.

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QTc, Tp-e Interval and Tp-e/QTc Ratio Changes in Hypoxia Due to Hypertensive Pulmonary Edema-Case Control Study

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Abstract

Aim: As far as we have investigated, although there are researches on QT and QTc interval, there are no studies evaluating T wave peak-to-end distance (Tp-e interval), the ratio of Tp-e to QT and QTc used in the evaluation of cardiac arrhythmia risk and ventricular repolarization changes in patients with hypoxia due to hypertensive pulmonary edema. Therefore, in this study was aimed to study whether there is a change in Tp-e interval, the ratio of Tp-e to QTc in hypoxia due to hypertensive pulmonary edema.

Materials and Methods: Forty patients diagnosed with hypertensive pulmonary edema in the emergency room were included in the study retrospectively. Forty patients with similar age and gender distribution were included in the study as a control group. All patients underwent 12-lead electrocardiography (ECG). In addition to the routine measurements, Tp-e interval, the ratio of Tp-e to QTc were measured in ECG. Study data were grouped as patients with and without hypoxia

Results: Mean age for patients was 68.60±15.25. QTc interval, Tp-e interval and Tpe/QTc values were found to be significantly higher in hypoxia caused by hypertensive pulmonary edema ($p<0.001$ for each). QTc interval, Tp-e interval and Tpe/QTc ratio showed significant negative correlation with hypoxia levels.

Conclusion: In patients with hypertensive pulmonary edema, Tp-e interval and Tp-e/QTc rates are increased significantly compared to those without hypertensive pulmonary edema, and these measurements can be used more effectively in the close follow-up of cardiac fatal arrhythmias.

Keywords: Tp-e/QTc ratio, arrhythmia, emergency medicine, hypoxia

Introduction

Hypertensive pulmonary edema is an important cause of mortality and morbidity, which is frequently encountered in the emergency room and often occurs as a result of acute heart failure. It may occur due to conditions such as diastolic and systolic dysfunction, myocardial ischemia, acute mitral regurgitation (1), and may cause cardiac rhythm disorders with resulting hypoxia (2). In addition, it is stated that resulting hypoxia can prolong the QT interval (3,4). Prolonging of QT interval increases the risk of developing ventricular arrhythmias and sudden cardiac death (3). As far as is known, although there are studies showing that hypoxia prolongs the QTc interval, there are no other studies studying hypoxia-related changes in Tp-e interval and Tp-e/QTc rates, which are indicators of ventricular arrhythmia.

There are multiple electrocardiographic (ECG) measurements related to ventricular repolarization, which are associated with the risk of ventricular arrhythmia. These measurements used are QT and QTc interval, QT and QTc dispersion and T wave peak-to-end distance (Tp-e interval). Among these parameters, QT and QTc are indicators of ventricular depolarization in addition to repolarization. However, Tp-e is more indicative

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of ventricular repolarization, and may be more meaningful especially in repolarization assessment. The ratio of Tp-e to QT and QTc obtained are associated with the ventricular transmural dispersion that occurs during repolarization (5). An increased Tp-e interval shows abnormal spread in ventricular repolarization and is associated with an increased risk of ventricular arrhythmia (6). Literature research shows there is no research related to the Tp-e interval, the ratio of Tp-e to QT and QTc used in the assessment of ventricular repolarization in those with hypoxia detected in the emergency department.

It was aimed to evaluate the changes in QTc, Tp-e interval, ratio of Tp-e to QTc in patients with hypoxia due to hypertensive pulmonary edema compared to patients without pulmonary edema and hypoxia in the emergency room.

Materials and Methods

Records of patients who applied to the University of Health Sciences, Adana City Research and Training Hospital Emergency Medicine Clinic between July 1, 2019 and December 31, 2019, and who are diagnosed with hypertensive lung edema after evaluation of vital signs, physical examination and radiological imaging were examined retrospectively. Electrocardiography (ECG) recordings obtained from the files of these patients were examined. A total of 40 patients were enrolled as the patient group. Arterial blood pressure values, physical examination findings, and radiological imaging results of the patients admitted to the emergency department for various reasons were examined and found to be healthy. ECG recordings of these patients without hypertensive lung edema were obtained. Forty outpatients who were found to be healthy were enrolled as the control group.

Exclusion criteria for all patients included in the study and control group were all medical treatments known to extend or shorten QT and QTc distance, known syncope or sudden cardiac arrest history in the patients or their family, presence of acute or chronic systemic or local infection, being in the pediatric age group (<18 years), inability to perform Tp-e and QTc measurements on ECG, presence of known diabetes mellitus, medium-advanced valvular disease, electrolyte deficiency, and having the diagnosis of chronic liver disease or chronic renal failure. This research complies with Helsinki Declaration and ethics approval was obtained from Adana City Training and Research Hospital Clinical Researches Ethics Committee (decision no: 629, date: 04.12.2019).

12-lead ECG and laboratory results of all patients were obtained from the files. From the demographic variables of the patients, age, sex, pulse, blood pressure, oxygen saturation values of all patients were recorded from the archived files. From the routine biochemistry parameters, renal function tests, serum electrolytes, liver function tests were recorded.

12-Lead Electrocardiographic Evaluation

Firstly, 12-lead ECG obtained by MAC 2000 ECG Machine (GE medical systems information technologies, Inc., WI, USA) with a sinus rhythm of 25 mm/sec and 1 mv/10 mm standard calibration was obtained from the files. The time from QRS to the point where the T wave returns to the isoelectric line was calculated for the QT time. QTc in patients with heart rate between 60-100/minute was calculated using the Bazett Formula (QTc=QT/√R–R). QTc in patients with heart rate outside the range of 60-100/minute was calculated using Frederica Formula (QTc=QT/RR 1/3). The Tp-e interval was defined as the time from the peak of the T wave to the point where the T wave interconnected with the isoelectric line. Measurements were made primarily from V5. If V5 was unsuitable for measurement (amplitude <1.5 mm), measurements were taken from V4 or V6 (7). Tp-e/QTc ratio was calculated based on these measurements. All ECG examinations in sinus rhythm were evaluated by a cardiologist with at least 5 years of experience in electrophysiology and ≥2,000 arrhythmia patients annually, while unaware of the clinical status of the patient.

Statistical Analysis

All analyzes were performed using SPSS 22.0 (Chicago, IL, USA) statistical software package. Using the Kolmogorov-Smirnov test, it was determined whether continuous variables distribution was normal. Continuous variables in data were presented as mean ± standard deviation, and categorical as numbers and percentages. Continuous variables showing normal distribution was compared using the Student t-test, whereas the Mann-Whitney U test is used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed. Categorical variables were compared using chi-square (χ^2) test. The kappa coefficient was used to examine the interobserver variability of all ECG measurements. Pearson's and Spearman's correlation analysis was used to determine the presence of a relationship between countable parameters. Statistical significance level was set as $p<0.001$.

Results

The study data was conducted as two groups; patient and control. ECG measurements were taken successfully from all patients.

When demographic data were compared according to the study groups, age and sex were similar. Laboratory results were also similar (Table 1).

Table 1. Comparison of demographic and laboratory findings between hypertensive pulmonary edema and control group			
	Patients with hypertensive pulmonary edema (n=40)	**Patients without hypertensive pulmonary edema (n=40)**	**p value**
Age (years)	68.60±15.25	67.60±7.77	0.607
Systolic blood pressure (mmHg)	189.75±21.90	169.63±16.23	<0.001
Diastolic blood pressure (mmHg)	104.75±9.33	96.50±6.90	<0.001
Heart rate (pulse/minute)	121.75±11.45	76.50±11.25	<0.001
Pulse-oximeter (%)	82.55±5.39	97.03±5.33	<0.001
Urea (mg/dL)	35.07±5.74	32.50±7.82	0.098
Creatinine (mg/dL)	0.90±0.18	0.74±0.20	<0.001
Sodium (mEq/L)	138.50±2.84	138.50±2.21	0.999
Potassium (mEq/L)	4.53±0.35	4.33±0.49	0.043
Glucose (mg/dL)	141.67±18.20	110.22±13.57	<0.001
ALT (u/L)*	20.20±8.47	18.80±9.17	0.481
AST (u/L)**	28.17±10.02	23.13±6.59	0.010
Significant values are shown in bold. *ALT: Alanine aminotransferase, **AST: Aspartate aminotransferase, n: Number			

Table 2. Comparison of ventricular repolarization parameters between hypertensive pulmonary edema and control group			
	Patients with hypertensive pulmonary edema (n=40)	**Patients without hypertensive pulmonary edema (n=40)**	**p value**
QTc interval time (ms)	483.05±8.91	415.90±12.77	<0.001
Tp-e interval time (msn)	108.85±9.38	60.13±7.80	<0.001
Tp-e/QTc ratio	22.51±1.54	14.42±1.43	<0.001
Tp-e: T wave peak-to-end distance, QTc: Corrected QT, n: Number			

When ventricular repolarization parameters were examined according to the study groups, QTc interval, Tp-e interval and Tp-e/QTc values were significantly higher in patients with hypoxia (Table 2).

Table 3 shows the correlation of QTc, Tpe-interval and Tpe/QTc measurements with the systolic and diastolic blood pressure, and pulse-oximeter values. All three measurements were positively correlated with systolic and diastolic blood pressure, and were negatively correlated with pulse-oximeter oxygen saturation levels (Table 3). In linear regression analysis, hypoxia significantly related to QTc, Tpe-interval Tpe/QTc measurements (Table 4). In linear regression analyses, QTc, Tpe-interval and Tpe/QTc ratio were independently associated with pulse-oximeter oxygen saturation levels. In Scatterplot analyses of pulse-oxymeter oxygen saturation levels with QTc interval, Tp-e interval and Tp-e/QTc ratios, R^2 linear values were 0.722, 0.696 and 0.690 respectively (Figures 1-3).

Discussion

The most important result of our research was that in patients with hypoxia due to hypertensive pulmonary edema, the rate of QTc, Tp-e interval and Tp-e/QTc were significantly higher than the control group. As far as known, findings of our research are the first in the literature to show an increase in ventricular repolarization parameters Tp-e interval and Tp-e/QTc in patients with hypertensive pulmonary edema. Our study also supports previous studies showing QT and QTc prolongation in hypoxic patients.

Depolarization of ventricular myocardium occurs from the endocardial region towards the epicardial region. Depolarization occurs before ventricular repolarization. There is dispersion between the endocardial and epicardial region. The interval between the T wave peak and the end distance is called the Tp-e interval, and this is associated with transmural ventricular repolarization (5,7). It has been showed to be associated with

Table 3. Correlation of QTc, Tp-e-interval and Tp-e/QTc ratio with blood pressure and pulse-oximeter						
	QTc		Tp-e-interval		Tp-e/QTc ratio	
	r	p value	r	p value	r	p value
Systolic blood pressure (mmHg)	0.431	<0.001	0.423	<0.001	0.417	<0.001
Diastolic blood pressure (mmHg)	0.391	<0.001	0.378	<0.001	0.376	0.001
Pulse-oximeter (%)	-0.775	<0.001	-0.759	<0.001	-0.757	<0.001
QTc: Corrected QT						

Table 4. A Linear regression analysis for pulse-oximeter significantly correlated with QTc, Tp-e-interval and Tp-e/QTc ratio						
	QTc		Tp-e-interval		Tp-e/QTc ratio	
	β	p	β	p	β	p
Pulse-oximeter	-0.775	<0.001	-0.759	<0.001	-0.757	<0.001
R-square for QTc, Tp-e interval and Tp-e/QTc ratio as 651, 787, 707, respectively. QTc: Corrected QT						

arrhythmias in the Tp-e interval and the ratio of this interval to the QT interval in the presence of many cardiac pathological conditions, and poses a high risk for sudden cardiac death (8-11). The association of increased Tp-e interval and Tp-e/QTc ratios with arrhythmias and sudden cardiac death was thought to stem from the dispersion in the ventricular myocardium between the epicardial and endocardial region, causing the slow conduction of these two anatomic regions, which could cause arrhythmias associated with re-entries, one of the most common causes of arrhythmias.

Hypertensive pulmonary edema is a clinical condition caused by increased hydrostatic pressure or capillary permeability, resulting in decreased oxygen delivery to tissues due to ventilation/perfusion mismatch (12). Even short hypoxemia periods are reported to be associated with prolonged sinusal pauses, transient A-V blocks, multifocal ventricular extrasystoles, and ventricular tachycardia (13). Hypoxia changes the plateau phase of the action potential of L-type Ca^{++} channels, which is the main pathway of calcium flow into cells, therefore may result in cardiac arrhythmias (14). There are studies evaluating the QT and QTc interval, one of the ventricular repolarization parameters that can lead to arrhythmias due to hypoxia, and similar to ours, these studies show that prolongation in QTc is an independent risk factor for hypoxia (3,4). On the other hand, there is no research evaluating the ratio of Tp-e interval, Tp-e/QT and Tp-e/QTc in hypoxic patients with hypertensive lung edema. Increase in ventricular repolarization parameters such as QT and QTc duration, QTc dispersion, Tp-e interval and Tp-e/QTc have been shown risk determinants for ventricular arrhythmias and death (6,15). In our study, the Tp-e/QT and Tp-e/QTc ratio increases significantly in patients with hypoxia.

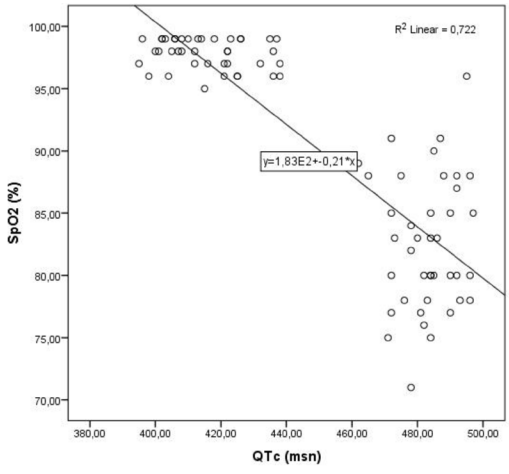

Figure 1. Analysis of Scatterplot for the relationship between SpO_2 and QTc interval

QTc: Corrected QT

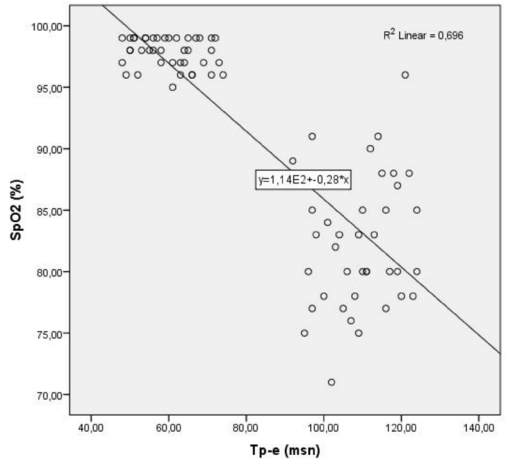

Figure 2. Analysis of Scatterplot for the relationship between SpO2 and Tp-e interval

QTc: Corrected QT

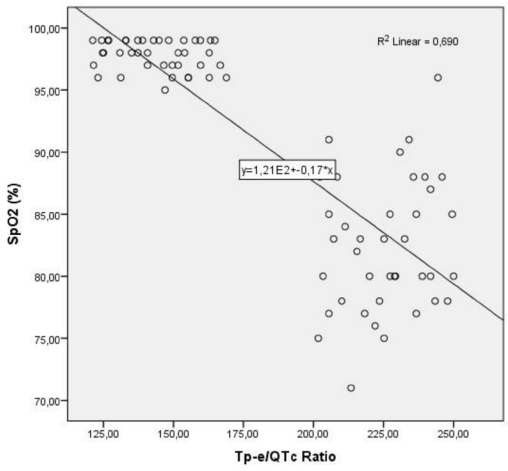

Figure 3. Analysis of Scatterplot for the relationship between SpO_2 and Tp-eQTc ratio

QTc: Corrected QT

Hypoxia with hypertensive pulmonary edema, besides prolonged QTc distance, changes in Tp-e and Tp-e/QTc parameters are precursors of ventricular dispersion and repolarization as a result of hypoxia. This shows the importance of monitoring patients with hypertensive pulmonary edema under strict observation accompanied by rhythm monitoring, due to cardiac complications that may arise from hypoxic conditions. According to this research, it may be effective to use the Tp-e and Tp-e/QTc ratio in addition to QT and QTc intervals for assessing ventricular repolarization.

Study Limitations

This research has some limitations. One of these was the retrospective design of the search. The number of patients is limited to 40. Conducting prospective studies with more patients may produce more meaningful results.

Conclusion

Tp-e interval and Tp-e/QTc rates are significantly increased in hypoxic patients with hypertensive pulmonary edema. In addition to QT and QTc evaluation during routine ECG evaluation in patients with hypertensive pulmonary edema in the emergency departments, it should be noted that Tp-e-interval and Tp-e/QTc ratios, which are among other ventricular repolarization parameters, could be observed more frequently due to increased probability of cardiac arrhythmias in patients with an increase in these values. However, since this information obtained in our study is shown for the first time, studies involving new and more patients are required.

Ethics

Ethics Committee Approval: This study was approved by Adana City Training and Research Hospital Clinical Researches Ethics Committee (decision no: 629, date: 04.12.2019).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.A., H.K., F.K., Concept: A.A., S.B., B.Ş.A., Design: A.A., S.B., B.Ş.A., Data Collection and/or Processing: M.G., Ö.Y., Analysis and/or Interpretation: A.A., F.İ., Literature Search: A.A., Ö.Y., S.B., S.S., Writing: A.A., Ö.Y., S.S.

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Factors Related to Mortality in Occupational Injuries: Five-Year Experience

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Abstract

Aim: This study aims to evaluate factors related to mortality in occupational injuries admitted to emergency departments (EDs).

Materials and Methods: Patients admitted to the ED because of occupational injuries between January 2015 and December 2019 were retrospectively analyzed. The first admission to the ED following each occupational injury was recorded.

Results: Three thousand and two hundred and forty patients included in the study. We observed that occupational injuries decreased with age and were more common in males (91.4%), in agriculture (27.6%) and construction (24.9%) industries, and in summer (29.9%) and spring (28%). Additionally, occupational injuries generally occurred due to falling (31.8%) and caused superficial injuries (39.8%). A majority of patients (83.6%) were discharged from the ED. Three hundred and fifty-one and 156 patients were hospitalized in the surgical clinics and intensive care unit respectively. A total of 25 and 18 patients died in ED and intensive care unit, respectively (total 43 deaths, 1.32%). Moreover, increasing age (p=0.000), construction industry (p=0.008), immigration (p=0.037) and working in night shifts (p=0.009) are independent risk factors related to mortality after occupational injuries.

Conclusion: The labor conditions of immigrants as well as of those working at night shifts and in construction industry should be supervised. Their job security should be improved and working without social security should not be allowed.

Keywords: Construction industry, emergency department, immigration, mortality, night shift, occupational injuries

Introduction

Occupational injuries are one of the main causes of injuries and deaths worldwide. They decrease people's healthy and productive years. It has been estimated that 374 million nonfatal occupational injuries occur in the world every year, and 2.34 million people die from occupational injuries (1). Occupational injuries and related deaths are more common in the developing countries where production is more in the construction industry. The number of occupational deaths in the United States (US) is 3.6/100,000 workers, whereas it reaches 9.3/100,000 workers in Latin American countries (2). Based on the data published by the Turkish Statistical Institute, the number of occupational injuries that occurred in Turkey in 2018 was 431,276, and 1,542 people died because of occupational injuries (3).

Social costs of occupational injuries also cause a serious burden to all countries. Economic costs account for ~3.9% of the gross domestic product (1). In 2015, workers' compensation costs alone were approximately $95 billion in the US, and the total cost is estimated to be hundreds of billions of dollars (4,5).

It is important to examine the mechanism of injury in workers, the types of injuries, the medical services required after injuries, and the causes of occupational deaths to ensure occupational safety. Because occupational injuries are preventable injuries and most of them are still not reporting.

The aim of this study was to determine the distribution of mortality rates based on gender, age, and other factors, to evaluate the economic and social results and to shed light on the measures to be taken against possible occupational injuries.

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Materials and Methods

This retrospective study was conducted out in the emergency department (ED) of a regional academic hospital, that provides tertiary healthcare services. The study was conducted in compliance with the Declaration of Helsinki and approval by the regional ethics committee with decision no: 2020/01-08.

Study Design, Setting, and Patient Selection

The medical records of patients who were admitted to ED because of occupational injuries between January 1, 2015 and December 31, 2019 were retrospectively analyzed. The first admission to the ED following each occupational injury was recorded. Patients with missing medical data and repeated admissions were excluded from the study.

Statistical Analysis

In addition to the patients' age and gender, the following information was recorded: nationality (Turkish/immigrant); social security status; related industry; day of the injury (weekday/weekend); hour of the injury (day time/night shift) and season along with the mechanism of injury (falls, blunt object injury, lifting heavy weight, penetrating sharp object injury, burns, traffic accidents, and intoxications); type of injury (superficial injuries, strain-sprain, bone injury, burn injury, solid organ injury, deep cut and multiple injuries); injured body sites (thorax, spine, lower extremity, upper extremity, head and neck, abdomen, and multiple sites); presence of fracture; emergency termination; treatment costs due to injury; and the duration of the disability.

Data were analyzed using SPSS version 22.0. Visual (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk's tests) were used to determine if the variables showed normal distribution. Descriptive analyzes are expressed as mean ± standard deviation (SD) for variables showing normal distribution and as median and interquartile range (IQR) for those lacking normal distribution. In comparing groups, chi-square test was used for categorical variables, student's t-test for continuous variables, and Mann-Whitney U test for non-normally distributed continuous variables and sequential variables. Multivariate logistic regression analysis was performed to determine the relationship between mortality and possible confounding factors. Age, gender, nationality, social security status, time of the day, season, industry information, injury mechanism, injury type and injury site included in the model for multivariate logistic regression analysis. A p value of<0.05 was considered statistically significant.

Results

A total of 3,608 patients were found to be eligible for this study, and 368 of those patients were excluded because of missing data and repeated admissions; thus, 3,240 patients were finally included. Most of the patients were male (n=2,960, 91.4%) and the mean age was 32.69±10.61 (range: 14-80). The patients' demographic data are summarized in Table 1.

Table 1. Socio-demographic data of study population

Age (years), mean ± SD	**32.69±10.61**
Age (years), n (%)	
<18	92 (2.8)
18-29	1,350 (41.7)
30-39	980 (30.2)
40-49	572 (17.7)
50-64	233 (7.2)
≥65	13 (0.4)
Gender, n (%)	
Male	2,960 (91.4)
Female	280 (8.6)
Nationality, n (%)	
Turkey	3,163 (97.6)
Others	77 (2.4)
Presence of social security, n (%)	
TSSI or private insurance	2,909 (89.8)
None	331 (10.2)
Days of the week, n, (%)	
Weekday	2,652 (81.9)
Weekend	588 (18.1)
Time of the day, n (%)	
Day time (08:00 a.m. - 04:00 p.m.)	1,997 (61.6)
Night shift (04:00 p.m. - 08:00 a.m.)	1,243 (38.4)
Season, n (%)	
Spring	906 (28)
Summer	968 (29.9)
Autumn	741 (22.9)
Winter	625 (19.3)
Sector, n (%)	
Agriculture and forestry	894 (27.6)
Construction	808 (24.9)
Manufacturing and textile	650 (20.1)
Wholesale and retail trade	445 (13.7)
Transportation and storage	443 (13.7)

TSSI: Turkish Social Security Institution, SD: Standard deviation, n: Number

Table 2. Injury characteristics of the study population	
Mechanism of Injuries, n (%)	
Falls	1,031 (31.8)
Blunt object injury	562 (17.3)
Lifting heavy weight	460 (14.2)
Penetrating sharp object injury	882 (27.2)
Burns	105 (3.2)
Traffic accidents	157 (4.8)
Intoxications	43 (1.3)
Injury type, n (%)	
Superficial injuries	1,291 (39.8)
Strain-sprain injuries	703 (21.7)
Bone injury	562 (17.3)
Burn injury	92 (2.8)
Organ injury	293 (9)
Deep cuts	186 (5.7)
Multiple injuries	113 (3.5)
Injury site, n (%)	
Thorax	160 (4.9)
Spine	102 (3.1)
Lower extremity	759 (23.4)
Upper extremity	1,220 (37.7)
Head and neck	497 (15.3)
Abdomen	108 (3.3)
Multiple	394 (12.2)
Presence of fracture, n (%)	795 (24.5)
Prognosis, n (%)	
Discharged from ED	2,708 (83.6)
Admitted to a hospital	351 (10.8)
Neurosurgery	24 (0.7)
Plastic and reconstructive surgery	112 (3.5)
Thoracic surgery	20 (0.6)
Orthopedic surgery	170 (5.2)
General surgery	14 (0.4)
Ophthalmology	7 (0.2)
Cardiovascular surgery	4 (0.1)
Admitted to the ICU	156 (4.3)
Exitus	43 (1.3)
Exitus in ED	25 (0.7)
Exitus in ICU	18 (0.6)
Length of stay in a hospital (days), median, (IQR)	4 (6)
Treatment costs (TL), median, (IQR)	1,729 (2,757)

ED: Emergency department, ICU: Intensive care unit, TL: Turkish lira, IQR: Interquartile range, n: Number

The occupational injuries were most common in the agriculture industry (27.6%), followed by the construction industry (24.9%). The most common mechanism of injury was falls (31.8%), followed by penetrating a sharp object (23.1%). The most common injured body areas were upper and lower extremities (23.4%-37.7%). Fractures were diagnosed in 795 (24.5%) patients. Injury characteristics of the patients are presented in Table 2.

