

The Relationship between Echocardiography Findings with Prognosis and Response to the Treatment during Cardiopulmonary Resuscitation in Patients with Cardiac-Pulmonary Arrest Referred to the Emergency Department

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Abstract

Background and objective: Ultrasound can increase to diagnose the reversible causes of cardiac arrest. This study aimed to determine the relationship between Echo findings during CPR with prognosis and response to treatment in patients with cardiac-pulmonary arrest referred to the Emergency Department (ED).

Materials and Methods: This descriptive cross-sectional study was performed in all the patients referred to the ED. Patients were included in the study if needed for cardiopulmonary resuscitation on the basis of inclusion and exclusion criteria. Echo were implanted at resuscitation intervals (0 min), 15 min and 30 min after resuscitation. Demographic data including age, sex, heart rhythm of the patient, need for shock and life situation 24 hours after resuscitation in case of positive response to resuscitation were recorded in the checklist.

Results: The male to female ratio was 1.56. The age mean of the total population was 56.40 years. The ratio of cardiopulmonary arrest cases outside to inside was 3.25, the rate of successful CPR was 30.9%, and the ratio of life to death after 24 hours of successful CPR was 1.6. 72.1% of patients had asystole at the onset of resuscitation, 63.2% of patients had no mechanical activity at the onset of resuscitation. The success rate of CPR in cardiopulmonary arrest cases in-hospital was 50% and 25% in outside ($P=0.058$). The success rate in patients who did not asystole initiate resuscitation was 73.7% and in patients who did asystole initiate resuscitation was 14.3% ($P < 0.001$). Survival rates at 24 hours after CPR were 47.4% in patients with no asystole and 8.2% in patients with asystole at onset of resuscitation ($P= 0.001$). The success of CPR in patients who had cardiac mechanical activity at the onset of resuscitation was 3.48 times greater than that of the group that did not have cardiac mechanical activity. The survival rate at 24 hours after CPR in the group that had cardiac mechanical activity at the start of resuscitation was 3.57 times higher than that of the group that had no cardiac mechanical activity at the start of resuscitation.

Conclusion: In sum, it can be concluded that the presence of mechanical activity in echocardiography during cardiopulmonary resuscitation in patients with cardiac arrest is associated with better success rate and awareness; therefore, echocardiography can be used as a suitable tool during cardiopulmonary resuscitation.

Keywords: Cardiopulmonary resuscitation, cardiac arrest, echocardiography

Introduction

Cardiac arrest is reported as the lack of a palpable pulse and the absence of respiratory effort in unresponsive patients (1). It is resulted in a cessation of circulation due to an underlying etiology and annually kills much people (2). A medical rapid management for cardiac arrest should be considered in a organized status parallel with usual guidances (1). Medical providers try to diagnose the cause for an appropriate treatment (3). Despite advantages in technology, only some patients with cardiac arrest will leave the hospital alive, but the most patients are neurologically impaired (4). Palpating central pulses and assessment of blood pressure are used to diagnose cardiac arrest, but these are not reliable. (2). The most health care professionals cannot accurately assess central pulses during a cardiac arrest (5). Cardiopulmonary arrest is resulted due to several diseases and it is needed to use cardiopulmonary resuscitation (CPR) protocols (6). It was reported that early detection of cardiac arrest and CPR could rescue lives of hundreds of thousands of people worldwide (7). Sonography diagnoses

reversible causes of cardiac arrest and predicts survival (8). Pulseless electrical activity is used to diagnose the rhythm of cardiac arrest (9). There are four cardiac rhythms related to cardiac arrest that are grouped into shockable and nonshockable rhythms (10). Shockable rhythms are including ventricular fibrillation and pulseless ventricular tachycardia (2). Asystole is defined by no detectable cardiac activity and palpable pulse (2). If nonshockable rhythms are to be found, prognosis is hardly conducted (11-13). Echocardiography is capable to visualize the presence or lack of cardiac wall contractility (14). Appropriate detection of rhythms helps providers to determine an appropriate treatment (6). The use of point of care ultrasound in emergency is used for several years. It is used in trauma, gynecologic, procedural, cardiac, and vascular clinical presentations (15) and is an essential diagnostic tool in the emergency department (ED) for managing patients with hypotension (16). In patients with the cardiac arrest, the use of echocardiography may help efficient interventions and management. So far, any study has not been conducted to evaluate the

