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An Analysis for the Predictors of ROSC Rate in Cardiac Arrest Patients

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ABSTRACT

Objective: The present study aims to investigate the utility of femoral pulse examination as a feedback mechanism to evaluate CPR effectiveness in non-traumatic cardiac arrest patients.

Materials and Methods: The cases that were brought to the emergency department (ED) as non-traumatic cardiac arrest were included in this study. They were separated into two groups as follows: return of spontaneous circulation (ROSC) and died patients. Then, the groups were compared concerning age, gender, initial rhythm, CPR duration, arrest site, the presence of comorbidities, how to go to the ED, and the detection of the femoral pulse during CPR. The logistic regression analysis was carried out to investigate the factors that associate with the ROSC rate.

Results: A total of 130 patients were included in this study, and 23 of them become spontaneous circulation after CPR in ED. No significant difference was determined between cases in ROSC and died, concerning age, gender, presence of comorbid status and the way to go to the ED (p>0.05). The number of patients in which the femoral pulse was detected during CPR, patients with in-hospital cardiac arrests, patients with shockable initial rhythm, and patients with short CPR durations were significantly higher in ROSC group (p<0.001). No significant difference was observed between the patients who died and survived by one-month of surveillance (p>0.05).

Conclusion: The detection of the femoral pulse during CPR may provide us with advice about the effectiveness of CPR in non-traumatic cardiac arrest patients.

Keywords: Femoral pulse, resuscitation, ROSC

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INTRODUCTION

Sudden cardiac arrest is an important challenge for modern medicine due to the social responsibility it brings to health workers and the economic burden it brings to the health system (1). Five hundred thousand deaths are seen per year due to cardiac arrest in America and Europe (2). In hospital, cardiac arrest rate is 0.16% of all admissions, and their survival rate is 18.4% (3). The survival rate of cardiac arrest outside the hospital is lower and ranges from 4.3% to 10.7% (4). Cardiopulmonary resuscitation (CPR) is the main factor that determines survival in cardiac arrest patients in a timely and appropriate manner. The most important steps to increase the patient's survival are adjusting the chest compressions with minimum interruption, compression depth between 5 to 6 cm, the number of the compressions in the range of 100–120 per minute, and the adjustment of the intervals so that the chest is completely relaxed (5).

Chest compression determines the cardiac output and coronary perfusion, which directly affects the chances of survival. Since the first chest compression applied in 1960, many studies have been carried out about what depth should be done. While very superficial compressions reduce the cardiac output and reduce the chance of survival, also very deep compressions may cause ribs and sternum fractures, pneumothorax, hemothorax, liver, spleen and cardiovascular injuries. Therefore, it is vital to investigate the optimal compression depth (6). In resuscitation, chest compressions should provide sufficient blood flow to vital organs. The main condition that provides cardiac recovery is adequate coronary perfusion pressure (above 20 mmHg) (7). Coronary perfusion in a healthy heart occurs in the diastolic phase, where the coronary vessels are under reduced pressure. However, coronary perfusion occurs out of the diastolic phase because there is no pressure on the myocardium in a stopped heart during resuscitation. The difference between mean femoral artery pressure and right atrial pressure measured during compression-decompression can determine coronary perfusion pressure in a stopped heart (7, 8).

Femoral pulse, which is a measure of ROSC due to coronary perfusion, is an easy method that we frequently check during resuscitation in the emergency department (ED). In this study, we sought whether a femoral pulse was detected or not during each chest compression in patients who underwent CPR in our ED. Then, we tried to determine whether this can be used to assess the effectiveness of CPR by investigating its relationship to return and survival.

MATERIALS and METHODS

Study Design and Setting

This study performed prospectively in a tertiary care ED. This study was initiated following the permission of the Clinical Research Ethics Committee and in compliance with the principles of the Declaration of Helsinki (Approval number: 2018/9-4). The emergency service of our hospital is a health agency that serves adult patients with working of two emergency medicine specialists (EMS) and two general practitioners together at the same time. Emergency medicine specialists intervene in CPR and they carry out adult life-support in accordance with the 2015 European Resuscitation Guidelines (ERC 2015) (9). All of the emergency medicine specialists in our ED (n=8) had been told and trained for this study.