A majority of the patients (n=2,708, 83.6%) were discharged from the ED. A total of 351 (10.83%) and 156 (4.81%) patients were hospitalized in the surgical clinics and intensive care unit (ICU), respectively. A total of 25 and 18 patients died during the treatment in ED and ICU, respectively (total 43 deaths, 1.32%).

There was a statistically significant difference in terms of age, gender, working hours, season, industry, the presence of fracture, nationality, social security status, length of hospital-stay, and treatment costs between the patients who died and survived ($p<0.05$) (Table 3).

In non-fatal injuries, 125 (3.9%) patients had permanent incapacity and 3072 (94.8%) patients had temporary incapacity. Two thousand and three hundred and twenty-two patients could return to work after 1 day. Among the other 750 patients, the hospitalized patients lost median 36 (IQR: 17) workdays and discharged patients lost mean 14.88 ± 2.81 workdays.

There was a statistically significant difference in terms of age, gender, season, industry, the presence of fracture, length of hospital-stay, and treatment costs between the patients with permanent and temporary incapacity ($p<0.05$) (Table 4).

Logistic regression analysis revealed that increasing age, construction industry, immigration, and night shifts were risk factors for mortality. There was no statistically significant correlation between gender, social security status, season, mechanism of injury, type of injury, injured body site, and mortality (Table 5).

Discussion

The number of fatal occupational injuries worldwide has tended to decrease in the last decade (1). It has been shown that morbidity and mortality due to occupational injuries have decreased significantly thanks to improved measures. Although employment has doubled following the establishment of institutions, such as the Occupational Safety and Health Administration and National Institute for Occupational Safety and Health in 1970 in the US, occupational injuries and deaths have gradually decreased (6). The study by Turkkan and Pala (7) showed that occupational injuries decreased from 1988 to 2003; however, they relapsed with a sudden rise in 2011, and the

Table 3. Comparison of survival and death patients			
	Survival (n=3,197)	**Death (n=43)**	**p value**
Age (years), mean ± SD	32.57±10.55	41.47±12.01	<0.001
Length of hospital stay (days), median (IQR)	4 (5)	11.5 (20)	<0.001
Treatment costs (TL), median (IQR)	1,684 (2,320)	9178 (32,307)	<0.001
Gender, n (%)			
Male	2,917 (98.5)	43 (1.5)	<0.05
Female	280 (100)	0 (0)	
Nationality, n (%)			
Turkey	3,125 (98.8)	38 (1.2)	<0.01
Others	72 (93.5)	5 (6.5)	
Presence of Social security, n (%)			
TSSI or private insurance	2,876 (98.9)	33 (1.1)	<0.05
None	321 (97)	10 (3)	
Days of the week, n (%)			
Weekday	2,620 (98.8)	32 (1.2)	0.203
Weekend	577 (98.1)	11 (1.9)	
Time of the day, n (%)			
Day time (08:00 a.m. - 04:00 p.m.)	1,978 (99)	19 (1)	<0.05
Night shift (04:00 p.m. - 08:00 a.m.)	1,219 (98.1)	24 (1.9)	
Season, n (%)			
Spring	900 (99.3)	6 (0.7)	<0.001
Summer	947 (97.8)	21 (2.2)	
Autumn	725 (97.8)	16 (2.2)	
Winter	625 (100)	0 (0)	
Sector, n (%)			
Agriculture and forestry	887 (99.2)	7 (0.8)	<0.001
Construction	782 (96.8)	26 (3.2)	
Manufacturing and textile	643 (98.9)	7 (1.1)	
Wholesale and retail trade	443 (99.6)	2 (0.4)	
Transportation and storage	442 (99.8)	1 (0.2)	

TL: Turkish Lira, TSSI: Turkish Social Security Institution, SD: Standard deviation, IQR: Interquartile range, n: Number

number of occupational injuries in Turkey increased again. After the enforcement of legal regulation on occupational health and safety (law no: 6331), the number of fatal occupational injuries decreased. The mortality rate of 8.91/100,000 workers in 2010 decreased to 6.98 in 2018 (3,8). However, this does not mean that occupational health and safety has improved in Turkey. The study by Nishikitani and Yano (9) have reported that the mortality rate in Turkey is higher than that in 26 Organisation for Economic Co-operation and Development (OECD) countries.

This study has shown that although the number of occupational injuries and deaths gradually decreased in the last 5 years, the rate of death/occupational injuries has been gradually increasing (Figure 1). We observed that occupational injuries decreased with age and were more common in males, in agriculture and construction industries, and in summer and spring. In addition, they generally occurred due to falling and caused superficial injuries in extremities, and a majority of patients were discharged from the ED. Moreover, there was a statistically significant correlation between age, construction industry, immigration, working in night shifts, and mortality.

Although the number of female patients (8.6%) was higher than that in studies conducted in Turkey, it was lower in many other

Table 4. Comparison of temporarily incapacity and permanent incapacity patients			
	Temporarily incapacity (n=3,072)	**Permanent incapacity (n=168)**	**p value**
Age (years), mean ± SD	32.37±10.39	38.57±12.81	<0.001
Length of hospital stay (days), median (IQR)	4 (5)	5 (9)	<0.001
Treatment costs (TL), median (IQR)	195 (129)	2,088 (8,231)	<0.001
Gender, n (%)			
Male	2,795 (94.4)	165 (5.6)	<0.01
Female	277 (98.9)	3 (1.1)	
Nationality, n (%)			
Turkey	3,003 (94.9)	160 (5.1)	0.06
Others	69 (89.6)	8 (10.4)	
Presence of social security, n (%)			
TSSI or private insurance	2,759 (94.8)	150 (5.2)	0.827
None	313 (94.6)	18 (5.2)	
Days of the week, n (%)			
Weekday	2,518 (94.9)	134 (5.1)	0.470
Weekend	554 (94.2)	34 (5.8)	
Time of the day, n (%)			
Day time (08:00 a.m. - 04:00 p.m.)	1,900 (95.1)	97 (4.9)	0.286
Night shift (04:00 p.m. - 08:00 a.m.)	1,172 (94.3)	71 (5.7)	
Season, n (%)			
Spring	871 (96.1)	35 (3.9)	<0.01
Summer	897 (92.7)	71 (7.3)	
Autumn	700 (94.5)	41 (5.5)	
Winter	604 (96.6)	21 (3.4)	
Sector, n (%)			
Agriculture and forestry	850 (95.1)	44 (4.9)	<0.01
Construction	748 (92.6)	60 (7.4)	
Manufacturing and textile	613 (94.3)	37 (5.7)	
Wholesale and retail trade	427 (96)	18 (4)	
Transportation and storage	434 (98)	9 (2)	

TL: Turkish Lira, TSSI: Turkish Social Security Institution, SD: Standard deviation, IQR: Interquartile range, n: Number

studies (6,10,11). This can be explained by the fact that women work in jobs with a relatively lower risk of work-related injuries. Another reason for this is that women in Turkey commonly work in cleaning services and the agriculture industry and informally. In Turkey, the obligation of women to take out insurance while working in daily jobs was enacted in 2015 and its scope is very limited. We think that these injuries are generally unrecorded, since such injuries are superficial and do not need hospital admission.

The majority of occupational injuries cause superficial injuries and most patients are discharged after treatment without the need for further examination or treatment (10,12). In this study, 2,708 (83.6%) patients were discharged from ED after their treatments were completed, which is consistent with the literature.

Previous studies have reported various mortality rates. In the study by Ozkan et al. (12), the mortality rate due to occupational injuries was 7.8%. In the study by Turkkan and Pala (7), the mortality rate was 22/100,000 workers and the fatality rate was 13.4/1,000 injuries. However, they also observed that the official data used did not comprise a significant proportion of active employees. The mortality rates due to occupational injuries

are affected by differences in the industrial sectors in the study region. Agriculture, construction, and manufacturing industries are common in our region, but there are no working areas in the mining sector. In this study, 25 and 18 patients died during the treatment in ED and ICU, respectively. The number of deaths per 1,000 occupational injuries was 13.27. Based on the data from the Turkish Social Security Institution (2018), the number of deaths per 1,000 occupational injuries was 3.57 (3). The rate of death/occupational injuries in this study was higher than that in the official data. We believe that this is due to the lack of hospital admissions after nonfatal and superficial injuries that did not require hospitalization.

In this study, the mean age was 32.69±10.61 years, and 1,350 patients were in the age range of 18-29 years. It has been previously shown that occupational experience improves as the age progresses and therefore injuries decrease (2). The number of studies on occupational injuries involving patients <18 years is very limited (7). However, agriculture is an important source of income in our region, and people <18 years work to support their families. Hence, we included this age group in our study. There were 92 (2.8%) patients <18 years, and most of them were working in the agriculture sector (35.9%) and with no social security (51.1%). The number of occupational injuries decreased with increasing age, whereas the mortality rate increased significantly with increasing age. The study by Gonzalez-Delgado et al. (13) reported that the mortality rate increases with age. On the other hand, the study by Salminen (14) has shown that younger workers have a higher risk of occupational injuries but lower risk of death due to occupational injuries. The reason for this is that the young people are more impact-resistant and recover faster than the elderly. In this study, increased age was considered a significant risk factor for mortality.

Table 5. Multivariate logistic regression analysis of mortality predictors

Risk factor	Odds ratio (%95 confidence interval)	p value
Age	1.06 (1.04-1.09)	**0.000**
Male gender		0.995
Immigration	4.82 (1.1-21.11)	**0.037**
Lack of social security		0.968
Night shift	3.43 (1.36-8.61)	**0.009**
Season		0.507
Construction industry	4.1 (1.73-9.7)	**0.008**
Injury mechanism		0.471
Injury type		0.966
Injury site		0.984

Significant p values are shown in bold

Most fatal injuries in the construction industry occur because of falling down from height and crashing into a moving vehicle, whereas most nonfatal injuries are caused by falling down (from same level) or crashing into moving objects (15,16). The study by Arndt et al. (17) reported that 2.52 times more occupational disabilities occur in construction injuries compared to the general labor force. Additionally, Aksorn and Hadikusumo (18) emphasized that the risk of fatal injuries in the construction industry is five times higher than that in other industries. In this study, the majority of the occupational injuries in the construction industry were due to falls (38%). Because of occupational injuries in the construction industry, 60 patients permanently lost their working ability while 26 patients died. The risk of fatal occupational injuries in the construction industry was 4.1 times higher than that in other sectors, which is consistent with the literature.

Many previous studies have reported that working at night shift causes various cognitive disorders; therefore, resulting in more occupational injuries compared to working at daytime (19,20). In this study, occupational injuries were more common between 08:00 a.m. and 04:00 p.m. (62.1%). Although daytime occupational injuries are numerically high, nighttime occupational injuries are proportionally higher, considering the number of daytime and nighttime workers. We have observed that working at night shift increases the risk of death due to occupational injuries 3.43 times.

Migrants work without receiving adequate occupational health and safety training and without health or social security protection, in physically harder jobs with longer working hours and lower wages, and therefore face more occupational injuries (1,21-25). In this study, the number of immigrants was 77 (2.4%). Most immigrants worked in the agriculture and construction industries (n=59, 76.6%, p<0.001). We think that,

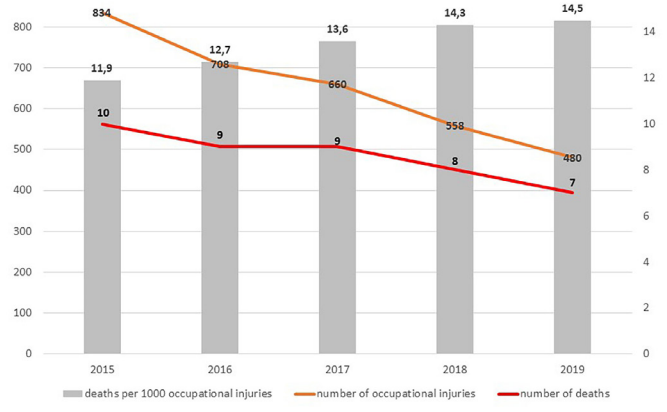

Figure 1. Changes in the number of occupational injuries, deaths and the rate of deaths per 1,000 occupational injuries within five years

immigrants are not admitted to the ED after superficial injuries because of the fear of losing their current job and in fact, the number of occupational injuries among immigrants is much higher. Immigrants constituted 11.6% (n=5) of all deaths, and immigration was considered a significant risk factor for deaths due to occupational injuries.

Study Limitations

The main limitation of this study is that patients who were not admitted to the hospital and whose data were missing could not be included in the study. Additionally, this was a single-center retrospective study. There is a need for multicenter, prospective studies in which employers also provide data, to better understand occupational injuries and improve measures.

Conclusion

The labor conditions of immigrants as well as of those working at night shifts and in the construction industry should be supervised. Their job security should be increased and working without social security should not be allowed. Moreover, the number of occupational injury and deaths has been decreasing over the years, whereas the death/occupational injuries rate has been increasing. Many of the occupational deaths and injuries can be prevented if the measures are improved.

Ethics

Ethics Committee Approval: The study was conducted in compliance with the Declaration of Helsinki and approved by Aksaray University Faculty of Medicine Scientific Research Evaluation Committee with decision no: 2020/01-08 and date 20.01.2020.

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.Ç., N.B.A., Concept: A.Ç., İ.K., B.Ö., N.B.A., Design: A.Ç., M.H., N.B.A., Data Collection and/or Processing: A.Ç., İ.K., M.H., B.Ö., S.Ö., Analysis and/or Interpretation: A.Ç., N.B.A., Literature Search: A.Ç., S.Ö., N.B.A., Writing: A.Ç., İ.K., M.H., B.Ö., S.Ö., N.B.A.

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Assessment of the Satisfaction Levels of Intern Students

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Abstract

Aim: Given the importance of internship in emergency medicine, intern doctors are supposed to take more responsibility during this period. They are involved in the admission, examination, planning and implementation of the treatment of patients under the supervision of assistants and instructors. This study aims to specify the expectations and satisfaction levels of Pamukkale University 6th grade medicine students for emergency medicine internship in 2018-2019 academic year.

Materials and Methods: The students who completed their emergency medicine internship within one year were evaluated with a questionnaire at the beginning and at the end of the internship period. Without writing their names, the respondents are expected to answer the survey questions designed on a 5-point Likert scale.

Results: The study group consisted of 149 students, whose average age is 24.4 and, 68 of the participants were male, while 81 were female. The obtained results reveal that the participants thought they would use their practical knowledge at the end of the internship, that the internship period proved efficient, that they did not have reservations about practising in the emergency department (ED), and that they wanted to be an emergency medicine assistant (p=0.009; 0.014; 0.05; 0.029).

Conclusion: The results of this evaluation demonstrate that the emergency medical internship was efficient, and that they were able to apply their practical knowledge. Our study concludes that, following the internship period, their fears for serving in the ED decreased, their communication skills improved, and their desire to work as emergency medicine assistants at Pamukkale University increased.

Keywords: Student, intern doctor, feedback, internship, satisfaction, faculty of medicine

Introduction

According to the Turkish Language Institution (TDK), the word "intern doctor" refers to "pre-physician". In a widely used sense, it is the name assigned to students who serve in a hospital for a year to acquire basic knowledge and skills before graduating from a medical school. Intern doctors are supposed to visit hospitalized patients together with their instructors and assistants, follow up patients, and take care of their treatment. Part of their training also involves admitting the patient, taking a blood sample, measuring blood sugar, taking an electrocardiography, and recording the findings on the files. In accordance with their internship plan, these intern doctors practise in departments, such as internal medicine, pediatrics, gynecology, public health, psychiatry and emergency medicine for two months.

Given the importance of internship in emergency medicine, intern doctors are supposed to take more responsibility during this period. They are involved in the admission, examination, planning and implementation of the treatment of patients under the supervision of assistants and instructors.

While Pamukkale University is preparing their intern students for the field of medicine, internship education is provided so that they assimilate the importance of preventive medicine, scientific thinking, and continuous professional education and development. During this internship period, education and training is organized by the relevant educational boards and departments in the form of practising modules. The internship process at the 6th grade is organized as two-month periods, and two weeks of this process is arranged as a general surgery rotation. When it comes to general information on our department, where

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five faculty members and 35 research assistants serve, the number of patients presenting with the emergency department (ED) annually is 119,802, and around 150 intern doctors per year complete their internships in the ED. Whereas research assistants are provided with theoretical and practical training every week, intern doctors undergo training on medical conditions and diseases they frequently encounter in the ED under 16 topics for four weeks.

This study aims to identify the satisfaction level of intern medical students doing their internship and evaluate their feedback.

Materials and Methods

The respondents filled in the survey without writing their names on it. A 5-point Likert scale was administered as the pre-test with 29 questions and the post-test with 31 questions to determine the satisfaction level of the emergency medicine internship.

This study included intern medical students performing their emergency internship at Pamukkale University Faculty of Medicine during the 2018-2019 academic year. The approval for the study was granted from the Non-Interventional Clinical Research Ethics Committee of Pamukkale University with the number 60116787-020/58595 and date September 04, 2018. During this period, there were 156 intern students, 149 (95.5%) of whom agreed to participate in the study. An informed consent form was obtained from each student. A pre-survey was handed out to all students at the contact meeting held collectively before embarking on their internship, and the intern students were asked about four questions on demographic features and 25 questions on their internship expectations. Two additional questions related to the evaluation of the course lectured during the internship along with the same 25 questions (27 questions in total) were asked at the meeting held to receive post-internship feedback as a group at the end of the period. The items asked in the survey are provided in Table 1.

The items in the survey were designed on a 5-point Likert scale. A Likert scale refers to the scales used by combining multiple Likert-type questions (1). It is described as creating two or more Likert-type items to answer a single research question and using the average (combined) values of these items in the analysis phase.

Additionally, calculating the arithmetic average of the replies provided to the items in the Likert scale turns the data into interval data, and thus parametric tests can be run on this arithmetic average (2).

Statistical Analysis

All the data obtained in the study were recorded and analysed in the statistical software SPSS 22. All the items were prepared and

Table 1. Survey questions

Demographic information
Age
Gender
Grade
Type of high school you graduated
Pre-test and post-test
Do you think the duration of the emergency internship is sufficient?
Do you think you will be/were able to acquire enough practice in the emergency internship?
Is emergency internship very important in preparing you for your professional life?
Do you think you will be/were able to use your theoretical knowledge in the ED?
Do you think you will be/were able to use your practical knowledge in the ED?
Do you think that emergency medicine internship will be/were effective?
I think I will be/was able to contact the emergency instructors easily.
I will be/was able to communicate with the emergency instructors.
Do you think your shifts in the ED will have/had an effect on your practice?
Do you think the visits in the ED will be/were useful?
I am satisfied with the physical conditions in the ED.
I think I will improve/improved my communication with patients/their relatives.
I think I will feel/felt like a team member.
I think I will increase/increased my self-confidence in the ED.
I am afraid to work in the ED.
I think I will not/did not have problems with the ED assistants.
I will not/did not have any problems with the emergency staff (nurses, health officers).
The solidarity between the interns was as it should be.
Are you happy to study at Pamukkale University?
Are you proud to study at Pamukkale University?
Would you recommend Pamukkale University Faculty of Medicine to those who will take the university exam?
Would you like to do your assistantship at Pamukkale University?
Would you like to be an assistant in ED?
I would like to be an assistant in the ED at Pamukkale University.
I think the emergency medical internship should last longer.
Internship education
Was the content of the classes lectured in the emergency internship sufficient?
Was the theoretical and practical distribution of the classes balanced?

ED: Emergency medicine

asked in the structured questionnaire format. The descriptive statistics were calculated as mean ± standard deviation for numerical variables and as number and percentage values for categorical variables. A chi-square test was run to analyse the between-groups differences.

Results

The study group consisted of 149 students, whose average age was 24.4 [minimum (min): 22; maximum (max): 28]. In terms of the distribution of both groups by gender, 68 (45.6%) of the participants were male, while 81 (54.4%) were female.

While many students at the internship period spent at least 6 years in the faculty, some others spent maximum 9 years, and the average time of students in the faculty who were practising their internship was calculated as 6.2 years (min: 6; max: 9). In terms of the type of high school they graduated, 3 (2%) students reported to have graduated from regular high school, 1 (0.7%) from vocational high school, 9 (6%) from private high school, 91 (61.1%) from Anatolian high school (schools with intensive English classes), 31 (20.8%) from science high school, and 14 (9.4%) from Anatolian teacher training high school (schools with intensive English classes).

As far as the answers given to all survey questions are concerned, the items revealing significant difference between the pre-test and post-test are illustrated in Table 2.

Discussion

This study attempts finding out the expectations and satisfaction levels of intern medical students toward emergency medicine internship. Overall, the survey items question the duration and content of the internship, education and practice in the internship, communication skills, anxiety suffered during the internship, satisfaction with the university, and the issues related to emergency medicine. Sixth grade medical students are supposed to serve actively in internships for one year before graduation. It is noteworthy to re-assess the internship content by receiving feedback on the emergency medicine internship and questioning the satisfaction levels of intern doctors.

As far as the student responses are concerned, it can be concluded that the intern students could exploit their practical knowledge, found the emergency medicine internship efficient overall, were frightened to work in the ED, and did not encounter problems with the ED assistants and staff. Further, significant changes were identified in the questions about working as an emergency medicine assistant at the Pamukkale University.

However, there are no significant changes in the students' opinions on duration of the emergency internship, expectation of doing sufficient practice during this time, preparation for professional life, expectations of applying the theoretical knowledge in this period, efficiency of the internship, adequacy of the content of the courses lectured in the internship, expectations of emergency shifts on practice, and physical conditions in the ED. When it comes to communicative issues, the students' opinions remained unchanged in terms of contacting their instructors in the ED, communicating with their instructors in the ED, making visits in ED, communicating with patients, feeling like a member of the ED team, feeling self-confident in emergency medical internship, and considering solidarity among intern doctors as it should be. In relation to their sense of fulfilment and future career, no significant change was found in their satisfaction with studying at Pamukkale University, their pride in being at Pamukkale University, their recommendation to the students who will take the university exam, their opinions on becoming an assistant in the ED, and their views on a longer emergency medical internship.

As is evident in Table 2, a significant change was found only in the question related to internship education, which is "Was the theoretical and practical distribution of the courses balanced?".