effects of relationship between Echocardiography findings with prognosis and response to the treatment during CPR in patients with cardiac-pulmonary arrest referred to the ED. This study, for first time, was conducted to evaluate the relationship between Echocardiography findings with prognosis and response to the treatment during CPR in patients with cardiac-pulmonary arrest referred to the ED.

Methods

A descriptive cross-sectional study was conducted in the Department of Emergency of Shahid Mohammadi, Bandar Abbas from December 2017 and February 2018. All the used procedures were approved by Ethical Committee of Hormozgan University of Medical Science (Ethics code: IR.HUMS.REC.1398.416). A total of 68 eligible patients were randomly selected from patients referred to Department of Emergency of Shahid Mohammadi, Bandar Abbas, using the following inclusion criteria: 1) All the patients with cardiac arrest during referring to the ED and health care professionals conducted resuscitation on them, 2) All the patients with pulse and breathing when entrance into the ED and then occurred cardiac arrest and 3) All the patients lack of pulse and breathing when entrance into the ED. Cardiopulmonary resuscitation was conducted on the basis of AHA guidelines. Echocardiography was conducted in time intervals of start of resuscitation (Time=0), 15 and 30 min after the start of resuscitation.

Mitral valve, septum and apex movements were checked and recorded. Demographic characteristics including age, sexuality, heart rhythm and life situation were recorded 24 h after resuscitation. In the current study, response to the treatment was defined as return critical signs during cardiopulmonary resuscitation and prognosis was defined as patient situation 24 h after cardiopulmonary resuscitation. The data were analyzed by SPSS statistical software (version 22) and multiple analyses of Odd Ratio were conducted. A $P < 0.05$ value was considered as significant.

Results

Demographic characteristics

The results showed that out of 68 patients, 41 patients (60.2%) were male and 27 patients (39.80%) were female. The mean of age for the studied population was 56.40 ± 22.46 year.

Main findings

The results for place, CPR results and life situation are shown in Table 1. The results showed that cardiac arrest was occurred in 23.50% and 76.50% of patients inside and outside of hospital, respectively. The results showed that 21 patients (30.90%) had successful results for initial cardiopulmonary resuscitation. Out of 21 patients, 8 patients were death and 13 patients showed life situation. The final results for life situation of patients were 19.10% with life situation and 80.90% death.

Table 1 The results for cardiac arrest place, CPR initial results and life situation in the studied patients

Variables	Subgroup	N (%)
Place	Inside	16 (23.50)
	Outside	52 (76.50)
Initial results	Successful	21 (30.90)
	Unsuccessful	47 (69.10)
Life situation in successful CPR	Alive	13 (61.90)
	Death	8 (38.10)
Life situation in total population	Alive	13 (19.10)
	Death	55 (88.90)

The data for echocardiography and electrocardiogram for receiving shock are presented in Table 2. In the studied population, 17.60% of patients received shock during initial CPR. In the studied population, 72.10% of patients were asystole 27.90% had arrhythmia. Electrocardiogram pattern showed 33.50% sinusoid rhythm, 16.20% arrhythmia, and 60.30% asystole. The results for echocardiography showed that 26.50%,

30.90% and 38.20% of patients had heart apex in 0, 15 and 30 min after the start of CPR, respectively. The results also showed that 35.30%, 35.30% and 42.60% had mitral valve movement in in 0, 15 and 30 min after the start of CPR, respectively. The results also showed that 30.90% apex movements. The heart mechanical activity was reported in 36.80% of patients.