This study included non-traumatic cardiac arrest patients who underwent CPR in our ED in 2018. An emergency medicine specialist examined the femoral pulse of patients repeatedly while other health care provider was performing CPR. Then, the status of the femoral pulse, "detected during each chest compression" or "not", was written on forms. In addition, age, gender, presence of comorbid diseases, the manner in which they were brought to the ED, arrest site, the duration of CPR performed, the initial rhythm (shockable or not), the patient's outcome and 1-month survival were also investigated. Firstly, the patients were separated into two groups as follows: one group consisted of patients who achieved ROSC after CPR and the other group consisted of patients who died despite performing CPR in ED. We analyzed age, sex, arrest site, whether the initial rhythm was shockable, presence of comorbid diseases, the ways in which patients admitted to the ED (by EMS or own facilities), and detection of the femoral pulse variables in both groups and investigate any significant difference to investigate factors that affect ROSC rate. Then, one-month survival of patients who returned with the emergency intervention was studied and these cases were divided into two groups who survived and died. Afterwards, the presence of a femoral pulse, shockable rhythm, age, gender, arrest site, presence of comorbid diseases, and the way in which patients admitted to the emergency room were compared and the presence of significant difference was investigated. In this study, the reason for choosing the femoral artery pulse is, any health personnel can easily perform this examination without obstructing CPR. The second reason is that if enough blood reaches this area, it will certainly reach vital organs like the brain and heart. The study did not include traumatic cardiac arrest, pregnant and pediatric patients.

Statistical Analysis

Data analysis was performed on SPSS version 17.0 and $p<0.05$ was regarded as statistically significant. The normality of variables was evaluated by the Kolmogorov-Smirnov test. The mean±standard deviation was given for the normally distributed variables and the median (minimum–maximum) was given for those without normal distribution. Student's t-test was used in the analysis of quantitative data when data were normally distributed, and the Mann-Whitney U test when data were not normally distributed. The chi-square test and Fisher's exact chi-square test were used to compare qualitative data. The association between the ROSC rate and independent variables was analyzed by binary logistic regression.

Table 1. Descriptive statistics

Characteristics	n	%
Age (years)		
<65	43	33.1
≥65	87	66.9
Total	130	100
Gender		
Female	63	48.5
Male	67	51.5
Outcome		
ROSC	23	17.7
Exitus	107	82.3
Arrest time		
00.01–08.00	29	22.3
08.01–16.00	47	36.2
16:01–00.00	54	41.5
Arrest season		
Spring	48	36.9
Summer	26	20
Autumn	8	6.2
Winter	48	36.9

ROSC: Return of spontaneous circulation

RESULTS

Of the 130 patients included in this study, 67 (51.5%) were male and 63 (48.5%) were female. After the intervention in the ED, 23 (17.7%) patients returned and 107 (82.3%) patients died. When ROSC was achieved by CPR in the ED, and after looking at the one-month survival of these patients who were admitted to the intensive care unit, it was found that 19 of them died and four were survived. The mean age of all patients was 70.4±16.4 years, 68.7±18.8 years in the ROSC group, and 70.7±15.9 years in the died group. Cardiac arrests were observed mostly between 16.01–00.00 hours (41.5%) and in spring and winter (36.9%) seasons (Table 1).

There was no significant difference between the ROSC group and died patients concerning age and gender ($p>0.05$). The more cardiac return was determined in patients with femoral pulse detected during resuscitation ($p<0.001$). The shockable rhythm was detected on 18 patients, 39.1% of the ROSC group and 8.4% of the died group had shockable initial rhythm ($p<0.001$). In-hospital cardiac arrests had a significantly higher ROSC rate than out of hospital arrests ($p<0.001$). There was no significant difference between the two groups concerning comorbid conditions of the patients and the way of bringing patients to the ED ($p=0.981$, $p=1.0$, respectively). Patients in the ROSC group had shorter CPR duration compared to the died group ($p<0.001$) (Table 2).