Dechesne (3) suggests that designing a curriculum requires three stages. The first is "development", in which the goals and organization of the program are specified, whereas the second stage is called "implementation", in which the program already developed is implemented. In the final step called "evaluation", how much the program meets the objectives is assessed ultimately. In this study, the educational process was planned in advanced, and the guidelines which laid down the internship goals in the written form were handed out to the intern doctors in the early days of the internship period. Their practices and performances were evaluated in their internship reports at the end of the period, while their satisfaction with the internship process was measured with the survey. The results of this evaluation revealed that the emergency medical internship was efficient and that they could apply their practical knowledge. The feedback provided by intern doctors should be taken into consideration in other internships, too. If dissatisfaction is identified, reviewing and re-evaluating the curriculum and practices may be suggested.

In a study by Yeniceri et al. (4), the State-Trait Anxiety Inventory with 18 questions was administered to 45 intern medical students to identify the anxiety about their prospective professional life and their trait anxiety. The results revealed that 70% of the students suffered moderate trait anxiety, and that the highest anxiety states were listed as failure in the examination for specialty in medicine, inadequate preparation for this exam and not working as a specialist in their future career. On the other

Table 2. Items revealing significant difference between the pre-test and post-test					
Items	**Answers***	**Pre-test**	**Post-test**	**Total**	**Between groups p**
Do you think you will be/ were able to use your practical knowledge in the ED?	1	0 (0%)	3 (2.01%)	3 (1.01%)	0.009** (χ^2=13.516)
	2	5 (3.38%)	1 (0.67%)	6 (2.02%)	
	3	17 (11.49%)	6 (4.03%)	23 (7.74%)	
	4	45 (30.41%)	45 (30.2%)	90 (30.3%)	
	5	81 (54.73%)	94 (63.09%)	175 (58.92%)	
Do you think that emergency medicine internship will be/ were effective?	1	0 (0%)	2 (1.34%)	2 (0.67%)	0.014** (χ^2=12.539)
	2	2 (1.35%)	1 (0.67%)	3 (1.01%)	
	3	18 (12.16%)	9 (6.04%)	27 (9.09%)	
	4	61 (41.22%)	45 (30.2%)	106 (35.69%)	
	5	67 (45.27%)	92 (61.74%)	159 (53.54%)	
I am afraid to work in the ED.	1	44 (32.59%)	56 (43.41%)	100 (37.88%)	0.05** (χ^2=9.343)
	2	30 (22.22%)	35 (27.13%)	65 (24.62%)	
	3	35 (25.93%)	16 (12.4%)	51 (19.32%)	
	4	16 (11.85%)	12 (9.3%)	28 (10.61%)	
	5	10 (7.41%)	10 (7.75%)	20 (7.58%)	
I think I will not/did not have problems with the ED assistants.	1	7 (4.86%)	4 (2.72%)	11 (3.78%)	0.003** (χ^2=16.058)
	2	2 (1.39%)	2 (1.36%)	4 (1.37%)	
	3	14 (9.72%)	8 (5.44%)	22 (7.56%)	
	4	54 (37.5%)	31 (%21.09%)	85 (29.21%)	
	5	67 (46.53%)	102 (69.39%)	169 (58.08%)	
I will not/did not have any problems with the emergency staff (nurses, health officers).	1	5 (3.42%)	3 (2.01%)	8 (2.71%)	0.002** (χ^2=16.89)
	2	8 (5.48%)	3 (2.01%)	11 (3.73%)	
	3	18 (12.33%)	11 (7.38%)	29 (9.83%)	
	4	52 (35.62%)	33 (22.15%)	85 (28.81%)	
	5	63 (43.15%)	99 (66.44%)	162 (54.92%)	
	5	104 (70.27%)	102 (68.46%)	206 (69.36%)	
I would like to be an assistant in the ED at Pamukkale University.	1	29 (21.01%)	16 (11.43%)	45 (16.19%)	0.029** (χ^2=10.772)
	2	20 (14.49%)	18 (12.86%)	38 (13.67%)	
	3	43 (31.16%)	48 (34.29%)	91 (32.73%)	
	4	34 (24.64%)	30 (21.43%)	64 (23.02%)	
	5	12 (8.7%)	28 (20%)	40 (14.39%)	
Internship education					
Was the theoretical and practical distribution of the classes balanced?	1	1 (0.79%)	6 (4.11)	7 (2.57%)	0.017** (χ^2=12.009)
	2	5 (3.97%)	4 (2.74)	9 (3.3%1)	
	3	37 (29.37%)	23 (15.75)	60 (22.06%)	
	4	47 (37.3)	54 (36.99)	101 (37.13%)	
	5	36 (28.57)	59 (40.41)	95 (34.93%)	

ED: Emergency department
*: 1 Strongly disagree; 2 Disagree; 3 Neither agree nor disagree; 4 Agree; 5 Strongly agree, **: Significant difference between the pre-test and post-test questions chi-squared test (χ^2)

hand, our study deals with the contribution of the internship to the student, intern doctors' training during the internship, communication skills during this period, and their preference for being emergency medicine assistants. Our study concludes that, following the internship period, their fears for serving in the ED decreased, their communication skills improved, and their desire to work as emergency medicine assistants at Pamukkale University increased. One of the plausible reasons for this could be the positive communication among the emergency personnel.

In a study by Celebiler et al. (5), in which a survey with 84 questions was administered to 125 4th, 5th, 6th grade medical students to specify their satisfaction level, the participants primarily reported that they had difficulties in buying lunch tickets from the registrar's office, did not have an intern doctor's room, and were beset with transportation problems in getting to the hospital. In our study, the participants reported that the physical conditions in the ED were not sufficient, and that the solidarity among the intern doctors was inadequate, which was not statistically significant.

In a review study by Steinert et al. (6), the main features of effective faculty development are cited as effectiveness, encouragement of experimental learning, feedback, effective peer relationships, properly-planned interventions after educational principles, and interventions through various instructional methods. However, our study evaluated the feedbacks as a survey, the relations with peers and other staff, the feedback on education, reporting that positive feedback was received in relation to the internship process.

In his study, Teutsch (7) states that efficient and effective communication can be promoted through a well-designed training, but still that current and future developments will not eliminate the importance of empathic and caring dialogue between the physician and the patient. He further concludes that communication proves to be an integral part of patient management, and that communication tended to be treated informally in the form of faculty feedback in the curriculum of medical schools, rather than allocating some space for clinician-patient communication in their curriculum. When our study is evaluated as pre- and post-internship, it can be concluded that no change occurred in the intern doctors' perceptions of communicating with their instructors in the ED, in their opinions on improving the communication with the patient/patient relatives, and in the communication among their own peers. This may have resulted from the fact that the internship period is not long enough to create a change in communication skills over a period of two months.

Karabilgin and Sahin (8) listed the issues to be considered at every stage from planning to using the results of student feedbacks which are frequently used to evaluate the educational program and instructor. It is stated that surveys should allow students to assess the performance of the educator through with quantitative and qualitative data, reflect the instructional effectiveness of the educational program or the educator, and have a clear and expressive title. Besides, the authors conclude that student feedback by using surveys cannot be used alone as a resource for evaluating education and educators, and that surveys should be such as to complement other evaluation methods. Apart from this study, the feedback by the students in our university is evaluated through post-training surveys in their pre-intern years, but no feedback is received from our intern students in their final year. Our research attempts specifying the satisfaction level of intern doctors during their emergency medicine internship. Because of the current study, no significant changes were observed in the participating intern doctors in terms of performing adequate practice, employing theoretical knowledge, doing beneficial rounds, boosting self-confidence in the emergency internship and developing solidarity among themselves.

Study Limitations

As our study encompasses the intern students only within a period of one year, it excludes a sufficient amount of data. Additionally, even though similar studies have been carried out in different universities, it is difficult to draw comparisons owing to the varying numbers of patients and students in every university and students' different perceptions. Similar studies should be conducted in other universities with a larger population to unveil the full picture of internship in the ED.

Conclusion

This study reveals that the emergency internship proved efficient, and that the intern students could implement their practical knowledge. Additionally, it can be concluded that, following their emergency internship, the intern students did not feel reserved about working in the ED, got along well with the ED personnel, and wished to be an assistant in emergency medicine. This study also suggests that the surveys may act as effective instruments in evaluating the satisfaction levels of the intern students, and that the required arrangements should be made in the light of the student feedback in order to further improve these satisfaction rates.

Ethics

Ethics Committee Approval: Non-Interventional Clinical Research Ethics Committee of Pamukkale University with the number 60116787-020/58595 and date September 04, 2018.

Informed Consent: Informed consent was obtained from the participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: M.S., A.Y., M.O., Design: M.S., A.Y., M.O., Supervision: M.S., Materials: M.S., A.Y., M.O., Data Collection and/or Processing: M.S., A.Y., M.O., Analysis and/or Interpretation: M.S., A.Y., M.O., Literature Review: M.S., A.Y., M.O.

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Mode of Arrival Aware Models for Forecasting Flow of Patient and Length of Stay in Emergency Departments

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Abstract

Aim: Flow of patients to emergency departments (EDs) and their stays in EDs (ED-LOS) depend significantly on their arrival modes. In this study, developing effective models for forecasting patient flow and length of stay (LOS) in EDs by considering arrival modes led better planning of ED operations.

Materials and Methods: In this study, by categorizing the mode of arrival into two, self-arrived in and by ambulance, autoregressive integrative moving average (ARIMA) models are applied for forecasting four time series: daily number of patients self arrived/arrived by an ambulance and average LOS of patients self-arrived/arrived by an ambulance. The models are validated with real-life data received from a large-scaled urban ED in İzmir, Turkey.

Results: While seasonal ARIMA is proper for forecasting the daily number of patients on both modes, non-seasonal models are proper for forecasting the average LOS. The mean absolute percentage errors (MAPE) for the models of four time series are 5,432%, 13,085%, 9,955% and 10.984%, respectively. Thus, daily arrivals to the EDs show seasonality patterns.

Conclusion: By emphasizing the impact of mode of arrival in ED context, this study can be used to aid the strategic decision making in the EDs for capacity planning to enable efficient use of the ED resources.

Keywords: Emergency department, forecasting, patient flow, length of stay, ARIMA

Introduction

Emergency departments (EDs), which provide prompt and essential medical care for patients, are an important component of health systems. However, patients in many countries often suffer from the overcrowded environment of EDs that causes an increase in the length of stay (LOS), intensive stress among ED personnel, increase in costs, and decrease in patient satisfaction (1). Although increasing resources is a possible solution to deal with such problems, it is not always efficient since it requires high budgets. Thus, efficient management of patient flow/demand in EDs has become an urgent issue and currently significant attention is paid for planning ED operations and improving management strategies. To this end, forecasting has become a prominent subject for researchers and practitioners, since ability to generate real-like forecasts has substantial implications for EDs in improving strategic planning.

In this context, the first thing comes to mind is forecasting the patient flow. However, in planning and managing ED operations, forecasting not only the flow of patient but also the LOS, time from registration of patient in ED to final disposition, has a great importance (2). Nonetheless, both the daily flow of patients and their LOS values depend highly on how they arrived to ED. Mode of arrival of patients is mainly grouped into two as those arrived by an ambulance and by walking. While LOS of patients arrived by an ambulance is generally higher than those arrived by walking, the opposite comparison holds for daily demand (3). Undoubtedly, generating mode of arrival aware models for forecasting daily demand and LOS, which mainly consider differences in the values

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for the patients who arrived by an ambulance and by walking, has a significant impact in ED operations management.

Many different forecasting models such as regression models, time series analyses, queueing theory-based models, neural network models and simulation models have been proposed in the ED literature (4). Since daily patient flow, LOS and many other ED-related data have a time series structure, time series models are most widely used among all these forecasting models both in theory and practice. Time series analysis is defined as a branch of statistics that provides methods for making numerical predictions about future events by using past observations collected at regular intervals. Generated long and/or short-term forecasts are used to make current decisions and plans in EDs.

The main objective of this work is to propose statistical models based on univariate time series of the daily patient flow and LOS which can be used in generating forecasts for short and/or long-term planning. Although, modelling with ED-based time series have frequently studied in literature, previous studies have been limited to generate models for either daily flow of patient or LOS by considering all types of patient arrivals; effect of mode of arrival is not considered. Thus, this study contributes to literature by developing mode of arrival aware models for two main time series of EDs, both daily flow of patient and LOS, and by analyzing the impact of mode of arrival in performance of forecasting models.

The remainder of this paper is organized as follows: In Section related studies are summarized. In Section 3 data of this study and the used forecasting model are presented. The results on data analysis and validation of the models on the dataset are shown in Section 4. The main findings, practical implications and limitations of this study are discussed in Section 5. Finally, the sixth section presents the conclusion of this study.

Literature Review

Existing studies vary in target time series data of ED to be forecasted and the used forecasting methods. In this section, studies on forecasting patient flow, forecasting LOS and different methods used for forecasting in the ED context are summarized respectively.

ED Patient Flow Forecasting

Many of the existing studies focus on forecasting demand in EDs. These studies differ based on their objectives, methods and type of forecasting intervals. Although some of these studies aim to predict flow of patients in different time-intervals such as hourly (5-8), periodically (9,10), weekly (11), or monthly (12-16), many of them focus on generating forecasts on the daily basis. A few of those studies generating forecasts for daily demand are presented here.

Batal et al. (17) formed a mathematical equation, which forecasts daily number of patients seeking for urgent care by considering the calendar variables. Jones et al. (18) aimed to forecast daily patient volumes in the emergency department. Sun et al. (19) developed forecasts for daily ED attendances to aid resource planning for micro and macro level. Kam et al. (20) developed models for forecasting daily number of arrivals of a Korean regional hospital's ED. Higginson et al. (21) proposed that analysis of ED demand was the first step towards effective workforce planning and process redesign. Boyle et al. (22) developed and validated models to predict ED presentations for the day of the year. Cote et al. (23) proposed a tutorial for ED practitioners for forecasting patient volumes in support of strategic, tactical and operational planning. With the aim of modelling daily number of patients and assess the relative importance of contributing variables, Xu et al. (24) applied forecasting models. By using calender variables and ambient temperature readings, Marcilio et al. (25) forecasted daily visits of an ED. Kadri et al. (26) aimed to model and forecast ED overcrowding. Considering the seasonality of time series, Luo et al. (27) focused on forecasting daily arrivals to a hospital. Carvalho-Silva et al. (28) evaluated various forecasting models for daily arrivals of a Portuguese ED. Besides generating periodical forecasts, Sariyer (10) used techniques to forecast daily demand of EDs, and compared the performances of periodical and daily forecasting. In order to present a baseline to ED management for allocating human resources and medical equipment efficiently, Yucesan et al. (29) proposed methods for patient arrival forecasting. By using the previous arrival and departure times of all patients and exogenous variables, Whitt and Zhang (30) focused on forecasting future daily arrivals in an ED. With the objective of creating a tool that accurately predicts daily arrivals at EDs to support optimal planning of resources, Jilani et al. (31) applied models for both short- and long-term levels. In order to provide an insight for researchers and practitioners on forecasting in EDs to show current state and potential areas for future studies, Gul and Celik (32) presented an exhaustive review in the context of forecasting ED arrivals.

ED-LOS Forecasting

A literature gap is identified in modelling ED-LOS despite ED-LOS remains the most commonly reported outcome measure resulting from overcrowding. A few studies aiming to model ED-LOS are summarized in this section. With the aim of identifying the factors characterizing LOS in EDs, Combes et al. (33) developed models for ED-LOS prediction. Gul and Guneri (34) aimed to forecast ED-LOS by using the predictive input factors such as age, sex, mode of arrival, treatment unit, medical tests, and inspection in the ED. By using the input variables of gender, age, triage level, mode of arrival and diagnosis Sariyer,

et al. (2) proposed models for classifying patients of EDs based on their LOS.

Although many existing studies aimed to analyze or model the relation between ED flow of patient and ED-LOS (3,35,36), to the best of the knowledge, only a few studies provided models for forecasting both of the flow of patients and LOS in EDs (37).

Used Methods in Forecasting

Various forecasting techniques have been proposed in the ED literature. Although some of those studies use queueing theory-based models and/or simulation models (28,30), most of them employ regression models and/or time series models.

In order to predict flow of patients in EDs, many of the existing studies was applied different types of regression models (6,7,9,17,18,23,25). On the other hand, as most widely used time series model, many researchers employed non-seasonal/seasonal auto regressive integrative moving average [ARIMA/seasonal autoregressive integrated moving average (SARIMA)] in ED demand prediction (10,11,13-16,19,20,26,27).

More current approach in forecasting ED demand is use of artificial neural networks (ANN). Xu et al. (24), Menke et al. (38) can be cited as just few of those studies utilizing neural networks in this context. Besides, some researchers applied hybrid models such as regression-ANN or ARIMA-ANN hybrid models in ED patient volume forecasting (1,29,31).

For ED-LOS forecasting, although some researchers employed regression and time series modelling (3,37), most of the others used artificial neural networks or some other types of classification models (2,33,34).

In this study, in order to model two main time series in EDs, patient flow and ED-LOS, ARIMA-SARIMA models are employed. The proposed models differ from existing studies based on their arrival mode awareness. That is, while existing studies used all patient arrivals and corresponding LOS values, in this study, different time series models are proposed for patients who arrived in ED by walking or by an ambulance.

Materials and Methods

Study Design

This is a retrospective study to model daily patient flow and average daily LOS of both walk in and ambulance patients at a single ED. The local institutional review board approved this study and waived the requirement for informed consent.

Study Setting and Participants

The data of this research is obtained from a large-scaled urban training hospital having an average daily number of around 1,000 patients in İzmir, Turkey. All patients who registered to this ED during the study period of January 2017 to June 2017 are included in the study.

Data Sources and Variables

Data of all these patients are extracted from the hospital's electronic data warehouse. This database includes protocol numbers, time stamps and different demographics of registered patients. In this study, time stamps (times of arrival and departure stored in the following form "dd.mm.yyyy hh:mm:ss") and mode of arrival, which is then combined in two categories as patients who arrived by walking and by an ambulance, are used. The variables of this study are then defined as 1) daily number of patients who arrived by walking, 2) daily number of patients arrived by an ambulance, 3) average daily LOS of patients arrived by walking and 4) average daily LOS of patients arrived by an ambulance. The daily number of patients is defined as the total number of patients arrived in the single day, and counted by all days during the study period. LOS of each patient is defined as the difference between his time of departure and time of arrival and measured in minutes. Average daily LOS is calculated by taking the average LOS values of patients who arrived on a single day and for each day of the study period these average LOS values are similarly obtained.

Statistical Analysis

In this study, ARIMA models are used in analyzing time series data representing the study variables. These models analyze autocorrelations among the observations of the time series. The general structure of ARIMA is represented as $ARIMA(p, d, q) * (P, D, Q)_s$. While in this representation, lower case letters (p, d, q) represent the non-seasonal parameters, upper case letters (P, D, Q) represent the seasonal parameters where s denotes seasonality length. This model has two main parts as $AR(p)$ and $MA(q)$. The integrative part, $I(d)$ is used to integrate non-stationary series into stationary series. $AR(p)$, $MA(q)$ and $ARMA(p, q)$ models are used to analyze and forecast non-seasonal and stationary time-series. $ARMA(p, q)*(P, Q)_s$ is used to analyze seasonal and stationary time series. While non-stationary and non-seasonal series are analyzed with $ARIMA(p, d, q)$, non-stationary and seasonal series are analyzed with $ARIMA(p, d, q)*(P, D, Q)_s$ (39).

In an $AR(p)$ model, an observation is mathematically modelled with previous p observations of the times series and the random error as:

$$Y_t = \sum_{i=1}^{p} \alpha_i Y_{t-i} + \varepsilon_t \quad (1)$$

where Y_{t-i}'s show previous observations, α_i corresponding coefficients ($i = 1, \ldots, p$) and ε_t is the random error term having the standard normal distribution $\varepsilon_t \sim N(0, \sigma^2)$.

In the other main part, *MA(q)*, an observation is a linear function of past q error terms and their average:

$$Y_t = \varepsilon_t + \sum_{j=1}^{q} b_j \varepsilon_{t-j} \quad (2)$$

where, ε_{t-j}'s represents past error terms of q observations and b_j's are the model coefficients ($j = 1, \ldots, q$).

Besides, *ARMA(p, q)* model is a linear function of past observations and error terms:

$$Y_t = \sum_{i=1}^{p} a_i Y_{t-i} + \sum_{j=1}^{q} b_j \varepsilon_{t-j} + \varepsilon_t \quad (3)$$

When time series is non-stationary, integrative part of these models should be active, since before constructing the forecasting models, time series is needed to be stationary (29,40). By taking the differences of sequential observations, an original time-series can be integrated to new time series, and the process of taking differences in integrated time series should be repeated d times until the obtained time series becomes stationary. After the series becomes stationary, *AR(p)* or /and *MA(q)* parts of the model are used for forecasting time series.

If time series is seasonal, then the related seasonality part should work in a similar manner, where the models, *AR(P), MA(Q),* use the past observations/error terms which are seasonality length, s, behind of the current observation to be modelled. Likewise, integrating the seasonal time series means taking the differences in the observations and ones which are s period behind of them.

Outcome Measures

In this study, mean absolute percentage error (MAPE) is used to evaluate the performances of the forecasting models. For each model of this study, MAPE values are computed as follows:

$$MAPE = \frac{1}{n} \sum_{i=1}^{n} \left| \frac{\hat{Y}_i - Y_i}{Y_i} \right| * 100 \quad (4)$$

In equation (4) Y_i shows the observed value in period i and $\hat{Y}_i$ is the generated forecast value of the model for the same period, *n* represents the length of forecasting period.

Besides, to tentatively identify the numbers of AR or/and MA terms (**p, q, P, Q**), or check the appropriateness of the models with the identified numbers, autocorrelation (ACF) and partial autocorrelation (PACF) functions of the time series and the models are checked.

Results

Statistical tools of EViews Version 8 and Minitab Version 16 are used in obtaining the results of this study.

During the study period, average daily patient volume was 955.97, where daily average values for the number of the patients arrived by walking and by an ambulance are 909.33 and 46.64 respectively. While daily percentage of patients who arrived by walking is 95.08%, those for arrived by an ambulance is 4.92%. While the average daily LOS of all patients is 104.67 min, the respective values for the patients arrived by walking and by an ambulance are 97.43 and 244.77 min.

Daily distributions of each variable of this study are shown in Figures 1 and 2.

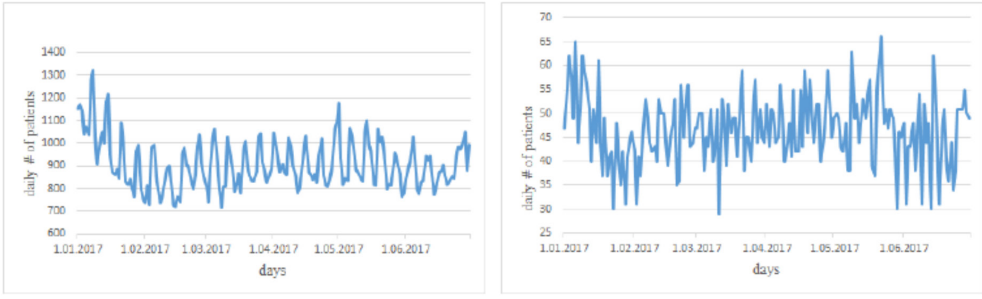
From Figures 1 and 2, it is mainly observed that both the daily number of patients and average daily LOS values differ significantly based on mode of arrival. During the study period, while the daily number of patients arrived by walking vary within the range [713-1,325], range is defined as [29-66] for those arrived by an ambulance. Similarly, while the range of average daily LOS of patients arrived by walking is defined as [73.55-138.26], it is [172.54-360.59] for the ones who arrived by an ambulance. Additionally, the seasonality pattern of time series "daily number of patients who arrived by walking" can be depicted from Figure 1a.

Main descriptive statistics of the study variables are represented by box plots in Figures 3 and 4.

According to Figures 3 and 4, it is seen that the median values for the fore-mentioned time series are 880, 47, 95.41, and 242.17 respectively. Besides, while the second, third and fourth time series of this study are symmetric (Figures 1b, 2a and 2b), the first time series is not symmetric (Figures 1a). Thus, while the last three time series of this study follow a normal distribution, normality fails for the first time series.

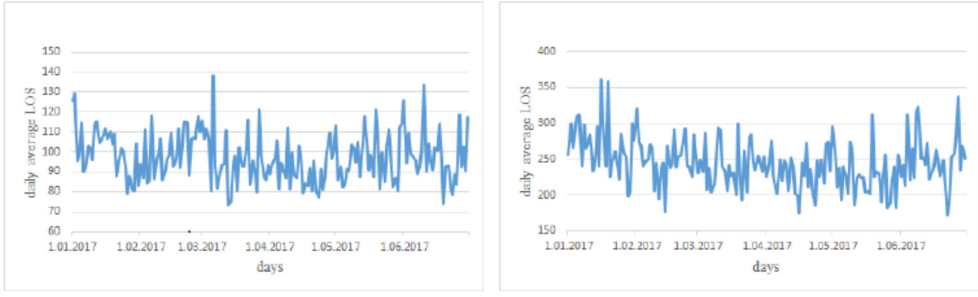
As mentioned earlier, time series should be stationary in ARIMA models. Thus, before deciding on the proper ARIMA models, setting the model parameters, stationarity of the dataset is checked based on Augmented Dickey-Fuller (ADF) test, which is one of the most widely used technique for unit root testing. In unit root testing, null hypothesis states that the time series of interest has a unit root, which is a signal for non-stationarity. Test results are shown in Table 1.

The results of Table 1 show that none of the time series of this study has a unit root meaning that all of them are stationary. Thus, differencing in time series is not required; i.e. integrative parts of the ARIMA models should be inactive (*d=0* and *D=0*).



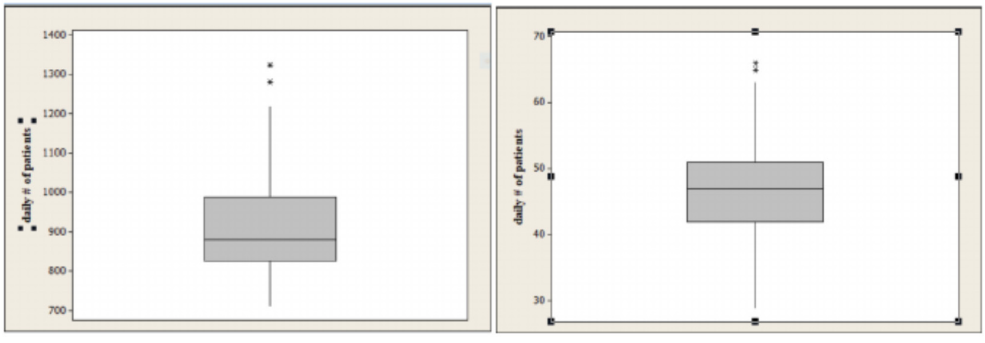
(a) arrived by walking **(b)** arrived by ambulance

Figure 1. Distribution of daily patient flow



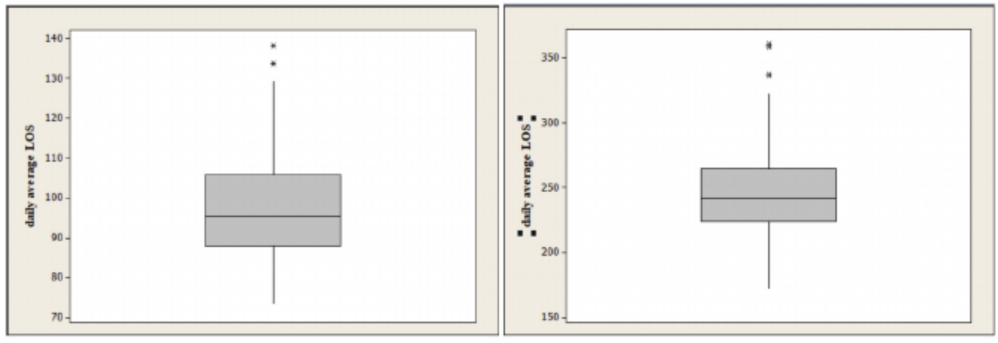
(a) arrived by walking **(b)** arrived by ambulance

Figure 2. Distribution of average daily LOS of patients
LOS: Length of stay



(a) arrived by walking **(b)** arrived by ambulance

Figure 3. Descriptive statistics on daily patient flow



(a) arrived by walking **(b)** arrived by ambulance

Figure 4. Descriptive statistics on average daily LOS of patients
LOS: Length of stay

In order to decide on the other parameters, *p/P* and *q/Q*, many different models are applied on the time series. Based on the model results, such as significance of model parameters and ACF-PACF of residuals, different ARIMA models seemed to be proper for each time series of this study. For example, for time series of the daily number of patients who arrived by walking seasonal models such as $ARIMA(1,0,0)*(1,0,0)_7$, $ARIMA(1,0,0)*(2,0,0)_7$, $ARIMA(1,0,1)*(1,0,0)_7$ are proper. For the other time series of this study, non-seasonal models are observed to be appropriate. For time series of daily number of patients arrived by an ambulance, the proper fits are $ARIMA(1,0,1)*(0,0,0)_7$ and $ARIMA(1,0,2)*(0,0,0)_7$. When $ARIMA(1,0,0)*(0,0,0)_7$ and $ARIMA(1,0,1)*(0,0,0)_7$ are good fits for average daily LOS of patients arrived by walking, $ARIMA(1,0,0)*(0,0,0)_7$, $ARIMA(2,0,0)*(0,0,0)_7$ and $ARIMA(1,0,1)*(0,0,0)_7$ are proper for average daily LOS of patients arrived by an ambulance.

For each time series, optimal forecasting models are decided by comparing the MAPE values of the proper models. Since minimizing the forecast error is aimed, the models with the lowest MAPE values are determined as the optimal ones. These optimal models and their performances based on MAPE values for the time series of this study are presented in Table 2.

Table 2 shows that ARIMA models with different parameters are the best fits for different time series. For the first time series seasonal ARIMA model, considering one non-seasonal and two seasonal auto regressive lags is the best fit. Seasonal models are not proper for the other time series. While model with one non-seasonal auto regressive and moving average lags is the best fit for the second and third time series, the best fit for the last time series considers two non-seasonal auto regressive lags. According to MAPE values of the optimal models, which are all smaller than 15%, it is concluded that while the performances of ARIMA models is good (41) for forecasting patient volumes and LOS in EDs, these models fit the best for time series of "Daily number of patients arrived by walking". It is additionally seen that the model performances are better for forecasting patient flow and ED-LOS for the patients who arrived by walking compared to those arrived by an ambulance.

Summary results of these optimal forecasting models of each time series are given in Table 3.

Values of Table 3 show that the model parameters as well as the constants of the models are significant in 95% confidence interval for the fit ARIMA models of each time series, since the corresponding p values are all smaller than 0.05.

In Figures 5-8 the ACF and PACF values of optimal forecasting model residuals are shown.

Based on the ACF and PACF of residuals shown in Figures 5-8, it is also concluded that the defined models are proper fits for time series of this study, since residuals fall within the control limits.

Discussion

Accurate forecasting of flow of patients in EDs is beneficial for the reasonable planning and allocation of healthcare resource to meet the emergency demands. Meanwhile, predicting ED-LOS

Table 1. Stationarity results

Variable/time series	t-statistic	p value	Result
TS1: Daily number of patients arrived by walking	-3.696	0.005	Reject H_0
TS2: Daily number of patients arrived by an ambulance	-11.753	0.000	Reject H_0
TS3: Average daily LOS of patients arrived by walking	-11.553	0.000	Reject H_0
TS4: Average daily LOS of patients arrived by ambulance	-11.128	0.000	Reject H_0

LOS: Length of stay

Table 2. Optimal models and their performances

Variable/time series	Optimal model	MAPE
TS1: Daily number of patients arrived by walking	$ARIMA(1,0,0)*(2,0,0)_7$	5.432%
TS2: Daily number of patients arrived by an ambulance	$ARIMA(1,0,1)*(0,0,0)_7$	13.085%
TS3: Average daily LOS of patients arrived by walking	$ARIMA(1,0,1)*(0,0,0)_7$	8.955%
TS4: Average daily LOS of patients arrived by ambulance	$ARIMA(2,0,0)*(0,0,0)_7$	11.984%

LOS: Length of stay, ARIMA: Autoregressive integrative moving average

can provide useful information for both patients and service providers: it could not only improve resource allocation, but also could facilitate decision-making. In this regard, presenting forecasting models for both of the patient flow and ED-LOS is aimed in this paper. It is additionally aimed to consider differences in patient flow and ED-LOS profiles based on the mode of arrival, patients who arrived by walking or by ambulance, in order to improve the performances of the proposed models. Thus, main variables of this study are defined as daily number of patients who arrived by walking, daily number of patients arrived an ambulance, average daily LOS of patients arrived by walking and average daily LOS of patients arrived by an ambulance, and the corresponding time series are analyzed appropriately.

First, it is observed that none of the time series has a unit root meaning that time series of this study is stationary which could be supported by existing studies (12,37).

It is also seen that while time series of daily number of patients who arrived by walking is seasonal, other time series of daily number of patients who arrived by an ambulance is non-seasonal. Average daily LOS time series are also non-seasonal for both of the patients arrived by walking and by ambulance. Since to the best of our knowledge, mode of arrival aware forecasting models have not been studied in ED context, these results should not be supported with literature. However, this result is consistent with real life experiences. In EDs, for the patients who arrived by walking, these are frequently the ones who are categorized as not urgent, significant differences exist in their daily volumes between the days of the week. Indeed, in weekends flow of patients who arrived by walking significantly increases compared to weekdays, since other services or departments of the hospitals do not provide service to patients, while EDs provide 7/24 service (3). Besides, many of these patients having slight complaints and working

Table 3. Summary results of the optimal forecasting models

Variable/time series and optimal models	Final estimates on model parameters					
TS1: Daily number of patients arrived by walking, $ARIMA(1,0,0)*(2,0,0)_7$	Type	Coef	SE	Coef	T	P
	AR	1	0,5564	0,0654	8,51	0,000
	SAR	7	0,4963	0,0758	6,55	0,000
	SAR	14	0,2946	0,0743	3,97	0,000
	Constant	87,553	4,930	17,76	0,000	
	Mean	943,63	53,13			
TS2: Daily number of patients arrived by an ambulance $ARIMA(1,0,1)*(0,0,0)_7$	Type	Coef	SE	Coef	T	P
	AR	1	0,8870	0,1058	8,39	0,000
	MA	1	0,7803	0,1426	5,47	0,000
	Constant	5,2918	0,1192	44,38	0,000	
	Mean	46,831	1,055			
TS3: Average daily LOS of patients arrived by walking $ARIMA(1,0,1)*(0,0,0)_7$	Type	Coef	SE	Coef	T	P
	AR	1	0,8824	0,0963	9,16	0,000
	MA	1	0,7547	0,1342	5,63	0,000
	Constant	11,5036	0,2211	52,03	0,000	
	Mean	97,835	1,880			
TS4: Average daily LOS of patients arrived by ambulance $ARIMA(2,0,0)*(0,0,0)_7$	Type	Coef	SE	Coef	T	P
	AR	1	0,1480	0,0737	2,01	0,046
	AR	2	0,1806	0,0738	2,45	0,015
	Constant	164,456	2,526	65,10	0,000	
	Mean	244,935	3,762			

ARIMA: Autoregressive integrative moving average, LOS: Length of stay, Coef: Coefficient

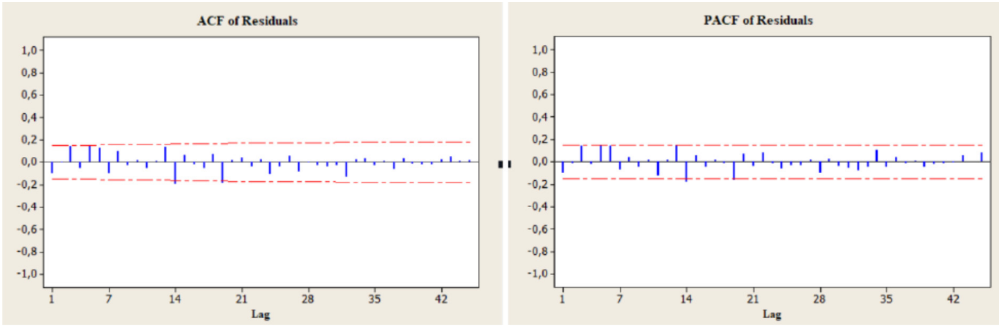


Figure 5. ACF and PACF of model for TS1

ACF: Autocorrelation, PACF: Partial autocorrelation

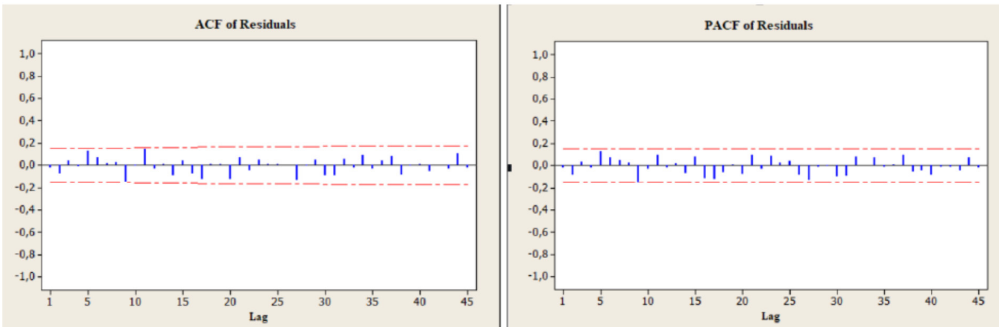


Figure 6. ACF and PACF of model for TS2

ACF: Autocorrelation, PACF: Partial autocorrelation

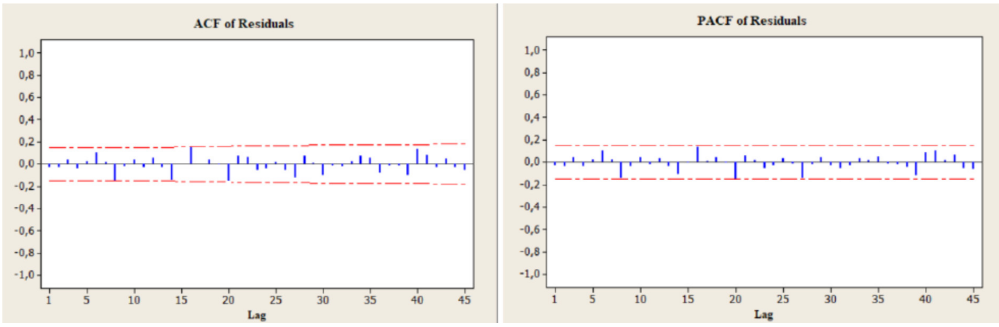


Figure 7. ACF and PACF of model for TS3

ACF: Autocorrelation, PACF: Partial autocorrelation

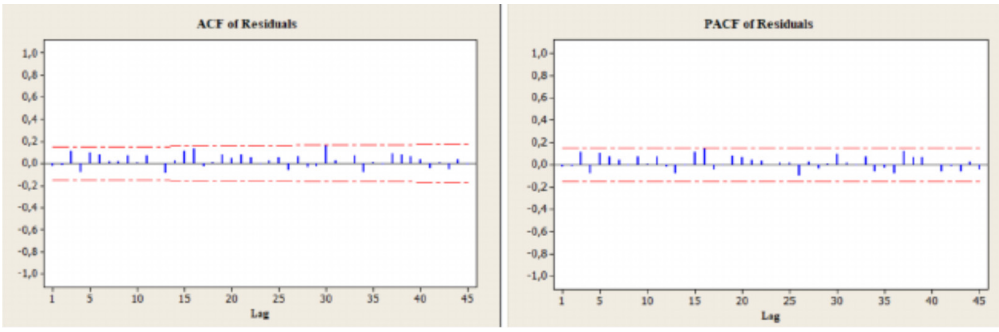


Figure 8. ACF and PACF of model for TS4

ACF: Autocorrelation, PACF: Partial autocorrelation

during the weekdays, may make a visit to EDs in weekends and this also causes an increase in daily number of patients who arrived by walking in weekends. On the other hand, for the patients who arrived by an ambulance, those generally being triaged as urgent or emergent, it is unlikely to observe such a significant difference in the daily patient volumes between days of the week. This is because, urgent or emergent situations such as myocardial infarction, cerebral bleeding, accidents and many of the others are time independent and may happen in any day and hour of the days. Besides, it is unlikely to observe a difference in daily average LOS values, since patients with similar characteristics may have similar LOS values and this is not significantly related to arrival days of them. These findings are then supported by adopted time series models. While seasonal models are adequate in forecasting the daily number of patients arrived by walking, non-seasonal models are more appropriate for other time series of interest.

For the performances of forecasting models, it should be stated that while forecasting performance for the time series of daily number of patients who arrived by walking is high, performances are good for other time series of this study (41). This is also interpreted with higher time dependency of daily number of patients who arrived by walking. For the other time series of this study, different models such as linear regression, in which additional inputs should be considered can improve the performance of forecasting. It is also concluded that the model performances are better for forecasting the patients who arrived by walking compared to those arrived by an ambulance. This result can be interpreted with the higher randomness of the related time series of the patients arrived by an ambulance.

This study has many implications in practice. Firstly, since the models accurately predicts the flow of patients and expected LOS values in EDs, they should be used to support optimal planning of human and physical resources. Optimal resource planning is valuable in EDs; unless they have sufficient capacity to satisfy demand, they will fail to meet performance standards and will be operating in the "coping zone" which carries high risks for not only the patients but also the ED staff (21). On the other hand, having more than required capacity is costly and leads an inefficient use of resources (42). Besides, since mode of arrival aware forecasting models are proposed in this paper, it is possible to make more specific decisions such as required number of ED staff in triage areas (urgent, emergent, not urgent) or predicating on average service times of patients for both of the arrival mode categories based on the results of these models. Thus, it is believed that results yielded by the proposed forecasting models will aid practitioners in their decision-making process to utilize and allocate ED staff efficiently, by considering the variability in demand and LOS values on the system as well as the differences based on the arrival mode of patients. It is also estimated that, making better decisions on resource planning may generate solutions to one of the biggest problems in ED environment, overcrowding, which may lead to increase in quality of ED services and patient satisfaction.

There are also some limitations of this study. The main limitation is related with the study design since it is conducted using data from a unique ED. However, although structure of optimal forecasting models for time series is data dependent and may not be generalizable, the motivation behind this study, being aware on the effect of mode of arrival on forecasting models' definitions and performances, should be used by other researchers and practitioners. Another limitation is related with the lack of some other explanatory variables of patient volume and ED-LOS in the forecasting models. For future research directions, it is planned to extend the current study by presenting an ARIMA model including some other explanatory variables, namely ARIMAX, and compare the results of these models with existing models.

Conclusion

In this study, ARIMA models with optimal parameters were proposed to forecast four main time series in the ED context; daily number of patients arrived by walking/by an ambulance, average daily LOS of patients arrived by walking/by an ambulance. While forecasting daily numbers and average daily LOS values, since patients are categorized based on how they arrived to ED, the proposed models are labelled as a mode of arrival aware forecasting models in EDs. The model results show that, while seasonal ARIMA models are proper for forecasting the first time series of interest (daily number of patients arrived by walking), non-seasonal models are best fits for the other time series of this study. Another main result of this study is that models perform better for forecasting walk in patients.

Although, this study presents an application of a unique ED, the proposed approach of generating mode of arrival aware forecasting models can be used in many of other EDs both in Turkey and other countries. It is believed that utilizing such models help ED practitioners and decision-makers to generate better plans and decision strategies in ED setting to improve the quality of the emergency services.

Ethics

Ethics Committee Approval: This study was approved by the İzmir Katip Çelebi University Non-Interventional Clinical Studies Institutional Review Board (IRB: 69, date: 19.04.2017).

Informed Consent: The local institutional review board waived the requirement for informed consent.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and/or Medical Practices: M.G.A., Concept: M.G.A., Design: M.G.A., G.S., Data Collection and/or Processing: G.S., Analysis and/or Interpretation: M.G.A., G.S., Literature Search: M.G.A., Writing: M.G.A., G.S.

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

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

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Experiences of Turkey's First National E-Congress of Emergency Medicine

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Abstract

Aim: In our study, by analyzing the first national emergency medicine e-congress organized during the pandemic process, it was investigated what differences it made to the emergency medicine field.

Materials and Methods: The study was arranged by taking data from www.acilakademi.net website, which was published under the title of "1st National Emergency Medicine E-Congress of the Emergency Medicine Physicians Association of Turkey (ATUDER)" between June 11 and June 13, 2020.

Results: A total of 120 speakers and 545 listeners attended. 66.7% of the speakers were male, 45% verbally (oral presentation) presented, and 45.8% participated with the title of attending physicians. 13.3% of the topics presented by the speakers were critical care. The clothes 69.2% of them wore were in the style of daily clothes. The average speaking time of the invited speakers is 18.71±4.91 (13.3-31.19) minutes. While the average number of people watching the invited speakers was 46.65±43.86 (16-252), the number of those who watched the presentations until the end was calculated as 14.73±8.43 people. It was observed that the male gender was in a significant majority with oral presentations, invited speakers, and moderators (p=0.020).

Conclusion: Organizing online congresses is advantageous for the participants as an alternative to the traditional congress and it can be made more effective with some arrangements.

Keywords: E-Congress, emergency medicine, pandemic, gender balance

Introduction

Congresses are formal meetings, usually lasting a few days, where individuals with the same business or interests come together to share their views (1). Today, there is a rapid change in training and meeting models as in many areas. This situation has been seen more clearly in the coronavirus disease-2019 (COVID-19) pandemic we have experienced recently. The virus outbreak that occurred in Wuhan, China in December 2019 spread all over the world and was declared a global epidemic by the World Health Organization (WHO) in March 2020 (2). Many meetings, congresses, and training seminars, formal education programs were canceled or postponed. The trainers had to schedule their meetings as online webinars or offline sessions to continue their training.

In this context, emergency medical specialists who work under the Emergency Medicine Physicians Association of Turkey (ATUDER) moved their national and international congresses held annually to the online platform. In this study, the analysis of the First National Emergency Medicine E-congress organized during the pandemic process was made.

Materials and Methods

The study was arranged by taking data from the www.acilakademi.net website published under the title of "1st National Emergency Medicine E-Congress of ATUDER" between June 11 and June 13, 2020. The study was conducted without the approval of the ethics committee as it evaluated the educational activity and publicly available data were used.

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The team conducting the study also served as the organizing committee and secretary of the congress. The congress was held free of charge with the support of sponsorship. Congress promotions started to be made about two weeks before the congress via Twitter, Instagram, Facebook, many WhatsApp groups including emergency medicine specialists, and the ATUDER web page (visual and audio promotion), SMS (to the mobile phones of ATUDER members). As of this date, it has been ensured that participants register for the congress. Participants were not required to be an emergency medicine specialist.

Four online sponsored webinars with session chairman, speakers, and participants in the congress program (topics; pain management, once corona, emergency management in seasonal diseases, management of respiratory tract infections in emergency medicine from influenza to corona), under six main headings (cardiovascular diseases, pediatric emergencies), trauma, toxicology and environmental diseases, critical care, emergency imaging and other (except for the specified categories) 35 offline sessions and a forum for participants to contribute and ask questions at the end of each session related to the topic. Suggestions and questions sent to this forum were planned to be discussed and answered online on the last day of the congress in the presence of the session chairman and speakers. Oral presentations were given on the last day of the congress and were limited to 5 minutes. It is planned to present the papers such as original study, case report, a methodological study prepared by the participants online in three separate server rooms. It was decided by a scientific committee consisting of six people to award three oral presentations.

On the congress days, the online webinar was broadcast live without being recorded. In offline sessions, the presentations of the speakers, which were required to last 15 minutes, were recorded by making an appointment at a suitable date, without specifying a special situation (dress, place, time, etc.). Offline recordings are planned to be published for 6 months period to ensure that participants can watch the sessions whenever they want.