When we looked at the one-month survival of 23 cases in whom cardiac return was achieved by the intervention in the emergency ward, there was no difference concerning age, gender, initial

Table 2. Comparison of died and ROSC patients by some variables

Variables	ROSC (n=23)		Died (n=107)		p
	n	%	n	%	
Age (years)	72 (28–103)		73 (18–100)		0.671
Duration of CPR (minutes)	15 (5–70)		45 (5–90)		
Shockable rhythm	9	39.1	9	8.4	
Gender					
Female	10	43.5	53	49.5	<0.001
Male	13	56.5	54	50.5	<0.001
Femoral pulse detection					
Yes	22	95.7	26	24.3	0.766
No	1	4.3	81	75.7	
Arrest site					
In hospital	16	69.6	26	24.3	<0.001
Out of the hospital	7	30.4	81	75.7	
Comorbidity					
Present	17	73.9	76	71	0.981
Absent	6	26.1	31	29	
How to get to ED					
By EMS	20	87	91	85	1.0
Own facility	3	13	16	15	

ROSC: Return of spontaneous circulation; ED: Emergency department; EMS: Emergency medical services

rhythm, CPR duration, comorbid conditions, the way of bringing to ED, arrest site and detecting femoral pulse during CPR in patients who died and survived (p>0.05). No significant difference was also found between died and survived patients in terms of pH levels, lactate and potassium (p>0.05) (Table 3). In addition, binary logistic regression showed that the CPR duration, arrest site and detection of the femoral pulse were significantly associated with the ROSC rate. In-hospital cardiac arrests and the patients who had detectable femoral pulse have a higher association with ROSC rate (B:-3.480, 95% CI: 0.003–0.320, B:-6.633, 95% CI: 0.000–0.161, respectively) (Table 4).

DISCUSSION

In this study, we found that the patients with a detectable femoral pulse during CPR, the patients with shockable initial rhythm, patients who had an in-hospital cardiac arrest, and those with shorter CPR duration were more likely to return after CPR. CPR duration, arrest site and detectable femoral pulse were associated with a higher ROSC rate. However, the factors mentioned above did not affect the one-month survival of the patients.

Although 50 years have passed since the first CPR has been performed, the rate of return in patients with cardiac arrest is still low. One of the reasons for this is that the guidelines are not strictly observed in the basic parameters, such as the number and depth of chest compressions, the lack of adequate ventilation, and the absence of interruption during cardiac massage (10). The rate of ROSC is between 2–22%, regardless of the reason for arrest, on average, 8.4%. Increasing this rate is a difficult purpose for health care workers; however, new devices produced in this field can also help us like guidelines (11). Mechanical chest compressors that provide constant number and depth of compressions, devices, such as end-tidal CO_2 and smart defibrillators that evaluate resuscitation effectiveness can be given as an example (10). In addition to improvements in medicine and technology, devices, such as TrueCPR and CPRmeter, as well as smartphone applications, such as PocketCPR, can help us to measure the effectiveness of CPR (4). In human study with Q-CPR device (11), in manikin studies conducted by Gonzalez-Otero et al. (5) and Majer et al. (1) with CPR feedback devices, and in Kurowski et al. (4) study which was used smartphone application, showed that resuscitation with these devices gives better results than routine practice. In our study, we found that in cases where we received a femoral pulse during each chest compression during CPR, we found more cardiac return than the cases we could not get.

The site where the cardiac arrest occurs significantly affects the patient's chances of survival. The rapid monitoring of the patient in the hospital setting and the early medical intervention in this group of patients result in a higher ROSC rate than in patients who experience cardiopulmonary arrest in out of hospital settings (3). In a study that investigated cases of out of hospital cardiopulmonary arrest with and without witness, it was observed that the presence of a defibrillator and a person who could perform early CPR significantly improved the patient survival. In the same study, it was observed that the EMS team intervention leads to less neurological squeal in resuscitated patients (12). Additionally, the initial shockable rhythm

Table 3. Comparison of died and survived patients by some variables in one month period

Variables	Survived (n=4)		Died (n=19)		p
	n	%	n	%	
Age (years)	57.5±16.7		71±18.7		0.196
Duration of CPR (minutes)	17.5 (5–70)		15 (8–45)		0.902
Shockable rhythm	2	50	7	36.8	1.0
Gender					
Female	1	25	9	47.4	0.604
Male	3	75	10	52.6	
Femoral pulse detection					
Yes	4	100	18	94.7	1.0
No	0	0	1	5.3	
Arrest Site					
In hospital	3	75	13	68.4	1.0
Out of hospital	1	25	6	31.6	
Comorbidity					
Present	3	75	14	73.7	1.0
Absent	1	25	5	26.3	
How to get to ED					
By EMS	3	75	17	89.5	0.453
Own facility	1	25	2	10.5	
pH	7.18±0.21		7.14±0.13		0.584
Lactate	7.2±3.6		9.1±3.6		0.338
Potassium	4.6 (3.3–8.4)		4.3 (3.3–10)		0.839