Approximately one month after the end of the congress, work started to evaluate the congress. In offline presentations, the speaker's gender, academic title (professor, associate professor, doctoral lecturer, specialist, other), whether the dress he wears during the presentation is official (cases where the tie and shirt are not worn together in men; sleeveless and very open-collared shirt, blouse or dress for women wearing considered daily clothing) (3), the subject area (cardiovascular diseases, pediatric emergencies, trauma, toxicology and environmental diseases, critical care, emergency imaging, and other), the presentation time, the number of clicks for offline viewing of the presentation and how many times exactly it was checked whether questions were asked to the forum completed by the person and created at the end of each presentation regarding the subject.

In the oral presentation module, the speaker's gender, academic title (professor, associate professor, doctoral lecturer, specialist, other), specialty, the subject area (cardiovascular diseases, pediatric emergencies, trauma, toxicology and environmental diseases, critical care, emergency imaging and other) has been examined.

Statistical Analysis

The relationships of the variable at the categorical measurement level with each other were examined using Fisher's Exact chi-square. As descriptive statistics, numbers and percentage values are given for categorical variables. SPSS Windows version 23.0 package program was used for statistical analysis and $p<0.05$ was considered statistically significant.

Results

A total of 120 speakers and 545 listeners attended the congress. 66.7% of the speakers were male, 45% verbally presented, and 45.8% participated with the title of an attending physicians. 13.3% of the topics presented by the speakers were critical care, 12.5% trauma, 10.8% cardiovascular diseases, 10% toxicology and environmental diseases, 7.5% emergency imaging, 4.2% of them were pediatric emergencies, and 30.9% under the other heading [(n=6, 5%) mostly infectious diseases] (Table 1).

As the camera angle showed the upper chest, the dressing style of many speakers could not be determined exactly, but most of the 39 speakers (69.2%), whose clothing style could be determined, wore daily clothes. The average speaking time of the invited speakers is 18.71±4.91 (13.3-31.19) minutes. While the average number of people watching the invited speakers was 46.65±43.86 (16-252), the number of those who watched the presentations until the end was calculated as 14.73±8.43 people.

It was observed that the male gender was in a significant majority with oral presentations, invited speakers, and session chairman ($p=0.020$). The number of attending physicians is higher than other titles, both in oral presentations and as invited speakers; Speakers with the title of professor found more space in the chairmanship of the session ($p=0.001$). Oral presentations were mostly covered under the title of other topics, followed by trauma-related topics in the second place. In the invited speeches, mostly critical care and cardiovascular diseases were the second most important ($p=0.001$) (Table 2).

Table 1. Descriptive statistics			
Parameters		**n**	**%**
Gender	Male	80	66.7
	Female	40	33.3
Reasons for attendance	Guest speaker	53	44.2
	Moderator	13	10.8
	Oral presentation	54	45.0
Academic title	Professor	20	16.7
	Associate professor	12	10.0
	Asistant professor	26	21.7
	Attending physician	55	45.8
	Others	7	5.8
Subject area	Cardiovascular diseases	13	10.8
	Pediatric emergencies	5	4.2
	Trauma	15	12.5
	Toxicology and environmental diseases	12	10
	Critical care	16	13.3
	Emergency ımaging	9	7.5
	Neurological diseases	9	7.5
	Others	28	23.4

Discussion

Female physicians constitute only 27% of the workforce in the academic field of emergency medicine (4). In many studies, it has been shown that male speakers are predominant in congresses and female speakers are not given sufficient presentation opportunities (4-6). Carley et al. (5) examined the presentations made in eight emergency medicine congresses and found that the presentation times (23 vs. 21 min 25 s) and number (29.9%) were less in women than in men. In a study where the presentations at 29 congresses held by the Spanish Society of Emergency Medicine (SEMES) between 1988 and 2017 were examined, it was observed that 79.6% of the speakers were male (7). In our study, it is seen that the participation of female physicians in congress is less (33.3%) and this is similar to the literature. The imposition of women on different missions in the society (motherhood, home-work responsibilities, etc.) can be shown as a reason for lagging in scientific activities or not being able to take part in them adequately. We think that women frequently experience problems such as distraction, focus problems, and insomnia, especially after motherhood (8), women often have to choose between family and career (9), and this is an important factor that prevents them from participating in academic activities. To increase the participation of women in academic activities, Martin's (10) ten basic rules can be applied to achieve a gender balance among speakers

Table 2. Comparison of participant characteristics with the reason of participation								
		Reason of participation						
		Oral presentation (n=54)		**Guest speaker (n=53)**		**Moderator (n=13)**		**p value**
		n	**%**	**n**	**%**	**n**	**%**	
Gender	Male	29	53.7	40	75.5	11	84.6	**0.020**
	Female	25	46.3	13	24.5	2	15.4	
Academic Title	Professor	0	0.0	15	28.3	5	38.5	**0.001**
	Associate professor	3	5.5	8	15.1	1	7.7	
	Assistant professor	10	18.5	13	24.5	3	23.1	
	Attending physician	34	63.0	17	32.1	4	30.7	
	Others	7	13.0	0	0.0	0	0.0	
Subject Area	Cardiovascular diseases	4	7.4	9	16.9			**0.001**
	Pediatric emergencies	0	0.0	5	9.4			
	Trauma	9	16.7	6	11.4			
	Toxicology and environmental diseases	5	9.3	7	13.3			
	Critical care	0	0.0	16	30.2			
	Emergency imaging	5	9.3	4	7.5			
	Neurological diseases	5	9.3	4	7.5			
	Others	26	48.0	2	3.8			
P value was obtained from Fisher's exact chi-square test.								

at congresses. We can also suggest that physical arrangements (such as baby care support, mini-nursery, and child activities) be made in such meetings to increase the concentration of women with maternity qualifications in academic activities.

The vast majority of speakers at the national emergency medicine congresses held in Turkey every year are physicians who are in academic positions (11,12). This situation may change in congresses in different countries and besides physicians, nurses and ambulance personnel can also make presentations at emergency medical congresses (7). When we examined the e-congress organized, most of the speakers (45.8%) consisted of physicians without academic positions and there were no speakers other than physicians. If it is accepted as the field of work where there are different health professionals such as physicians, nurses, paramedics and emergency medical technicians in emergency departments, the participation of other health professionals in emergency medical congresses may present a different perspective to the congresses.

In organizations such as congresses, in addition to scientific content, especially speakers may feel obliged to dress formally. On different blog sites, the speaker is given tips and advice on clothing (13,14). In our study, it draws our attention that 69.2% of the speakers make their presentations in daily clothes. We think that e-congress provides a sense of comfort for the speakers in scientific meetings.

Prolonged speaking times in presentations (didactic lecture) can reduce the participants' attention and memory retention of the subject. Regarding the duration of the presentations, although a clear presentation time is not specified in the studies, studies are indicating that the participant concentration decreases during the presentation period and attention decreases to the lowest level within 20 min (15). Lenz et al. (16) in his study stated that changing the presentation tempo or giving a cognitive break every 15-20 minutes can regain attention. In our study, the average speaking time was completed under the time recommended in the literature, but an average of 14.73±8.43 people out of 545 spectators watched the presentations where the percentage is very low (about 2.9%). We attribute this to the notion of not being able to focus on the lesson on the computer according to the traditional congress or the obligation to wait and listen to the presentation until the end in order not to disturb the flow of the presentation. In our opinion, this requirement probably disappears in the online platform.

Conclusion

Although organizing online congresses is advantageous not only during the pandemic but also in terms of comfort (clothing, office or home environment, etc.) and cost as an alternative to the traditional congress, it can become more effective by demanding a certain amount of participation to keep the participation rates high. While giving presentations to the speakers in congresses, attention should be paid to the gender distribution balance. We can also suggest that physical arrangements (such as baby care support, mini-nursery, and child activities) made in such meetings to increase the concentration of women with maternity qualifications in academic activities. Presentations should not be longer than 20 min in order not to distract the participants. The participation of health professionals such as nurses and paramedics rather than a congress attended only by emergency physicians may also present a different perspective to the congress.

Ethics

Ethics Committee Approval: The study was conducted without the approval of the ethics committee as it evaluated the educational activity and publicly available data were used.

Informed Consent: Written informed consent form was not obtained from the participants due to the retrospective nature of the study.

Peer-review: Externally peer-reviewed

Authorship Contributions

Concept: M.S., B.K., Design: M.S., Supervision: B.K., Resources: M.S., M.B., Materials: M.S., Data Collection and/or Processing: T.E., Analysis and/or Interpretation: M.S., M.B., Literature Search: T.E., B.K., Writing: M.S., M.B., Critical Review: T.E., B.K.

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The Accuracy of CPSS, LAPSS and MASS in Terms of Early Acute Ischemic Stroke Diagnosis

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Abstract

Aim: This study aimed to investigate the diagnostic accuracy of the Cincinnati Prehospital Stroke Scale (CPSS), Los Angeles Prehospital Stroke Screen (LAPSS), and Melbourne Ambulance Stroke Scale (MASS) in detecting acute ischemic stroke (AIS) in suspected cases and to compare these scales with each other.

Materials and Methods: This diagnostic accuracy study included patients with suspected AIS brought to the emergency department. Patients' data were collected from their medical records. All test data were compared with the final diagnosis of AIS based on the brain magnetic resonance imaging (MRI) report. Sensitivity, specificity, accuracy, positive predictive value, and negative predictive value were measured separately using statistical tests with confidence interval of 95%.

Results: Finally, 766 patients were included, among which 57.6% were male. The mean age of the patients was 66.8±13.7 years. All patients underwent brain MRI, which showed that 537 (70.1%) patients had an actual diagnosis of AIS. The accuracy rates of CPSS, MASS, and LAPSS were 82.9%, 79.2%, and 78.1%, respectively. In this study, the differences between the sensitivity and specificity of these scales were significant ($p<0.001$).

Conclusion: This study showed that the number of true-positive cases diagnosed by CPSS was higher than that by MASS, and the number of MASS true-positive cases was higher than that of LAPSS. The number of LAPSS true-negative cases was higher than that of MASS, and the number of MASS true-negative cases was higher than that of CPSS.

Keywords: Accuracy, decision support techniques, emergency medical service, stroke

Introduction

Acute ischemic stroke (AIS) is considered one of the leading causes of death as well as permanent disability worldwide (1,2). Early recognition of AIS events is associated with proper management, better clinical outcomes and faster neurologic recovery (3). Moreover, the duration between onset of AIS clinical symptoms and its recognition by healthcare providers is considered as a very crucial factor in deciding the treatment modality (4). Therefore, several prehospital stroke scales have been designed to come up with diagnostic tools that can allow paramedics and emergency medicine physicians to recognize patients with a high probability of having AIS based on clinical criteria and/or past medical history (5). However, there is no consensus regarding which Prehospital/Hospital Stroke Scale can provide the most accurate assessment of those patients.

The Cincinnati Prehospital Stroke Scale (CPSS) was first introduced in the medical literature during the 1990s (6). Although the study investigators suggested excellent CPSS reproducibility by physicians and paramedics, and also good validity of CPSS as a

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stroke screening tool, they have still stated that the study sample might have not been representative of the general patient population (6). Moreover, further studies revealed low sensitivity and specificity of CPSS as screening tool for AIS (7,8). Los Angeles Prehospital Stroke Screen (LAPSS) was also first introduced to the medical field in the late 1990s (8), and further validated by another study later on (9), yet a major issue still exists for LAPSS, which is the inability to reproduce the same reliable sensitivity when tested in a recent validation study (10). In 2005, Melbourne Ambulance Stroke Scale (MASS) was first investigated as a potential screening tool for stroke, and it was suggested to be a simple tool for use by paramedics with high sensitivity and specificity (11). However, MASS was not validated by many investigators in further studies after that.

In this study, we aimed to investigate the diagnostic accuracy of these three scales in detecting stroke events in suspected patients, and to compare these scales with each other in terms of sensitivity and specificity.

Materials and Methods

Study Design and Setting

This is a diagnostic accuracy study that included patients with suspected AIS brought to the emergency department (ED) of three educational medical centers in Tehran, Iran in January 2018 to December 2019. The implementation protocol was approved by the Ethics Committee of Tehran University of Medical Sciences (ethics code: IR.TUMS.MEDICINE.REC.1398.326, date: 06.07.2019). This study did not impose additional cost on the patients and the treatment system.

Study Population

Patients with suspected AIS diagnosis by the prehospital emergency services or via primary triage at the hospital were eligible. Patients with incomplete medical records and patients who left the ED against medical advice, before undergoing brain magnetic resonance imaging (MRI) were excluded. According to previous studies that reported a stroke prevalence in suspected patients referred to the emergency department, confidence interval of 95% and error of 5%, the sample size was calculated at a minimum of 610 cases.

Data Gathering

Data gathering was conducted prospectively. For this purpose, an appropriate checklist was prepared and inserted to the patients' files in educational centers in which both emergency medicine and neurology residents are working together. On admission to the ED, after proper neurological examination of the patients with any neurological complaint beside all documentation, filling of this checklist was also performed by the residents regularly; so, all required data for calculating the scales are easily available. Actually, all the findings of neurological examination are routinely recorded when the patient arrives to the ED. The checklist was provided in five parts. In the first part of this checklist, the baseline characteristics and demographic data including age, gender, smoking status (categorized as positive in those who have smoked more than 100 cigarettes in lifetime and needs to smoke every day or someday), past medical history [hypertension (HTN), ischemic heart diseases (IHD), diabetes mellitus (DM), coagulopathy, hyperlipidemia (HLD), seizure/epilepsy and previous history of stroke] were collected. The second, third and fourth parts were assigned to the criteria of MASS, CPSS and LAPSS, respectively. The fifth part of the checklist was assigned to the final diagnosis based on the brain MRI report (considered as the gold standard method of AIS diagnosis), which was extracted from the picture archiving and communication system (PACS). All imaging was performed by 1.5 T MRI scanners made by Siemens company. All reports were conducted with a team including one neurologist, one radiologist and one emergency medicine attending physicians, who participated in this study.

Stroke Evaluation

All eligible patients were evaluated by a trained emergency medicine/neurology resident. Totally, five PGY-3 emergency medicine residents and four PGY-2 neurology residents were involved. The required information for MASS, CPSS and LAPSS are simply completed via usual history taking and physical exam of a patient who referred to ED. In the CPSS criteria, three items (facial droop, speech, arm drift) are supplemented to decide a diagnosis of stroke. The abnormality of a single item of these criteria indicates a primary diagnosis of stroke according to the CPSS. LAPSS criteria for stroke diagnosis consist of four items related to the patient's medical history (age >45 years, absence of history of seizure or epilepsy, not being wheelchair bound or bedridden before the symptoms onset and arriving at the ED within less than 24 hours from the onset of symptoms), one item for blood glucose level (considered positive in the range from 60 to 400 mg/dL) and three items from the physical examination (facial droop, arm drift, and hand grip). Patients who met all the history criteria and had a blood glucose level in the aforementioned range with at least one positive physical examination criterion, were considered LAPSS positive (Table 1). MASS criteria are similar to those of LAPSS. However, in MASS criteria, there is no limitation in the time between the onset of symptoms and the arrival at the ED. Furthermore, the range of the blood glucose level in MASS is 50-400 mg/dL, and in the physical assessment part, speech is also included. Patients who met all the history criteria and had

Table 1. Detailed criteria of study tools			
Assessment criteria	**LAPSS**	**CPSS**	**MASS**
History			
Age >45 years	*		*
No history of seizures or epilepsy	*		*
At baseline, not wheelchair bound or bedridden	*		*
Blood glucose level between 2.8 and 22.2 mmol/L	*		*
Physical exam			
Facial droop	*	*	*
Arm drift	*	*	*
Hand grip	*		*
Speech		*	*
Stroke identification criteria			
Presence of any physical exam finding	*	*	*
All history items answered yes	*		*
LAPSS: Los Angeles Prehospital Stroke Screen, CPSS: Cincinnati Prehospital Stroke Scale, MASS: Melbourne Ambulance Stroke Scale			

a blood glucose level in the aforementioned range with at least one positive physical assessment criterion were considered MASS positive.

Statistical Analysis

All data were analyzed by SPSS version 25. Quantitative variables were described using means ± standard deviation (SD) and qualitative variables were described using frequency and percentage. Sensitivity, specificity, accuracy, positive predictive value (PPV) and negative predictive value (NPV) were measured separately using statistical tests with confidence interval (CI) of 95%. In order to examine the strengths of the test, the receiver operating curve (ROC) curve and the area under the curve (AUC) were used, and to compare the difference between aforementioned items, McNemar test was used. We used McNemar's chi-square test for comparing the sensitivities and specificities of each screening test based on the final diagnosis, which presents the difference between predicted stroke cases and final diagnosis for each screening tool. P value <0.05 was considered statistically significant.

Results

Data of 1,200 patients with suspected AIS were reviewed. After assessing their medical records, 434 patients were excluded due to deficient data and incomplete medical records. Finally, 766 patients were included, of whom 57.6% were males. The mean age for the study population was 66.8±13.7 years (minimum and maximum of 11 and 95, respectively). Baseline and demographic characteristics are listed in Table 2. Most of the participants were non-smokers with a history of HTN. All patients underwent brain MRI and the results showed that 537 patients (70.1%) had an actual diagnosis of AIS. Most of the rest had no remarkable/new finding, except for three cases who were diagnosed with brain tumor, one case with hemorrhagic stroke, and six with old ischemic stroke.

Table 3 shows a comparison between the results of MASS, CPSS, LAPSS criteria and final diagnosis of AIS or non-AIS based on the brain MRI. MASS criteria could not diagnose AIS among 77 patients (14%), of whom 26 patients did not meet any of MASS criteria. LAPSS or CPSS criteria could not either diagnose AIS among all those 26 patients. Fifty-one patients could not be diagnosed due to other reasons such as the absence of history of seizure or epilepsy, age of less than 45 years, being wheelchair bound or being bedridden before the onset of the stroke symptoms, and having a blood glucose level of less or higher value than that of the considered range. Also, among those 51 patients, none of them was diagnosed as a AIS patient based on LAPSS criteria, but all of them were diagnosed to have AIS based on CPSS criteria. LAPSS was not able to diagnose 130 patients with AIS (24%) and had 53 more false negative cases (10%) as compared to MASS. Twenty-one patients (4%) had just the abnormality on speech item which is not included in LAPSS criteria, and 32 patients (6%) were assumed to be false negative because of arriving at ED within more than 24 h from symptoms onset. CPSS criteria were unable to diagnose only 27 patients (5%) who had a positive AIS diagnosis by the brain MRI. None of these patients was diagnosed using CPSS criteria either and only one patient was diagnosed using MASS and LAPSS criteria due to having an abnormality in hand grip item which is excluded from CPSS criteria. The ROC Curve of MASS, LAPSS, CPSS are shown in Figure 1 and the statistics of each scale are reported in Table 4. In the present study, the differences between the sensitivity and specificity of MASS, CPSS, and LAPSS criteria were statistically significant (p=0.000).

Discussion

The present study assessed the sensitivity, specificity and accuracy of MASS, LAPSS and CPSS criteria in diagnosing AIS using brain MRI as the gold standard method of AIS diagnosis. This study was conducted in educational medical centers, in which both neurology residents and emergency medicine residents are working. All brain MRIs were performed within first 24 hours of patients' admission; And based on presence of compatible lesions on ADC map and DW views, the final diagnoses were made. Apparently, those with old infarct were not considered as AIS, as detection of old stroke is not the purpose of these tests.

Table 2. Baseline characteristics of studied population (n=766)	
Variables	**Number (%)**
Gender	
Male	441 (57.6)
Female	325 (42.4)
Past medical history	
Smoker	141 (18.4)
Hypertension	479 (62.5)
Ischemic heart disease	275 (35.9)
Diabetes mellitus	235 (30.7)
Coagulopathy	22 (2.9)
Previous stroke	118 (15.4)
Hyperlipidaemia	150 (19.6)
Seizure or epilepsy	18 (2.3)
n: Number	

The majority of patients had actual diagnosis of AIS based on brain MRI. CPSS had higher sensitivity than MASS, and MASS had higher sensitivity than LAPSS. LAPSS had higher specificity than MASS, and MASS had higher specificity than CPSS. In this regard, a simple combination of LAPSS and CPSS, MASS criteria, could provide appropriate and reasonable statistical sensitivity and specificity value for the identification of AIS in suspected patients. Among the patients who did not meet MASS criteria, all and one third, were not also diagnosed by LAPSS and CPSS criteria, respectively.

Stroke is heterogenous and multifaced disorder causes more than one million deaths worldwide, annually. Despite the fact that stroke mortality has decreased in recent decades, but the reported rates still revealed high mortality rates (12). Early and accurate identification of stroke is one of the most important and crucial factors implicated in timely stroke management and better recovery after that. Therefore, emergency medical services always attempt to use better and less time-consuming screening tools for identifying stroke. A variety of prehospital screening stroke scales were designed to improve diagnostic accuracy and reduce the delay of therapy initiation. In this regard, CPSS and LAPSS are considered to be standard prehospital tools which were designed to be sensitive and accurate (12,13). CPSS criteria are based on clinical assessment of related stroke symptoms and LAPSS criteria also contain history and blood glucose measurements. In the same vein, MASS criteria were designed to inherit the strengths of both CPSS and LAPSS criteria (14,15).

Various studies assessed the CPSS statistical value for identification of stroke. Similar to the result of our study, Kothari et al. (16) indicated that CPSS had 100% sensitivity in identification of stroke. However, two years later in another study, they showed a significant reduction of sensitivity to 59% that had disagreement with our results. The reasons for those significant reduction in the sensitivity of CPSS were explained by the change of the study from community to ED and high rates of selection bias (17).

Studnek et al. (18) evaluated the diagnostic value of CPSS for 461 suspected strokes and showed that CPSS had 79% sensitivity and 23.9% specificity in diagnosing stroke. Which was lower than the estimated values in our study which may be due to their lower sample size than ours.

In our previous study, the prevalence of stroke, among 899 suspected cases, was 69.5% based on brain MRI. CPSS cut-off 2.5 had 91.3% and 36.4% sensitivity and specificity, respectively (19). CPSS in the previous study had similar sensitivity and lower specificity than present study, although both studies were conducted in the same places and had almost the same sample size. The difference may be due to the more qualified implementation of the tests in the present study after enhancing the education and knowledge on this field in our prehospital setting.

Statistical value comparison of different stroke scales in different studies, increases the value of choosing the best diagnostic

Table 3. Comparing the results of MASS, CPSS, LAPSS criteria and final diagnosis of AIS based on brain MRI			
Scale	**Diagnosis by the scale**	**Final diagnosis of acute ischemic stroke by brain MRI (n)**	
		Positive (n=537)	**Negative (n=229)**
MASS	Positive	460 (85.7)	82 (35.8)
	Negative	77 (14.3)	147 (64.2)
CPSS	Positive	510 (95)	104 (45.4)
	Negative	27 (5)	125 (54.6)
LAPSS	Positive	407 (75.8)	38 (16.6)
	Negative	130 (24.2)	191 (83.4)
AIS: Acute ischemic stroke, MASS: Melbourne Ambulance Stroke Scale, CPSS: Cincinnati Prehospital Stroke Scale, LAPSS: Los Angeles Prehospital Stroke Screen, MRI: Magnetic resonance imaging, n: Number			

Table 4. Statistic indexes of MASS, LAPSS, and CPSS according to the final diagnosis of AIS based on brain MRI considering 95% confidence interval

Scale	Sensitivity	Specificity	PPV	NPV	PLR	NLR	Accuracy	AUC
MASS	85.7% (82.3-88.5)	64.2% (57.6-70.3)	84.9% (81.5-87.7)	65.6% (59/0-71.7)	2.39 (2.00-2.85)	0.22 (0.18-0.28)	79.2%	0.749 (0.708-0.790)
CPSS	95.0% (92.7-96.7)	54.6% (47.9-61.1)	83.1% (79.8-88.9)	82.2% (75.0-87.8)	2.09 (1.81-2.41)	0.09 (0.06-0.13)	82.9%	0.748 (0.705-0.791)
LAPSS	75.8% (71.9-79.3)	83.4% (77.8-87.9)	91.5% (88.4-93.8)	59.5% (53.9-64.9)	4.57 (3.40-6.13)	0.29 (0.25-0.34)	78.1%	0.796 (0.761-0.831)

MASS: Melbourne Ambulance Stroke Scale, CPSS: Cincinnati Prehospital Stroke Scale, LAPSS: Los Angeles Prehospital Stroke Screen, PPV: Positive predictive value, NPV: Negative predictive value, PLR: Platelet-to-lymphocyte ratio, NLR: Neutrophil-to-lymphocyte ratio, AUC: Area under the curve

method. Similar to the result of the present study, Bergs et al. (13) investigated the statistical value of stroke scales in a Belgian prehospital setting. For 31 suspected strokes enrolled in the study, the CPSS had sensitivity of 95% and specificity of 33%. LAPSS had sensitivity of 74% and specificity of 83%. MASS had sensitivity of 74% and specificity 67%. Purrucker et al. (20) indicated that CPSS had sensitivity of 76%-88% and specificity of 64%-73%. LAPSS and MASS had sensitivity of 44%-71% and specificity of 92%-98%.

A systematic review of eight studies conducted by Brandler et al. (21) compared the statistical value of CPSS, MASS, LAPSS and four other scales in diagnosis of stroke. They showed that each stroke scale had a wide range sensitivity and specificity. CPSS had sensitivity of 79%-95% and specificity of 24%-79%. LAPSS had sensitivity of 78%-91% and specificity of 85%-99%. MASS had sensitivity of 83%-90% and specificity of 74%-86%. A systematic review conducted by Rudd et al. (22) showed that CPSS had sensitivity of 44%-95% and specificity of 24%-79%, LAPSS had sensitivity of 59%-91% and specificity of 48%-97%, and MASS had sensitivity of 83%-90% and specificity of 74%-85%.

A systematic review conducted by Zhelev et al. (5) investigated the CPSS, LAPSS, MASS criteria and three other stroke scales and included 23 studies. It showed that CPSS had similar sensitivity to MASS and higher sensitivity than LAPSS. In the same systematic review, MASS had similar specificity to LAPSS and higher specificity than CPSS. The investigators favored MASS criteria, which had comparable sensitivity and higher accuracy than CPSS, to achieve better overall accuracy of stroke diagnosis.

In general, the statistical value of CPSS, MASS and LAPSS criteria in our study, mostly confirmed the results of previous studies which calls for testing reproducibility of these scales in different settings. LAPSS and CPSS were better in one of the two metrics

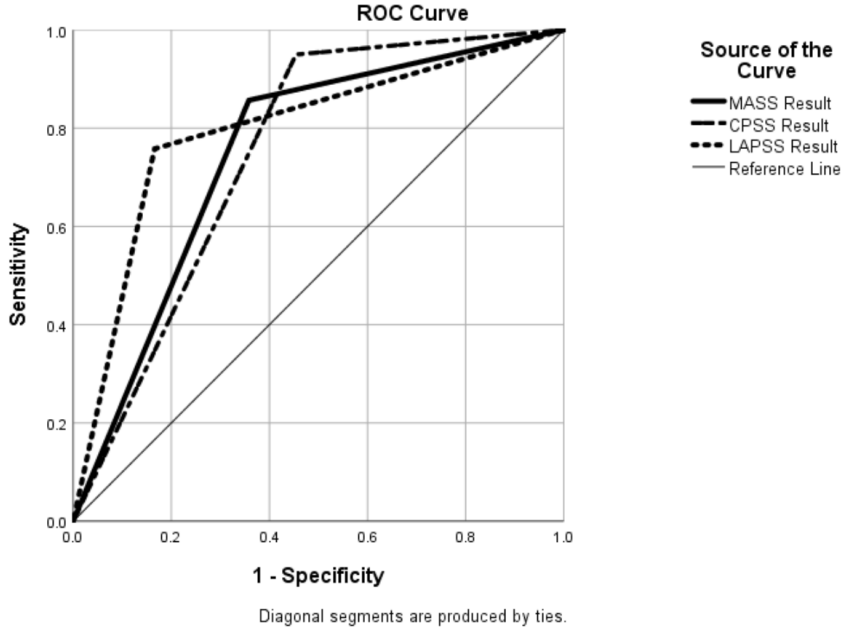

Figure 1. The ROC Curve of MASS, LAPSS, CPSS

ROC: Receiver operating characteristic, MASS: Melbourne Ambulance Stroke Scale, LAPSS: Los Angeles Prehospital Stroke Screen, CPSS: Cincinnati Prehospital Stroke Scale

as assessed and MASS could be an appropriate alternative which provide reasonable sensitivity and specificity in stroke diagnosis.

Study Limitations

This study assessed the AIS diagnostic power of three stroke screening scales in a large population of patients with suspected stroke. Here we just considered those with signs of acute infarcts on brain MRI, and transient ischemic attack was not included.

Conclusion

Choosing the most efficient scale, with the best statistical value, for stroke screening is of paramount importance to ensure early and adequate management of stroke in the ED. Our study showed that the number of true positive cases diagnosed by CPSS was higher than those of MASS, and MASS true positives were higher than those diagnosed by LAPSS criteria. The number of true negative cases of LAPSS was higher than MASS criteria, and MASS true negatives were higher than CPSS criteria. The high prevalence of stroke in males, elders, those without history of seizure and those with a blood sugar level of 50 to 400 mg/dL calls for greater attention to this issue and greater emphasizes on the importance of enhanced physicians and patients' knowledge in these areas.

Ethics

Ethics Committee Approval: The implementation protocol was approved by the Ethics Committee of Tehran University of Medical Sciences (ethics code: IR.TUMS.MEDICINE.REC.1398.326, date: 06.07.2019).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: A.P., S.K., A.B., Design: M.E., S.B., E.A., A.B., Data Collection or Processing: A.P., S.K., Analysis or Interpretation: M.E., S.B., E.A., A.B., Literature Search: M.E., A.B., Writing: A.P., S.K., M.E., S.B., E.A., A.B.

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Significance of pPTT-TAPSE and Mortality Prediction for Acute Pulmonary Thromboembolism in Emergency Department

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Abstract

Aim: TAPSE and pPTT are new echocardiographic parameters recommended in the evaluation of right ventricular function. Examine the echocardiographic parameters of patients diagnosed with acute pulmonary thromboembolism and determine the predictive of mortality.

Materials and Methods: The study was prospectively. Patients diagnosed with pulmonary thromboembolism (PTE) in the emergency department between 06.12.2019-31.05.2020 were included [86 patients (42 case - 44 control)] in the study.

Results: pPTT mean scores of the case and control groups were 91.88 ms and 127,09 ms ($p<0.001$). Also, the TAPSE mean scores were 1.76 mm and 2.60 mm for the case and control groups ($p<0.001$). In terms of sPESI, eight patients (19%) were determined to be at low risk in the case group. On the other hand, of the 34 patients (81%) in the case group determined to be at high risk, In the first 30 days after diagnosis, mortality developed in two patients (4.7%) in the case group. In the control group, the sPESI score of all participants was determined as low risk and no mortality developed ($p<0.001$). pPTT parameter was observed to be not at statistically significant levels to determine the predictive of mortality [area under the curve (AUC): 0.194, $p=0.07$]. TAPSE parameter was observed to reach statistically significant levels of distinctive markers to determine the predictive of mortality (AUC: 0.171, $p=0.05$).

Conclusion: We recommend the determination of pPTT and TAPSE with acute PTE patients in emergency departments to predict mortality indicators and pulmonary pressure changes in the early period.

Keywords: Pulmonary thromboembolism, TAPSE, pPTT, sPESI

Introduction

Pulmonary thromboembolism (PTE) is a critical disease that is life-threatening and has high mortality when its diagnosis is delayed or not established. PTE causes nearly 300,000 deaths a year in Europe (1). Short-term mortality varies in a wide range from 2%-95% depending on the severity of embolism (2). Mortality rates range from 1.7%-15% even in non-high-risk PTE situations (3). Systolic and diastolic functions of the right ventricle (RV) play an important prognostic role in patients with cardiopulmonary disease. RV performance is sensitive to preload and changes in pulmonary pressure (4). Assessment of the effect on the RV in PTE is necessary for the clinician to determine the clinical decision of the disease and influence treatment decisions (5). To identify nonspecific signs and symptoms, several RV echocardiographic (Echo) parameters have been proposed practically. RV functions are impaired in PTE-related pulmonary hypertension (PH). Studies indicate that acute PTE increases the RV pressure in the lung, leading to dysfunction of the arterial system and RV and that it may progress in circulatory collapse with right heart failure (6).

Right heart failure is the most common cause of mortality in hospitalized acute PTE patients and the main determinant of prognosis. European Society of Cardiology (ESC) guidelines recommend the assessment of RV function as a part of the clinical approach. Geometry-independent parameters such as Tricuspid Annular Plane Systolic Excursion (TAPSE) provide information about the RV function and can be used to overcome these limitations (4). Right ventricular ejection fraction (RVEF) is a marker of RV in PH, but its measurement is complex and time-

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consuming. TAPSE helps measure the longitudinal component of the RV contraction, and it is an easy measurement to obtain and reproduce (7). Studies have determined TAPSE significantly lower in patients with PTE, and particularly, this decrease was reported to be around 50% in the early PTE period (6-9).

Pulmonary Pulse Transit Time (pPTT) is a new parameter to evaluate heart functions (10). It is proportional to the pulmonary blood volume. Therefore, it can be used to measure pulmonary obstruction. pPTT was determined to be correlated with RV function and measurements of pulmonary vascular status (11). pPTT has recently been shown as a new echocardiographic marker by Wibmer et al. (12) and has been reported to be used as an indicator of hemodynamic and vascular change in patients with pulmonary fibrosis and hypertension. It is a parameter that shows a negative correlation with pulmonary stiffness.

The Pulmonary Embolism Severity Index (PESI) has recently been found to be a highly reliable clinical prognostic model for acute PTE patients. The PESI score was developed in 2005 with 11 parameters, but due to difficulties in remembering the PESI score and implementing it in crowded emergencies, it was reduced to the Simplified PESI (sPESI) in 2010 to include six of the 11 original PESI variables. Patients without variables (0 points) are classified as low risk, while variables between 1 and 6 (1-6 points) are classified as high risk (13). Zwierzina et al. (14) stated that PESI had a distinctive power in predicting short-term (30 days) mortality and morbidity in patients with acute pulmonary embolism. They reported that PESI and sPESI had similar accuracy and that sPESI was easier to use.

This study aimed to determine the relationship between echocardiographic parameters such as pPTT and TAPSE and acute PTE patients and to investigate the usability of these parameters with sPESI scores as predictors of mortality.

Materials and Methods

Study Group

The study group consisted of 86 people, including 42 in the case and 44 in the control groups. The case group was made up of patients diagnosed with acute PTE without a disease that would affect pulmonary pressure. The control group was admitted to the emergency department with shortness of breath or chest pain, suspected PTE but diagnosed negative (35 myalgias, five gastritis, three anxiety, one mastodynia). It consisted of people with no additional disease and no lung or heart disease. As a result of the prior and post hoc power analysis, the sizes of the case and control groups planned for this study were observed to be adequate.

Exclusion Criteria

The exclusion criteria for the individuals included having any other pathological diagnosis other than PTE, malignancy, having other diseases that cause right heart loading [Chronic Obstructive Pulmonary Disease (COPD), Right Heart Failure, etc.], autoimmune and rhythm disorders, having a New York Heart Association (NYHA) functional status ≥2, acute or chronic kidney failure, pregnancy, and chronic systemic disease.

Data Collection

The study data were collected prospectively from individuals in the case and control groups between 06.12.2019-31.05.2020 with the institutional approval of Tokat State Hospital and the approval of the Ethics Committee with issue number 19-KAEK-251. For the diagnosis of acute PTE of individuals in the case group, pulmonary CTA was done using the General Electric Revolution brand computed tomography. The demographic characteristics (age, gender) of the patients and their medical file documents were recorded. The patients were administered an echo by a cardiology specialist physician using Vivid 7 (GE Medical System) brand echo device and measurements were recorded with the Modified Simpson Method. pPTT was defined as the time (at milliseconds) interval between the R-wave peak on the ECG and the corresponding peak late systolic pulmonary vein flow rate. TAPSE was evaluated by measuring the distance (in millimeters) of the last diastole to the last systole with the M-mode from the RV free wall in the same cardiac cycle.

Statistical Analysis

The Shapiro-Wilk test was employed to test if the data were normally distributed. Student's t-test was used to compare the properties that had normal distribution in two independent groups, and the Mann-Whitney U test was used to compare the properties without normal distribution in two independent groups. Relationship analyses of categorical variables observed in two independent groups were analyzed with Pearson and exact chi-square tests. In the study, the effects of pPTT and TAPSE parameters on the dependent variable were analyzed with the multivariate logistic regression method. Also, the receiver operating characteristic (ROC) analysis was conducted to calculate the power of pPTT and TAPSE parameters in predicting the dependent variable. Descriptive statistics included mean ± standard deviation values for quantitative variables, and frequency and percentage values for categorical variables. SPSS Windows Version 22.0 software package was used for statistical analysis, and statistical significance was considered as $p<0.05$.

Results

The examination of the mean age in the case and control groups indicated that the mean age of the patients in the case group (66.90±17.10) yielded statistically significantly higher values compared to the mean age of the individuals in the control group (50.00±14.96) (p<0.001). On the other hand, the evaluation of the mean pPTT in the case and control groups revealed that the mean pPTT of the individuals in the control group (127.09±4.83 ms) yielded statistically significantly higher values compared to the mean pPTT of the individuals in the case group (91.88±18.81 ms) (p<0.001). Similarly, the examination of the mean TAPSE value in the case and control groups showed that the mean TAPSE value of the individuals in the control group (2.60±0.18 mm) was statistically significantly than that of the individuals in the case group (1.76±0.53 mm) (p<0.001). No statistically significant differences were found between the case and the control groups in terms of gender (p=0.2).

A statistically significant difference was observed in the case and control groups in terms of sPESI evaluation (p<0.001). According to the sPESI evaluation, all the observations in the control group were in the low-risk group (100%), and a 19.0% low-risk observation rate was found in the case group. Also, some individuals in the case group were observed to match sPESI high-risk (1 point, 2 points, and 3 points) values. There were no statistical differences in terms of mortality rates of observations in the case and control groups (p=0.1). The demographic characteristics of the case and control groups are shown in Table 1.

Table 2 presents the contribution of the variables pPTT and TAPSE, which were candidate variables that showed significant differences compared to the controls, using the Enter method in the multiple logistic regression model for the diagnosis of PTE. According to these results, the pPTT parameter was observed to be a statistically significant variable for PTE disease [odds ratio (OR): 0.55, p=0.01]. However, the TAPSE parameter was found to be not a variable that had a statistical significance for PTE disease (OR: 5.04, p=0.08).

pPTT and TAPSE parameters, which are candidates for PTE diagnosis, were analyzed by ROC (Receiver operating characteristic) analysis in Table 3. For the PTE diagnosis, the area under the curve (AUC) value of the pPTT parameter was observed to be statistically significant (AUC: 0.01, p=0.05). Otherwise, the AUC value of the TAPSE parameter was observed to not reach statistically significant levels for PTE disease (AUC: 0.09, p=0.17).

The contribution of the variables revealed using the Enter method in the multiple logistic regression model for the mortality estimation of pPTT and TAPSE values were examined in Table 4. According to these results, the pPTT parameter was not a statistically significant variable on mortality (OR: 1.01, p=0.85). In addition to this, the TAPSE parameter was observed to be not a variable that had a statistically significant effect in determining

Table 1. Demographic characteristics of the case and control groups

		Case	Control	p value
		Mean ± SD (min-max)	Mean ± SD (min-max)	
Age		66.90±17.10 (23.00-96.00)	50.00±14.96 (22.00-75.00)	<0.001
pPTT		91.88±18.81 (39.00-124.00)	127.09±4.83 (118.00-140.00)	<0.001
TAPSE		1.76±0.53 (0.90-3.00)	2.60±0.18 (2.10-2.90)	<0.001
PAP		45.38±13.30 (20.00-65.00)		
EF		54.88±9.59 (35.00-65.00)		
Gender, n (%)	Male	25 (59.5)	31 (70.5)	0.2
	Female	17 (40.5)	13 (29.5)	
sPESI, n (%)	Low risk	8 (19.0)	44 (100.0)	
	1.Point	20 (47.6)	0 (0.0)	<0.001
	2.Point	10 (23.8)	0 (0.0)	
	3.Point	4 (9.5)	0 (0.0)	
Mortality, n (%)	Alive	36 (92.3)	0 (0.0)	0.1
	Exitus	3 (7.7)	0 (0.0)	

EF: Ejection fraction, PAP: Pulmonary arterial pressure, pPTT: Pulmonary pulse transit time TAPSE: Tricuspid annular plane systolic excursion, sPESI: Simplified Pulmonary Embolism Severity Index, SD: Standard deviation, min: Minimum, max: Maximum, n: Number

Table 2. Multiple logistic regression model for PTE			
Parameter	**Odds ratio**	**95% CI**	**p value**
pPTT	0.55	(0.350-0.88)	0.01
TAPSE	5.04	(0.081-314.73)	0.08

PTE: Pulmonary thromboembolism, pPTT: Pulmonary pulse transit time, TAPSE: Tricuspid annular plane systolic excursion, CI: Confidence interval

mortality, either (OR: 0.11, p=0.25).

pPTT and TAPSE parameters, which are candidates for the diagnosis of mortality, were analyzed by Receiver operating characteristic (ROC) analysis in Table 5. The AUC value of the pPTT parameter was observed to be not at statistically significant levels (AUC: 0.194, p=0.07). However, the AUC value of the TAPSE parameter was observed to reach statistically significant levels of distinctive markers for mortality estimation (AUC: 0.171, p=0.05).

Discussion

TAPSE provides direct information about RV systolic functions and correlates well with RVEF (15). TAPSE varies inversely with PTE and has been determined significantly lower in patients with PTE (6-9). According to the results of the study by Şahan et al. (4), TAPSE was found to be significantly higher in the group with an sPESI score <1 compared to the group with ≥1. According to the results obtained from this study, TAPSE values were found to be significantly lower in PTE patients in the case group compared to the control group, which was in parallel with the literature.

pPTT measurement is reproducible, and it is a measurement model that accurately reflects cardiopulmonary function. pPTT is defined as the transit time to pass from the pulmonary valve to the pulmonary veins, and it has been reported to decrease in PH. pPTT has also been shown to have a negative relationship with RV function and measurements of pulmonary vascular status and increased pulmonary pressure. In particular, according to the study of Brittain et al. (11), a pPTT value of <105 ms was reported to be an indicator of the increase in the mean pulmonary artery pressure (11,16-18). According to the results of this study, the pPTT value was found to be significantly lower in case group patients. In line with this information, measuring pPTT and TAPSE values by doing Echo imaging in patients who have been diagnosed with PTE in the emergency department will reveal RV functions and facilitate patient management.

sPESI has been reported to have a distinctive power in predicting short-term morbidity and mortality in acute PTE patients (14). The sPESI low-risk group (0 points) was found to have a PTE-bound 30-day mortality rate of 0%, whereas the group with high risk (≥1 point) was determined to have a 6.3% rate (15). According to the findings of this study, a difference was found between the case group and the control group sPESI scores. However, when the mortality rates were examined, a similarly significant difference was found. Accordingly, it can be said that the levels determined according to sPESI values for the mortality prediction of patients diagnosed with PTE in emergency departments should be examined.

For the diagnosis of PTE, pPTT was found to be correlated with pulmonary vascular status, therefore it is a significant parameter in terms of PTE risk (11,12,16,19). It is also closely related to diastolic and systolic cardiac functions (10). pPTT is a good predictor for right ventricular fractional area change (17). According to multiple logistic regression and ROC analysis results by the literature, the pPTT parameter is a significant marker for the detection of PTE disease.

While TAPSE is more strongly associated with pulmonary vascular resistance than with pre-PTE, the post-PTE correlation has not been found, meaning that it can be used for the diagnosis of PTE, its use after diagnosis is not significant (9). According to the multiple logistic regression and ROC analysis results, TAPSE value is not a significant predictor in terms of detecting PTE.

RV function is closely related to PH (20). pPTT has been proven to be an integral part of the initial assessment of right heart function, it is particularly valuable for predicting morbidity and mortality (21). Pulmonary artery stiffness has also been shown to predict mortality in patients with PH. RV function is a strong prognostic factor and mortality marker in PH (16). According to multiple logistic regression and ROC analysis results are different from the literature and the pPTT parameter is not a significant predictor of mortality.

TAPSE is useful in the evaluation of RV function in patients with Acute PTE and is a high predictor of mortality (22). Low TAPSE may also be indicative of PTE prognosis (15). It plays an important role as a predictor of mortality in patients with PTE. It has been shown to have a significant correlation with poor

Table 3. ROC analysis for PTE						
	Cut-off	**AUC**	**SE**	**Sensitivity**	**Specificity**	**p value**
pPTT	120.5	0.01	0.007	0.024	0.114	0.05
TAPSE	2.65	0.098	0.040	0.095	0.386	0.17

PTE: Pulmonary thromboembolism, pPTT: Pulmonary pulse transit time, TAPSE: Tricuspid annular plane systolic excursion, ROC: Receiver operating characteristic, AUC: Area under the curve, SE: Standard error

Table 4. Multiple logistic regression model for mortality			
Parameter	**Odds ratio**	**95% CI**	**p value**
pPTT	1.01	(0.915-1.11)	0.85
TAPSE	0.11	(0.002-5.05)	0.25
pPTT: Pulmonary pulse transit time, TAPSE: Tricuspid annular plane systolic excursion, CI: Confidence interval			

Table 5. Determination of the relationship between mortality and the parameters by ROC analysis					
	Cut-off	**AUC**	**Sensitivity**	**Specificity**	**p value**
pPTT	104.0	0.194	0.33	0.35	0.07
TAPSE	1.96	0.171	0.35	0.35	0.05
pPTT: Pulmonary pulse transit time, TAPSE: Tricuspid annular plane systolic excursion, AUC: Area under the curve, ROC: Receiver operating characteristic					

outcome in patients with PTE with low TAPSE (6). TAPSE value in PH is one of the strongest predictors of mortality (23). The results of the ROC analysis show that TAPSE value may be predictive for mortality by the literature. According to multiple logistic regression analysis results, it was not determined as a predictor in terms of mortality.

Study Limitations

This was a single-center study, so it made the present results weaker. Also, pulmonary pressure could not be measured invasively; thence, the pulmonary hemodynamics could not be determined exactly. The determination of pPTT was limited to the availability of pulmonary vein Doppler signals. This study did not approach the influence of concurrent treatment on pPTT. Both of the functional exercise capacity and the variability of pPTT during the respiratory cycle were not assessed systematically. The Investigator of this study analyzing the echocardiograms was not blinded to the study hypothesis and the patients' medical histories. The effect of conduction disorders or arrhythmias on pPTT was not assessed. This study has a simple baseline determination at a single time point so it does not reflect the patient status over long periods. The age difference between the case and control groups may also have affected the results.

Conclusion

Echo can be done at the bedside, it is non-invasive, and that it is free from radiation are its advantages against pulmonary CTA. We recommend right ventricle assessment with Echo in patients diagnosed with acute PTE in emergency services in cases where the administration of CTA is difficult, pPTT and TAPSE measurements, which are among new parameters, and the determination of sPESI score to detect both mortality indicators and pulmonary pressure changes in the early period. Unnecessary CTA examinations can be prevented by combining PPTT and TAPSE parameters with the PERC score, particularly in patients who cannot undergo CTA.

Ethics

Ethics Committee Approval: This study was approved by Tokat Gaziosmanpaşa University Faculty of Medicine Deanship Clinical Researches Ethics Committee (project no: 19-KAEK-251, decision no: 12, date: 05.12.2019).