ED: Emergency department; EMS: Emergency medical services

Table 4. Binary logistic regression for ROSC rate

Independent variables	B	SE	Wald	df	p	Exp (B)	95% CI for Exp (B)
Age	0.049	0.031	2.604	1	0.107	1.051	0.989–1.115
Gender	0.368	0.941	0.153	1	0.696	1.445	0.229–9.131
Duration of CPR	0.144	0.040	13.192	1	<0.001	1.155	1.069–1.249
Comorbidity	-0.768	1.199	0.410	1	0.522	0.464	0.044–4.862
Arrest Site	-3.480	1.194	8.500	1	0.004	0.031	0.003–0.320
Femoral pulse detection	-5.633	1.941	8.419	1	0.004	0.004	0.000–0.161
How to get to ED	-2.549	1.635	2.431	1	0.538	5.142	0.003–1.925
Shockable rhythm	4.038	2.107	3.674	1	0.055	0.018	0.000–1.096

df: Degree of freedom; SE: Standard error; CI: Confidence; ED: Emergency department; CPR: Cardiopulmonary resuscitation

means higher resuscitation success, and it was shown that every minute without defibrillation reduces this success (13, 14).To increase survival of out of hospital cardiopulmonary arrest patients, the ideal CPR manner should be taught simple citizens, too (15). In our study, we have found a higher ROSC rate for in-hospital cardiac arrests and those with initial shockable rhythms. The majority of the patients who was brought to the ED by their relatives or own facilities died in the emergency ward, and it showed that longer non-intervention periods represented a poor prognosis on survival. Studies have shown an inverse relationship between CPR duration and the ROSC rate. It was observed that patients having undergone shorter CPR durations tended to have greater chances of returning than patients having undergone longer CPR durations. Silva et al. (3) found the average CPR duration of died patients 30.7 minutes and that of patients who survived as 10.8 minutes. In another study conducted on cardiac arrest cases, CPR duration was found to be of 21 minutes for patients discharged from the intensive care unit and of 24.4 minutes for patients who died (16). These studies were mostly single-centered studies in which the effects of CPR duration on survival were investigated. CPR duration was calculated to be shorter in these patients who survived due to a faster response to resuscitation. However, resuscitation is usually continued for a long time in cases of patients who do not survive. In a study that aimed to eliminate this effect, CPR duration and ROSC rate of 435 hospitals were compared. As a result, it was observed that the cardiac return of the hospitals that had long CPR duration was higher than the short-term ones. However, no clear consensus concerning the ideal length of CPR duration needed to resuscitate a patient was reached (17). Our study is a single centered one in which we found that patients who arrived at a ROSC status, had a shorter duration of CPR than the patients who died.

In a study involving 27 European countries on out of hospital cardiopulmonary arrests, the average age of the patients involved was 66.5 years and out of which 66.3% were male. In this same study, the ROSC rate was found to be 28.6% (18). In the study of Kampmeier et al. (19), the mean age of patients was 69.5, out of which 67.7% were males. In our study, 51.5% of the cases were male, the mean age was 70.4 years and the ROSC rate was 17.7%.

This study had a low number of patients and a single-centre study. The real cause of cardiac arrests is not known but can be guessed, especially in died patients. Additionally, the study team's records were deficient, so we were obliged to ignore the real causes of cardiac arrest in our study. Moreover, we ignored the CPR duration, which was performed out of the hospital because of incomplete information. The detection of the femoral pulse was done by finger and recorded as "present" or "absent" in a subjective manner. Any objective method that was defined quantitatively could yield more definite results.

CONCLUSION

It was observed that there was a greater cardiac return in cases where femoral pulse could be detected when each chest compression was performed during CPR in ED. Easy to perform femoral pulse examination can be used as a method for evaluating resuscitation adequacy, especially chest compression depth. We thought that if this preliminary study with a small number of cases is repeated with a higher number of cases and multi-centered, more precise results can be obtained.

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Ethics Committee Approval: This study was initiated following the permission of the Adıyaman University Non-interventional Clinical Research Ethics Committee and in compliance with the principles of the Declaration of Helsinki (date: 18.12.2018, number: 2018/9-4).

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