Informed Consent: Obtained.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: C.K., Concept: T.A., C.K., Design: T.A., C.K., Data Collection and/or Processing: T.A., C.K., Analysis and/or Interpretation: T.A., Literature Search: T.A., Writing: T.A.

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Comparison of Siriraj Stroke Score with Computed Tomography to Differentiate Acute Embolic and Hemorrhagic Stroke in a Tertiary Care-Teaching Center

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Abstract

Aim: The study aimed to compare Siriraj Stroke Score (SSS) with computed tomography (CT) in differentiating stroke subtypes.

Materials and Methods: This cross-sectional study consists of eighty consecutive patients admitted to the emergency department of the tertiary care-teaching center within four hours of the onset of stroke. A single experienced emergency medicine physician observed the patients for Siriraj score. An independent radiologist analyzed the CT of the patients who were not aware of the clinical condition. CT findings were considered the gold standard. Siriraj score findings were considered as a screening test. The sensitivity, specificity, predictive values, and diagnostic accuracy of the screening test, along with their 95% confidence interval (CI), were presented.

Results: A total of 80 subjects were included in the study. The mean age of the participants was 56.4 years, with the majority being males (58.8%). The sensitivity and specificity for SSS were 96.92% and 90.91%, respectively. The SSS had excellent predictive validity in predicting CT findings, as indicated by the area under the curve of 0.994 (95% CI 0.983 to 1.000, p value <0.001).

Conclusion: The clinical score, SSS, showed high sensitivity and specificity, and the results were satisfactory compared with CT imaging. Thus, it was concluded that SSS could be used for the bedside diagnosis to differentiate stroke subtypes in settings where CT scan facilities are lacking.

Keywords: Hemorrhagic stroke, ischemic stroke, cerebral hemorrhage, Siriraj stroke score

Introduction

Stroke is a significant health issue and the third major cause of mortality across the globe. A review by Kamalakannan et al. (1) showed that crude stroke prevalence ranged from 44.29 to 559/100,000 people in different regions of India during the past two decades. Stroke is characterized by sudden cessation of blood flow to an area of the brain and results in corresponding neurological function loss and disabilities like physical dependence, dementia, and depression (2). There are two types of strokes; hemorrhagic or ischemic. In ischemic stroke, thrombosis or embolism causes blockage of cerebral blood flow. Around 10%-15% of all strokes are hemorrhagic strokes and are associated with high mortality rates (3). An accurate diagnosis of the stroke subtype is required to make appropriate decisions regarding its therapeutic management (4).

Computed tomography (CT) imaging is an accurate, safe, non-invasive procedure routinely used and considered as the gold standard technique to distinguish between hemorrhagic and ischemic stroke (5). CT's cost and availability constraints prohibit its widespread usage in developing countries like India, mainly in rural and semi-urban regions. Different clinical stroke scores were developed on the basis of clinical parameters to overcome certain shortages of CT machines. Different clinical stroke scores are Siriraj Stroke Score (SSS), the Guys' Hospital Score or Allen Score, the Besson Score, and the Greek Stroke Score (6-9).

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Although several studies validating different stroke scores concluded that these scores were not sensitive enough compared to CT imaging in detecting hemorrhage and differentiating the stroke subtypes (10-13), a consistent higher predictive ability was observed with SSS in detecting ischemic stroke by ruling out hemorrhagic stroke (11). The SSS was developed by Poungvarin et al. (6) in 1991 in Thailand (Siriraj Hospital). SSS can be used as a diagnostic tool in clinical settings where a CT is not available, particulary in the rural health facilities. It seems more accurate than those made by physicians in clinical diagnosis b there was no literature available in this particular geographic area (Salem district) and the results provide an additional data to support the use of siriraj stroke score.

Hence, this study aimed to evaluate and compare the Siriraj stroke scoring system with CT findings to differentiate acute embolic and hemorrhagic stroke. The objectives were:

1. To differentiate cerebral hemorrhage from infarction using the Siriraj scoring system
2. To assess the accuracy of the Siriraj scoring system in differentiating stroke subtypes by comparing with CT brain.

Materials and Methods

Study population and Study site: The study was conducted in the Department of Emergency Medicine, Vinayaka Missions Medical College Hospital (VMKV MCH), Salem.

Inclusion Criteria

- The study group consists of patients admitted in the emergency ward of VMKV MCH, Salem, within four hours of the onset of stroke (stroke as defined by WHO definition), rapidly developing clinical syndrome of focal (or global in the case of subarachnoid hemorrhage), disturbance of cerebral function lasting longer than 24 h (unless interrupted by surgery or death), presumably of vascular origin (14).
- Patients in whom CT scan showed cerebral infarction or intracerebral hemorrhage.

Exclusion Criteria

- Previous history of stroke
- Subarachnoid hemorrhage
- Patients with a clinical picture suggestive of postictal paralysis
- Patients with a history of trauma

Study Design: Cross-sectional study.

Sample Size: Eighty patients who were admitted during the study period were selected by universal sampling.

Study Duration: Fourteen months from March 2019 to May 2020.

Ethical Considerations: Ethics Committee approval was taken before initiating the study from Vinayaka Missions Kirupananda Variyar Medical College, Ethics Committee number: VMKVMC&H/IEC/19/49, on 06.03.2019.

Data Collection Tools and Clinical Examination

On admission, detailed history and thorough clinical examination including age, gender, comorbidities, presenting complaint, general examination findings, and neurological assessment (head injury Glasgow Coma scale) were carried out by an experienced emergency medicine physician.

Siriraj Stroke Score (6)

All the patients were clinically examined for Siriraj score by a single experienced emergency medicine physician on admission. The parameters measured for Siriraj score was the presence of headache and vomiting (yes or no), level of consciousness (alert, stupor, drowsy, semicoma, coma), blood pressure (mmHg), history of hypertension, atheroma markers (transient ischaemic attack, diabetes mellitus, obesity, presence of history suggestive of angina pectoris, intermittent claudication) (none, one or more). The Siriraj score was computed as follows;

Siriraj Stroke Score (SSS) was calculated using the formula;

(2.5 × level of consciousness) + (2 × vomiting) +
(2 × headache) + (0.1 × diastolic blood pressure) -
(3 × atheroma markers) - 12

Scores were calculated by obtaining details of each clinical variable. If any variable was not available, e.g., if the patient was unconscious, information was obtained from the patient's relatives. If the relatives were unaware of a particular variable, then the variable score was adjusted as zero. A score above one indicates intracranial hemorrhage, while a score below minus one indicates infarction. The score between one and minus one represents an equivocal result.

CT (GE revolution act 16 slices) scan was obtained for all patients and was considered as the gold standard. Siriraj stroke score was compared with the CT findings by a radiologist from the institute, blind to the clinical features, classified the CT brain scans as those demonstrating infarction hemorrhage or equivocal.

Statistical Analysis

Siriraj score and CT findings were considered as primary outcome variables. Demographic variables were considered as primary explanatory variables. Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency, and proportion for categorical variables. Non-normally distributed quantitative variables were summarized by

the median and interquartile range (IQR). Categorical outcomes were compared between study groups using the chi-square test/ Fisher's exact test (If the overall sample size was <20 or if the expected number in any one of the cells is <5, Fisher's exact test was used). CT findings were considered as the diagnostic test (sensitivity and specificity) and Siriraj score as screening test. The sensitivity, specificity, predictive values, diagnostic accuracy of the screening test, and their 95% confidence interval (CI) were presented. P value <0.05 was considered statistically significant. Data was analyzed using coGuide software, V.1.03 (15).

Results

A total of 80 subjects were included in the final analysis.

The mean age of the study population was 56.4±7.61 years, 47 participants (58.8%) were males and 33 participants (41.2%) females. The majority of the participants (60%) had hemiparesis, followed by 16.3% hemiplegia, 13.8% headache and slurred speech each, and 12.5% had vomiting. Among comorbidities, diabetes mellitus was the highest (33.8%), followed by hypertension (28.8%), and coronary heart disease (CAD) (7.5%). Among the study population, four participants (5%) had pallor, two (2.5%) had cyanosis, and 13 (16.3%) had edema, 42 (52.5%) had a mild injury, 32 (40.0%) had moderate, and six (7.5%) had a severe injury (Table 1).

The majority of the participants (76.25%) had infarct, followed by 13.75% with bleeding and 10% was equivocal in Siriraj score findings. In CT findings, 65 participants (81.25%) had infarct, 11 (13.75%) had bleeding, and four (5.00%) were equivocal (Table 2).

Among the people with infarct in CT findings, 60 patients (92.31%) had Siriraj stroke score infarct, one (1.54%) had a bleed, and four (6.15%) were equivocal. Among the people with bleeding in CT findings, ten patients (90.91%) had Siriraj stroke score bleeding, and one (9.09%) was equivocal (Table 3).

The difference in Siriraj stroke score between CT findings is significant with a p value of <0.001 (Table 4).

The Siriraj stroke score had excellent predictive validity in predicting CT findings, as indicated by the area under the curve of 0.994 (95% CI: 0.983 to 1.000, p<0.001) (Figure 1).

The Siriraj stroke score had sensitivity of 96.92% (95% CI: 89.32% to 99.63%) in predicting CT findings. Specificity was 90.91% (95% CI: 58.72% to 99.77%), false positive rate was 9.09% (95% CI: 0.23% to 41.28%), false negative rate was 3.08% (95% CI: 0.37% to 10.68%), positive predictive value (PPV) was 98.44% (95% CI: 91.60% to 99.96%), negative predictive value (NPV) was 83.33% (95% CI: 51.59% to 97.18%), and the total diagnostic accuracy was 96.05% (95% CI: 88.89% to 99.18%) (Table 5).

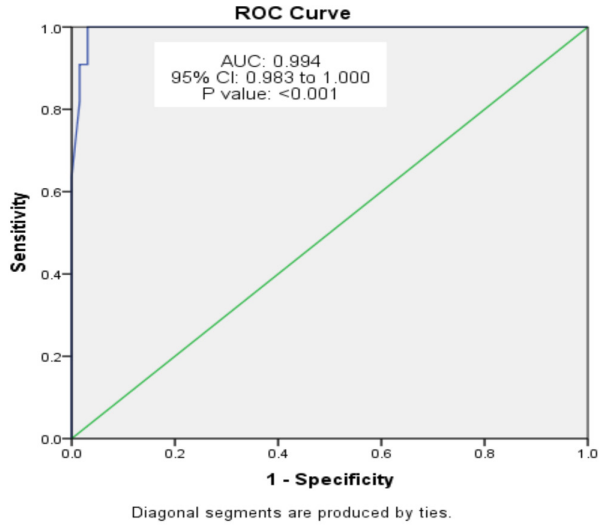

Figure 1. ROC analysis of Siriraj Stroke Score in predicting CT findings (bleed) (n=76)

ROC: Receiver operating characteristics, CT: Computed tomography, AUC: Area under the curve, CI: Confidence interval

Table 1. Summary of demographic variables in the study population (n=80)

Parameter	Summary
Mean age	56.4±7.61 (ranged 29 to 65)
Gender	
Male	47 (58.8%)
Female	33 (41.2%)
Complaints	
Hemiparesis	48 (60.0%)
Hemiplegia	13 (16.3%)
Headache	11 (13.8%)
Slurred speech	11 (13.8%)
Vomiting	10 (12.5%)
Comorbidities	
Diabetes mellitus	27 (33.8%)
Hypertension	23 (28.8%)
CAD	6 (7.5%)
General examination	
Pallor	4 (5.0%)
Icterus	0 (0.0%)
Cyanosis	2 (2.5%)
Edema	13 (16.3%)
Head injury (Glasgow Coma Scale)	
Mild	42 (52.5%)
Moderate	32 (40.0%)
Severe	6 (7.5%)

CAD: Coronary artery disease

Table 2. Summary of outcome parameters (n=80)	
Parameter	**Summary**
Siriraj score findings	
Infarct	61 (76.25%)
Bleed	11 (13.75%)
Equivocal	8 (10.00%)
CT Findings	
Infarct	65 (81.25%)
Bleed	11 (13.75%)
Equivocal	4 (5.00%)
CT: Computed tomography	

Discussion

The mean age of the study population was 56.4±7.61 years, and most participants were males (58.8%) in this study. The majority of the participants presented with hemiparesis (60%) followed by hemiplegia, headache, slurred speech, and vomiting. The majority of the participants had an infarct (76.25%, 81.25%) followed by bleeding (13.75%, 13.75%) in Siriraj Stroke Score and CT findings. The sensitivity, specificity, PPV, and NPV for SSS compared to CT were 96.92%, 90.91%, 98.44%, and 83.33%, respectively, with an overall accuracy of 96.05%. The Siriraj stroke score had excellent predictive validity in predicting CT findings, as indicated by the area under the curve of 0.994 (95% CI: 0.983 to 1.000, $p<0.001$).

The findings of this study showed higher values than those of earlier studies (16-18). A Nigerian study showed that SSS was highly predictive of both acute ischemic stroke and acute hemorrhagic stroke with a PPV of 97% and 86%, respectively, with an overall predictive accuracy of 93% (16). A recent study in India demonstrated that the sensitivity and accuracy of SSS were 59.2% and 82% for hemorrhagic strokes and 95.5% and 87.2% for ischemic strokes, respectively, when compared to the CT scan findings (17). A study conducted in Pakistan reported a sensitivity of 71.4%, specificity of 81.33 %, PPV of 79.7%, NPV of 73.5%, and an overall accuracy of 76.3% (18). In a systematic review, consistently higher specificities with a range from 65%-99% were reported for SSS compared to its corresponding sensitivities in 18 validation studies (11). The difference in settings, the prevalence of different strokes and ethnicity in different countries, and also data collection method used affects the variability of results for SSS (19). The reason for increased sensitivity and specificity in our present study may be due to, a single examiner clinically examined the patients and given the scoring, another blinded radiologist analyzed the CT findings. The cross-sectional nature of the present study might have positively influenced the results which was not in the case of a retrospective design. Over all, Siriraj score has better sensitivity in Asian population and less sensitivity in African and western population (18).

The mean age of the study population was 56.4±7.61 years, with ages ranging from 29 to 65 years and the majority were males (58.8%). In a study by Somasundaran et al. (17), most participants belonged to the age group 61 to 70 years, and the majority were males (55.4%). The mean age of the patients was 63.65±10.2 years in another study (19). The majority of the present study participants had diabetes mellitus (33.8%), followed by hypertension. The findings of an earlier study showed that hypertension was a major risk factor for both stroke subtypes, while diabetes mellitus was considered to be a risk factor for ischemic stroke (16).

Stroke management in patients mainly depends on the differentiation between hemorrhagic and ischemic stroke (18). Some studies recommended that critical decisions regarding the implementation of therapeutic management cannot be made without neuroimaging (18,20). Hence, it is understood that the stroke scoring system cannot completely replace CT but may be utilized in a resource-poor setting in order to initiate antiplatelet therapy.

Our study has a few limitations. First, our sample size was too small and second, the study population represents only a hospitalized subgroup of stroke patients. Another limitation of the study was that none of the patients had diffusion-weighted magnetic resonance imaging (MRI) which is considerably superior to CT in the first hours of an ischemic stroke.

Table 3. Comparison of Siriraj Stroke Score and CT findings (n=80)			
Siriraj Stroke Score	**CT findings**		
	Infarct (n=65)	**Bleed (n=11)**	**Equivocal (n=4)**
Infarct	60 (92.31%)	0 (0%)	1 (25%)
Bleed	1 (1.54%)	10 (90.91%)	0 (0%)
Equivocal	4 (6.15%)	1 (9.09%)	3 (75%)
No statistical test was applied due to 0 subjects in the cells. CT: Computed tomography			

Table 4. Comparison of CT findings with Siriraj Score (n=76)				
Siriraj Score	**CT findings**		**Chi-square**	**p value**
	Infarct (n=65)	**Bleed (n=11)**		
Low (<0.5)	63 (96.92%)	1 (9.09%)	54.584	**<0.001**
High (>=0.5)	2 (3.08%)	10 (90.91%)		
CT: Computed tomography				

Table 5. Predictive validity of Siriraj Score in predicting CT findings (n=76)			
Parameter	**Value**	**95% CI**	
		Lower	**Upper**
Sensitivity	96.92%	89.32%	99.63%
Specificity	90.91%	58.72%	99.77%
False positive rate	9.09%	0.23%	41.28%
False negative rate	3.08%	0.37%	10.68%
Positive predictive value	98.44%	91.60%	99.96%
Negative predictive value	83.33%	51.59%	97.91%
Diagnostic accuracy	96.05%	88.89%	99.18%
Positive likelihood ratio	10.66	4.88	42.258
Negative likelihood ratio	0.03	0	0.134
CT: Computed tomography, CI: Confidence interval			

Conclusion

Diffusion-weighted MRI and CT imaging is the best option to differentiate stroke subtypes in a clinical setting. In the present study, Siriraj stroke score, a clinical scoring system showed satisfactory results compared with CT imaging. Thus, Siriraj stroke score may be used for the bedside diagnosis of the stroke subtype in scenarios where the availability of a CT scan facility is limited.

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Ethics

Ethics Committee Approval: Ethics Committee approval was taken before initiating the study from Vinayaka Mission's Kirupananda Variyar Medical College, Ethical Committee number: VMKVMC&H/IEC/19/49, on 06.03.2019.

Informed Consent: Retrospective study.

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Authorship Contributions

Surgical and Medical Practices: K.N.P., Concept: K.N.P., M.D., Design: K.N.P., M.D., H.H.C., Data Collection and/or Processing: K.N.P., H.H.C., S.A.S., Analysis and/or Interpretation: K.N.P., M.D., H.H.C., V.P.C., Literature Search: K.N.P., V.P.C., R.K.R., Writing: K.N.P., S.A.S.

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Evaluation of Electrocardiography Parameters in Renal Colic Patients Admitted to the Emergency Department

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Abstract

Aim: Urinary stone disease is a common cause of comorbidity in the population. It causes an increased sympathetic tone due to pain during renal colic attacks. It is thought that increased sympathetic tone may also trigger vasospasm in coronary arteries and make ischemic changes more pronounced. However, there is no study in the literature that evaluating electrocardiogram parameters in patients with renal colic pain. In this study, the electrocardiogram parameters such as QT corrected for heart rate (QTc) interval, QTc dispersion, T peak-end (Tp-e) interval and Tp-e/QTc that are recorded when the patients are pain-free and during an episode of renal colic attack have been compared.

Materials and Methods: Patients who were clinically suspected of having renal colic and whose diagnosis was confirmed by abdominal computed tomography were included in this prospective observational study. On electrocardiograms in the episode of renal colic attack and when they are painless; QTc interval, QTc dispersion, Tp-e interval and Tp-e/QTc parameters were compared.

Results: Mean age of the 101 patients included in this study was 44.19±14.13 and 48.5% of them were female. Maximum QTc interval, and QTc dispersion parameters were significantly higher during renal colic attacks than pain-free periods. QTc interval was higher for females compared to males.

Conclusion: We found that renal colic pain is associated with increased QTc max and QTc dispersion. QTc interval was higher for females compared to males. These findings suggest that patients with renal colic pain may be under risk for ventricular arrhythmias especially in females.

Keywords: Renal colic, QTc dispersion, ventricular arrhythmias

Introduction

Urinary stone disease is a common cause of comorbidity in the population. The prevalence of this disease is estimated to be around 5%-13%. Due to its high recurrence rate, it has negative economic and social impacts on the society (1).

Patients with urinary stone disease frequently admit to emergency service with flank pain. This pain can range from a mild discomfort to severe enough to require taking a parenteral analgesic. The pain is typically in the form of colic and severe pain paroxysms usually last between 20 and 60 minutes. Pain occurs due to urinary retention and renal capsule stretching after the stone passes from the renal pelvis to the ureter and then the pain rapidly resolves when the stone passes through the urinary system. Urinary stone disease causes an increased sympathetic tone due to pain during renal colic attacks. It is thought that increased sympathetic tone may also trigger vasospasm in coronary arteries and make ischemic changes more pronounced (2,3).

However, there is no study evaluating electrocardiography (ECG) parameters in patients with renal colic pain in the literature.

In our study, we aimed to evaluate whether pain poses a risk for cardiac diseases and malignant arrhythmias as defined by either ventricular tachycardia (VT) or ventricular fibrillation (VF) or atrioventricular block causing hemodynamic compromise or cardiac arrest in patients who admitted to the emergency department with renal colic complain.

Therefore, QT corrected for heart rate (QTc) interval, QTc dispersion, T peak-end (Tp-e) interval and Tp-e/QTc parameters

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of the patients measured both during their renal colic attack and their pain-free period were compared.

Materials and Methods

This study is prospectively conducted in the Department of Emergency Medicine at the Zonguldak Bülent Ecevit University between 15.01.2016-15.07.2016.

Between the specified dates, patients who presented with clinical findings of renal colic and whose diagnosis was confirmed by abdominal computed tomography (CT) were included in this study.

Information on age, gender, height and weight of each patient were collected. Unenhanced abdominal CT was performed in patients with appropriate clinical diagnosis and then CTs were evaluated by a radiologist.

ECG of all patients were taken in the first fifteen minute of the admission. Drugs that did not make ECG changes or were the least risky were used during the treatment. A week after discharged patients are recovered, they come back and their ECGs were repeated. QTc interval, QTc dispersion, T peak - end (Tp-e) interval, Tp-e/QTc values of ECGs in two periods were compared.

Electrocardiographic Evaluation

Standard ECGs were taken from all patients with a sweeping rate of 25 mm/sec and amplitude of 10 mm/mV, using a Nihon Kohden Cardiofax M ECG-1350K, 12-channel electrocardiograph unit (Nihon Kohden, Tokyo, Japan). All ECGs were evaluated by the same researcher who was blinded to the group assignation.

QTc Interval and QTc Dispersiyon Measurement

The QT interval was measured from the beginning of the QRS complex to the end of the T-wave at the level of the T-P isoelectric baseline. QT interval that is corrected for heart rate (QTc) was calculated using Bazett's formula;

$$\text{(QT Interval corrected Bazett} = QTc = QT/\sqrt{RR}) \quad (1)$$

QTc dispersions were determined by calculating the difference between maximum and minimum QTc intervals in different leads (4,5).

Tp-e Measurement

The Tp-e interval was measured from the peak to the end of the T wave in leads V2 and V5. The end of the T wave was defined as the point of intersection of the isoelectric line with the line passing through the T wave. Tp-e/QTc were calculated from these measurements.

Exclusion Criteria

Patients with hypertension, diabetes mellitus, coronary artery disease, heart failure, valvular disease, arrhythmia, malignancy, chronic renal failure, metabolic diseases, electrolyte disorders, urinary system infections were excluded from the study.

Patients with high blood pressure at the time of admission were also excluded from the study.

Ethics

The research was submitted to the Research Ethics Committee of the Zonguldak Bülent Ecevit University, and approved under certificate number 2015-135-16/12. In this study, all processes complied with guidelines of the Declaration of Helsinki. Informed consent was received from all patients in the study.

Statistical Analysis

All statistical analyses were performed using SPSS software version 20.0 (SPSS Inc., Chicago, IL). Continuous variables were expressed as a mean ± standard deviation. Numbers and percentages were used for categorical variables. The categorical variables were compared using χ^2 test or Fisher's Exact test. For continuous variables the assumption of normality is checked using Shapiro-Wilk normality test. For continuous variables that are normally distributed, paired sample t-test and Student's t-test were used for comparisons as appropriate. A p value of <0.05 was considered as statistically significant.

Results

One hundred and one patients were included in the study and 49 of them were female. Average age was 44.19±14.13. The average height of the patients was 166.07±18.1, their average weight was 76.65±14.06.

Among all, 3.0% of the patients were underweight [Body Mass Index (BMI) <18.5], 28.7% of them were in normal range (18.5-24.9), 40.6% of them were overweight (25-29.9) and 27.7% of them were obese (BMI >30).

ECG parameters of renal colic patients during attack and pain-free periods were compared.

Maximum QTc interval (427.81±34.02 ms vs. 419.26±33.27 ms, p=0.005), and QTc dispersion (38.01±23.50 ms vs. 31.29±26.09 ms, p=0.049) were significantly higher during renal colic attacks compared with pain-free periods. However, there was no significant difference between during attack and pain-free periods in terms of QTc interval (407.94±30.74 ms vs. 409.13±24.84 ms, p=0.621), and minimum QTc interval (389.76±30.45 ms vs. 388.47±28.48 ms, p=0.653) (Table 1).

Table 1. ECG parameters of renal colic patients during attack and pain-free period				
ECG parameters	**Measurement time**	**Mean**	**SD**	**p value***
QTc	During the attack	407.94	30.74	0.621
	Pain-free period	409.13	24.84	
QTc maximum	During the attack	427.81	34.02	0.005
	Pain-free period	419.26	33.27	
QTc minimum	During the attack	389.76	30.45	0.653
	Pain-free period	388.47	28.48	
QTc dispersion	During the attack	38.01	23.50	0.049
	Pain-free period	31.29	26.09	
Tp-e	During the attack	77.90	14.32	0.291
	Pain-free period	76.39	14.86	
Tp-e/QTc rate	During the attack	0.19	0.04	0.190
	Pain-free period	0.19	0.04	
*Paired sample t-test, ECG: Electrocardiography, QTc: QT corrected for heart rate, Tp-e: T peak - end, SD: Standard deviation				

ECG parameters by gender during attack and pain-free period were compared using Student's t-test and given in Table 2 and Table 3 respectively. There was significant difference in QTc measurement during the attack by gender. QTc measurement during the attack for females was 416±35.1 while for males, it was 401±24.4. Among the measurements taken during the pain-free period, there was a significant difference in QTc interval by gender. The mean QTc interval for females was 417±24.9 while the mean QTc interval for females was 402±22.5.

Discussion

In our study, the repolarization indicators on the ECG that can be used to determine the risk for cardiac diseases and malignant arrhythmias in both healthy people and those with structural heart disease were examined.

We evaluated QTc dispersion and T-peak interval in patients with renal colic. QTc dispersion can be used as a non-invasive marker of sudden cardiac death and ventricular arrhythmia.

Table 2. Comparisons of ECG parameters measured during the attack by gender			
	Female	**Male**	**p value***
	Mean (SD)	**Mean (SD)**	
QTc	416 (35.1)	401 (24.4)	0.015
Minimum QTc	396 (32.7)	385 (27.6)	0.070
Maximum QTc	432 (35.3)	424 (32.7)	0.236
QTc dispersion	36.3 (24.7)	39.6 (22.4)	0.482
Tp-e	79.2 (13.7)	76.8 (14.9)	0.400
Tp-e/QTc rate	0.19 (0.04)	0.19 (0.04)	0.970
*Paired sample t-test, ECG: Electrocardiography, QTc: QT corrected for heart rate, Tp-e: T peak - end, SD: Standard deviation			

T peak-end interval is considered as the ventricular repolarization distribution index and when it is prolonged, it can result in the development of ventricular arrhythmia.

Tp-e/QT, Tp-e/QTc ratios were calculated so that QTc dispersion and T-peak interval parameters were not affected by heart rate (4-9).

The values of QTc dispersion and QTc maximum in the renal colic patients during the renal colic attack and the pain-free periods were compared and statistically significant differences were found (p=0.049, p=0.005 respectively). There was significant difference in QTc measurement during the attack and pain-free period by gender. QTc interval was higher for females compared to males. Changes in other ECG parameters observed were not statistically significant.

It is thought that renal colic pain may possibly cause cardiac effects through two mechanisms.

Table 3. Comparisons of ECG parameters measured during pain-free period by gender			
	Female (n=48)	**Male (n=53)**	**p value***
	Mean (SD)	**Mean (SD)**	
QTc	417 (24.9)	402 (22.5)	0.001
Minimum QTc	392 (29.6)	385 (27.3)	0.206
Maximum QTc	424 (33.2)	415 (33.1)	0.192
QTc dispersion	32.8 (27.4)	29.9 (25.0)	0.573
Tp-e	75.6 (14.3)	77.1(15.5)	0.604
Tp-e/QTc rate	0.18 (0.036)	0.19 (0.039)	0.299
*Student's t-test, ECG: Electrocardiography, QTc: QT corrected for heart rate, Tp-e: T peak - end, SD: Standard deviation, n: Number			

In renal colic; pressure in the collecting system and ureteral spasm cause the release of prostaglandins, which are the primary mediators of pain. Prostaglandins produced by many cells are involved in systemic and vascular inflammation.

Of the prostaglandins divided into different types according to their structural and functional properties; the imbalance between TxA2, a potent platelet aggregation agent and vasoconstrictor, and prostacyclin, a potent inhibitor of vasodilator and platelet aggregation, has been blamed as the mechanism that initiates thrombus formation in coronary blood vessels (10,11).

Furthermore, prostaglandins initiate sympathetic stimulation through the central nervous system. Sympathetic afferent fibers spread along the inferoposterior and anterior wall of the left ventricle stimulate the sympathetic activation of the heart.

It is thought that sympathetic activation makes ischemic symptoms more pronounced by making vasoconstriction in coronary arteries. This may cause ventricular arrhythmias. QT dispersion also emerges as an indicator of early ventricular arrhythmias on the ECG (12,13).

In our study the differences between QTc dispersion and QTc maximum values during renal colic attack and pain-free periods are found to be statistically significant. However, there were no statistically significant differences in T-wave peak-to-end interval (Tp-e interval) and Tp-e/QT ratios, which are other markers of ventricular arrhythmia and repolarization heterogeneity.

QTc interval was significantly higher for females compared to males during renal colic attack and pain-free periods. In patients with renal colic, it is possible to say that women are more at risk for malignant arrhythmias than men. Studies showing an increased risk of coroner's artery disease in women with urinary stone disease also support our data (14-16).

To the best of our knowledge there is no study on ECG in renal colic attacks in the literature.

For this reason, we compared our study results with several studies that similarly examine ECG parameters in other diseases with pain attacks similar to the renal colic attacks.

In the study conducted by Duru et al. (17), ECG was evaluated in migraine patients, another disease characterized by recurrent pain attacks, and it was found that the QTc max, QTc interval and QTc dispersion were significantly longer during the attack compared to the pain-free period.

In another study comparing the QT-QTc maximum and QT-QTc dispersion of the control group and migraine patients, it was found that the dispersion was significantly higher and the QT-QTc minimum dispersion was significantly lower (18).

In the QT dispersion study on fibromyalgia, which is a non-inflammatory disease characterized by widespread pain foci in the body and progresses with pain attacks; it was determined that the QTc dispersion was shorter (19).

Yazıcı et al. (20) found no significant difference between fibromyalgia and control groups in terms of QT dispersion and conventional echocardiographic parameters.

Study Limitations

Although the QTc dispersion is significantly higher in the ECGs since the patients are not followed for a long time, it has not been determined whether ventricular arrhythmia, which is a clinical reflection, occurred.

Conclusion

We conclude that renal colic pain is associated with increased QTc maximum and QTc dispersion.

This finding suggests that patients with renal colic pain may be under risk for ventricular arrhythmias. QTc interval was significantly higher for females compared to males during renal colic attack and pain-free periods. It is possible to say that women are more at risk for malignant arrhythmias than men.

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Ethics

Ethics Committee Approval: The research was submitted to the Research Ethics Committee at the Zonguldak Bülent Ecevit University, and approved under certificate number 2015-135-16/12.

Informed Consent: Informed consent was received from all patients in the study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Medical and Surgical Practices: A.C.H., H.H., Concept: A.C.H., H.H., Design: A.C.H., H.H., Data Collection and/or Processing: A.C.H., H.H., Analysis and/or Interpretation: A.C.H., H.H., Literature Search: A.C.H., H.H., Writing: A.C.H., H.H.

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Case Report
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Bilateral Hip Dislocation: Unusual Injury Mechanism

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Abstract

Bilateral hip dislocations are rare traumatic injuries considered as an orthopedic emergency. Most of the reported cases were caused by high-energy traffic accidents, a majority of which were along with femoral and acetabular fractures. The case in this study was a 25-year-old male who had severe pelvic tilt and lumbar lordosis due to the unusual mechanism of falling a heavy object from a high distance on his back. The vital signs were stable and the patient had no underlying disease. On examination, he had lower limb paresthesia, and the pelvic X-rays clearly showed that the patient had a right femoral head posterior dislocation with acetabular fracture and left femoral head obturator dislocation. Right after cardiopulmonary monitoring and checking the stability of vital signs as well as applying appropriate analgesia, a reduction was made, following which the patient's lower limb paresthesia gradually reduced. The patient was transferred to the orthopedic ward and the surgical treatment of the right acetabular fracture was performed. He was then discharged from the hospital with a good and stable general condition.

Keywords: Hip, dislocation, bilateral, injury

Introduction

Hip dislocations typically develop following high-energy traumatic injuries (1,2). According to studies, hip dislocations account for about 2% to 5% of total joint dislocations, which often occur at an early age, especially at a young age, following occupational and traumatic accidents (3,4). However, bilateral and asymmetric hip dislocations are relatively rare and concomitant injuries are frequent, accounting for about 1% to 2% of all hip dislocations (3-5). On the other hand, such injuries can typically be associated with pelvic ring injuries and femoral fractures (6). Although it is difficult to identify the possible mechanisms of the traumas leading to bilateral hip dislocations, in the past decade, researchers identified the factors such as road traffic and occupational accidents and male gender as the most important risk factors for such dislocations (2,7). In this study, we reported a case of bilateral asymmetric hip dislocation arising from a rare mechanism and occupational accidents which was reducted as soon as possible in the emergency department.

Case Report

The patient was a 25-year-old man living in Mashhad who had been admitted to the Emergency Department of Shahid Hasheminejad Hospital and was undergoing clinical trials due to the injury caused by a heavy object (a bar) fallen on his back from height while working. The accident has caused him severe pelvic tilt (the pelvic tilt was so severe that his knees were heavily loaded into his abdomen). He had no history of a chronic underlying disease, and was not treated with any specific medication. His vital signs at the referral were as follows: systolic blood pressure: 119 mmHg, diastolic blood pressure: 84 mmHg, pulse rate: 95 per minutes, O_2 saturation: 100%, and RR: 19 per minute.

Further examinations revealed no evidence of open wounds in the patient's pelvis, knees, spine and other organs, but his pelvis was deformed and his left lower limb was semi-flexed to laterally abduct. His right lower limb was also semi-flexed and medial-oriented, and was on his left thigh. The perineal examination showed no ecchymosis and hematoma, and no bleeding was observed.

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In the neurovascular examination, the pulses of the two organs were identical and normal, but the patient was complaining about paresthesia in the right limb from the hip to the toe tips. The pelvic X-ray showed posterior dislocation of the right femoral head with acetabular fracture and left femoral head obturator dislocation (Figure 1). Once the orthopedics on-call was informed the patient was monitored with oxygen therapy and was sedated within 10 minutes of arrival, with 200 mcg of fentanyl and 70 mg of propofol. The reductions were then successfully performed on both sides with allis maneuver. After successful reductions of the dislocations, the patient's vital signs were quite stable, and the pelvic computed tomography scanning also showed that the reductions of both sides had been performed correctly and appropriately (Figure 2). Following the reductions, the patient's lower limb paresthesia gradually decreased. Considering the accident mechanism, surgical service consultation was performed, and the results of abdominal and pelvic ultrasound were normal. Hence, the patient was allowed by the orthopedic specialist to be transferred to the orthopedic ward. In the ward, the acetabular fracture surgery was performed as a complementary treatment and the patient was discharged in a good and stable general condition. During the one-month follow-up after reduction at the orthopedic clinic, his general condition was good and he could walk by himself without pain but with support. The pelvic X-ray revealed evidence of acetabular union.

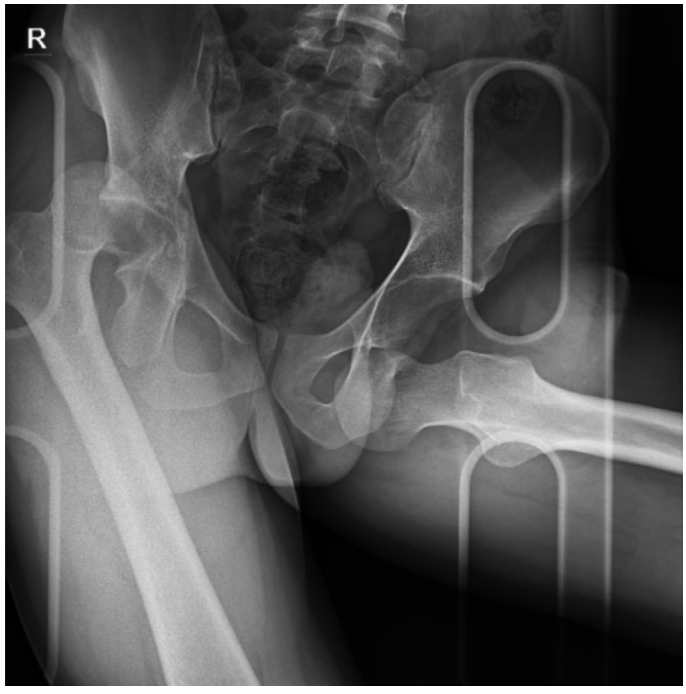

Figure 1. The pelvic X-ray showing posterior dislocation of the right femoral head with acetabular fracture and left femoral head obturator dislocation

Discussion

Herein, we have reported an interesting case of bilateral hip dislocations due to a rare mechanism which was redacted as soon as possible in the emergency department. These injuries are usually associated with acetabulum, femoral head, and trochanter fractures (2,8,9). In our study, the patient was not only suffering from bilateral hip dislocation, but also had acetabular fracture had occurred to him, which is consistent with the results of other reported cases. However, some studies did not report such fractures in the acetabulum and femoral head. For instance, Kanojia et al. (10) reported bilateral asymmetric hip dislocation without any evidence of hip fracture. In their study, Park et al. (1) also reported two cases of bilateral hip dislocation with acetabular fractures in two 53- and 36-year-old men who had fallen down from a height and had a road accident, respectively. Patton et al. (11) also reported a case of bilateral hip dislocation in a 30-year-old man due to an occupational accident on a farm.

The dislocation directions depend on the hip motion status, direction of force and pressure imposed, and the individual's anatomical position. Bilateral hip dislocations are rare, accounting for about 1.25% of all hip dislocations as stated by and Rufer et al. (4). Various mechanisms have been proposed to cause bilateral dislocation of hip joints, including traffic accidents, excessive anterior and posterior forces, and a load falling on the back in a bent position (2,12). In none of the reported cases, hip joint dysplasia was considered as a predisposing factor and it seems that the injury could only be caused by the severity of the trauma with a certain mechanism. In this study, the patient was suffering from severe pelvic tilt due to the high pressure from an object fallen from the top. It

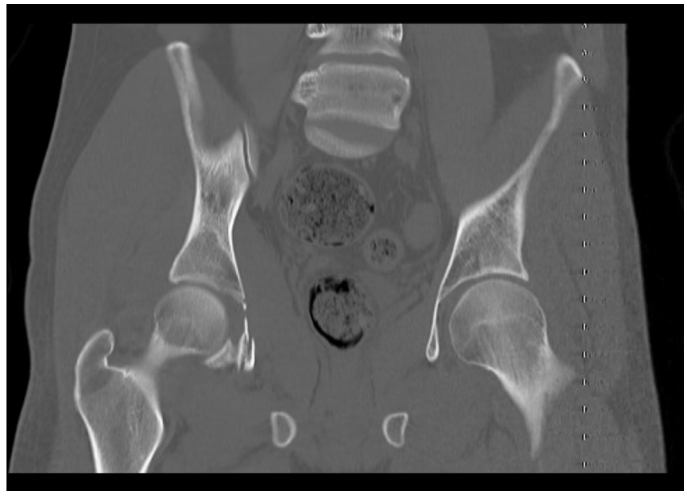

Figure 2. After successful reductions of the dislocations, the patient's vital signs were quite stable, and the pelvic computed tomography scanning shows that the reductions of both sides had been performed correctly and appropriately

was also associated with right acetabular fracture and bilateral hip dislocation, which were improved by appropriate treatment.

The incidence of dislocations at an early age (often at youth and working ages) and in males is higher) the number of men working are more than woman (so that age and gender appear to be two independent risk factors (4,13). Although hip dislocations are bilateral, treatment does not seem to be difficult and does not differ from unilateral cases. Thefore, treatment results are promising unless reductions are delayed due to the bilaterally of the lesion and it may be cause further complication.

Bilateral hip dislocations are considered an orthopedic emergency, and delayed reduction is associated with an increased risk of avascular necrosis (AVN) (4,7,8). In the study Beebe et al.'s (14) sciatica paralysis is also mentioned as a complication of this injury. The risk of developing AVN in femoral heads varies from 8% to 15% and may increase up to 40% depending on the duration and type of dislocation and the need for a surgery (15). However, the risk of developing AVN in the cases that are reduced within <6 h is about 4% to 5%, but it will reach 52.9% if the reduction is delayed for more than 6 h (3). In this study, the treatment was done as soon as possible in the emergency department and the patients follow up revealed no evidence of AVN.

In conclusion, like all other reported cases, our patient had bilateral hip dislocations due to a high-energy trauma without a predisposing factor (such as underlying diseases, use of specialty drugs, pathologic point, and hip dysplasia). Despite a severe trauma, there was no concomitant lesion except the acetabular fracture, and lower limb paresthesia was sedated following the timely and proper reduction. The post-treatment follow-ups (1 month after the surgery) well-indicated that the reduction was correct and proper, and regardless of some mild movement restriction, the patient could walk without pain.

Ethics

Informed Consent: It was obtained.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: S.M.M., M.T.M., S.M.S., P.K., E.V.M., Design: S.M.M., M.T.M., S.M.S., P.K., E.V.M., Data Collection or Processing: S.M.M., M.T.M., S.M.S., P.K., E.V.M., Analysis or Interpretation: S.M.M., M.T.M., S.M.S., P.K., E.V.M., Literature Search: S.M.M., M.T.M., S.M.S., P.K., E.V.M., Writing: S.M.M., M.T.M., S.M.S., P.K., E.V.M.

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Letter to the Editor
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Cough Syncope in the Times of COVID-19

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Dear Editor,

In the times of Coronavirus disease-2019 (COVID-19) pandemic, cough is a common clinical presentation, however its vasomotor effects on circulatory systems are underappreciated. A healthy 39-year-old gentleman with no comorbidities presented to the emergency room during the night shift with few episodes of syncope during bouts of coughing over a week. His father suffered from upper respiratory tract symptoms for a week and recovered. He was a non-smoker and denies any use of recreational drugs. There was no fever, shortness of breath, chest pain or chronic cough. He suffered from a ground-level fall at home while coughing with brief duration of loss of consciousness for few seconds and sustained 2 centimeters linear laceration over the occipital region. His physical examination, electrocardiogram, chest X-ray and laboratory investigations were within normal limits. Prior to this presentation, he had never experienced any syncopal episode. He was negative for COVID-19 polymerase chain reaction. On further investigation, computed tomography head, echocardiogram and holter monitoring were unremarkable. His laceration was repaired and later discharged with cough suppressants and oral antibiotics to treat presumed upper respiratory tract infection.

Cough syncope or laryngeal ictus (from Latin ictus means stroke or thrust) or laryngeal vertigo coined in 1876 by Charcot, is a phenomenon with episodic cough with loss of consciousness for few seconds followed by full recovery (1). In mid-19th century, the profile of cough-induced syncope emerged in middle aged muscular built males with underlying obstructive lung disease. Presumably, such individuals generate very high intra-thoracic pressures with coughing associated with low venous return and cardiac output, decreased cerebral perfusion, increased extravascular pressure around cranial vessels resulting in cerebral concussion like effect from rapid rise in cerebrospinal fluid pressure. It is a neutrally mediated reflex vasodepressor-bradycardia response to coughing (2,3). This case scenario suggest cough induced syncope can be a clinical problem. Reduced cerebral flow due to vagal modulation seems as a primary cause. Syncopal episode is a result of cough however elimination of cough is important hence evaluation and treatment of potential underlying causes of cough is required. The lack of robust research is due to dearth of large data sets and it is needed to investigate several pathophysiological processes. Some literatures further put forward interesting questions about vulnerable individuals with raised intra-thoracic pressures and their predisposition for this condition and suggested to incorporate new diagnostic modalities (3-5).

Keywords: Cough, syncope, COVID-19

Ethics

Peer-review: Externally peer-reviewed.

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

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Letter to the Editor
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Tramadol as a Misusing or Addiction Agent

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Dear Editor,

In the emergency ward of the hospital, I work in, which is Sina Medical Research and Training Hospital, seeing cases of tramadol poisoning is not an unusual thing. Moreover, it is a common trend throughout other hospitals in our country, Iran.

Tramadol is a synthetic codeine analog, and has central analgesic properties, acting on specific opioid receptors, causing it to have effects like morphine and codeine. Tramadol also has a weak inhibitory effect on norepinephrine and serotonin reuptake (1,2). It is usually prescribed for moderate to moderately severe chronic pain (3).

Tramadol has an oral bioavailability value of 75%, reaching a peak plasma concentration around 2 hours (4,5). It has a half-life if 6.3±1.4 hours (4), and reaches steady state after 2 days, after being administered in constant dosing of 4 times a day (3).

The most common adverse effects of tramadol therapy are nausea, somnolence, constipation, dizziness, vomiting, and headache (3). There is also a risk of seizures in patients receiving tramadol, and even though it occurs mostly in doses above the therapeutic range, it may also occur within the recommended dosing range. Its occurrence increases in patients using tricyclic compounds (e.g., tricyclic antidepressants), selective serotonin reuptake inhibitors, Monoamine oxidase inhibitors, neuroleptics, and other drugs that reduce the seizure threshold (3). It also increases in patients with epilepsy, those with a history of seizures, or in patients with a recognized risk for seizure, such as head trauma, metabolic disorders, alcohol, and drug withdrawal, and central nervous system infections (3). Treating tramadol overdose with naloxone may also increase the risk of seizures (3).

Also, tramadol has a low potential for abuse (6). Abuse cases are not infrequent, due to its effects, and also the fact that it is used off-label for erectile dysfunction. Tramadol, which is used in Iran, is either manufactured inside the country or is imported. Those manufactured in Iran are tablets in 100 mg and 200 mg doses. The imported ones are mostly as 200 and 220 mg tablets. Also, it seems that adverse effects, esp. seizures are most prominent in those who use imported forms. There are a few cases worthy of mentioning of tramadol misuse and abuse, which are as follows:

In a case of misuse, the patient a 25-year old male who suffered from premature ejaculation, consumed tramadol solely based on the suggestion of his friends to help with his problem. About an hour after consuming the drug (first time-a single dose tablet of 100 mg) the patient was admitted to the hospital with seizures. Patient was completely unaware of the abuse potential of tramadol and assumed it was a treatment for sexual dysfunction and premature ejaculation. In another case, patient was a 37-year old male which following occupational trauma, presented with sever pains that were unresponsive to routine analgesic drugs, and his physician prescribed for him tramadol 100 mg every 12 hours. This patient was admitted to the hospital in the post ictal phase, after having a seizure following consumption of 7 or 8 100 mg tablets. After an inquiry we found that the patient's tramadol was of those manufactured in Iran.

Finally, the last cast was a male patient around the age of 30, which subsequent to ingestion of 60 100 mg tablets, had seizures which lead to a head trauma causing intracranial hemorrhage. Due to the severity of the patient's condition and the state in which the patient was brought to the emergency room, unfortunately he was expired.

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Unfortunately, there is not enough evidence, because almost all of the hospital admissions are abuse cases and patients are not willing to participate in studies due to its consequences. Also, there are not enough regulations to control the import and use of these forms. Adding fuel to the fire, tramadol can be obtained with much ease much like over the counter medications, despite the guidelines and regulations of the ministry of health.

In conclusion, we need more studies related to this issue and an immediate revision on guidelines and regulations related to this matter.

Keywords: Tramadol, abuse, overdose

Ethics

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: S.S.V., Design: A.G., Literature Search: P.H., Writing: A.A.

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

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