Table 2 The data for echocardiography and electrocardiogram for receiving shock

Variables	Subgroups	N (%)
Receiving shock during CPR	Yes	12 (17.6)
	No	56 (82.40)
Electrocardiogram status during entrance	Arrhythmia	19 (27.90)
	Asystole	49 (72.10)
Electrocardiogram status during resuscitation	Sinusoid	16 (23.50)
	Arrhythmia	11 (16.20)

	Asystole	41 (60.30)
Apex movement in the start of CPR	Yes	18 (26.50)
	No	50 (73.50)
Mitral valve movement in the start of CPR	Yes	24 (35.30)
	No	44 (64.70)
Apex movement 15 minutes after CPR	Yes	21 (30.9)
	No	47 (69.1)
Mitral valve movement 15 minutes after CPR	Yes	24 (35.3)
	No	44 (64.7)
Apex movement 30 minutes after CPR	Yes	26 (38.2)
	No	42 (61.8)
Mitral valve movement 30 minutes after CPR	Yes	29 (42.6)
	No	39 (57.4)
Cardiac activity at the beginning of CPR	Yes	25 (36.80)
	No	43 (63.20)

The results for sexuality relationship with initial CPR results showed that 66.70 of patients with successful CPR were male and 33.30% were female. There was not a significant relation between sexuality and CPR findings ($P=0.578$) (Table 3). The results for mean of age did not show significant relationship for age

($P=0.926$). The results for place showed that successful CPR was conducted inside of hospital (50%), but the differences were not significant ($P=0.058$). The successful rate was 33.30% in patients that received shock, while it was 30.30% in patients that did not receive the shock ($P=1.00$).

Table 3 The results for relationship between initial CPR results with sexuality, age, place and electrical shock in the studied patients

Variables	Subgroups	Successful	Unsuccessful	P-value
Sexuality	Male	14 (66.70)	28 (59.60)	0.578
	Femal	7 (33.30)	19 (40.40)	
Age	Year	55.70	56.72	0.926
Place	Inside	8 (50.00)	8 (50.00)	0.058
	Outside	13 (25.00)	39 (75.00)	
Shock	Yes	4 (33.30)	8 (66.70)	1.00
	No	17 (30.30)	39 (69.70)	

The results for electrocardiography findings with initial CPR findings are shown in Table 4. The results showed that successful rate in patients with cardiac arrest that

had cardiac rhythm in the start of resuscitation was 73.70%, but it was 14.3% in patients that had asystole in the start of the resuscitation ($P<0.001$).

Table 4 The results for relationship between initial CPR results with electrocardiography in the studied patients

Variables	Subgroups	Successful	Unsuccessful	P-value
Start	Arrhythmia	14 (73.70)	5 (26.30)	<0.0001
	Asystole	7 (14.30)	42 (85.70)	
During resuscitation	Sinusoid	16 (76.20)	0 (0)	<0.0001
	Arrhythmia	5 (23.80)	6 (12.80)	
	Asystole	0 (0)	41 (87.20)	

The results for echocardiography with CPR results in the studied patients are shown in Table 5. The results showed that 38.10% had Apex movement in patients with successful CPR, while it was 21.30% in unsuccessful group and this difference was not significant ($P=0.146$). With regards to mitral valve movement in the start of resuscitation, there was significant difference between successful and unsuccessful groups (52.4 vs 27.7) ($P<0.05$). In sum,

cardiac mechanical activity was observed in 57.10% patients with successful CPR and 27.70% patients with unsuccessful CPR ($P=0.020$). Successful CPR was significantly higher (3.48 times) in patients that had mechanical activity in the start of resuscitation compared to who did not show mechanical activity. There was significant relationship between successful CPR and apex and mitral valve movements in times of 15 and 30 minutes ($P<0.001$).

Table 5 The relationship between echocardiography with initial CPR in the studied patients

Variables	Subgroups	Successful	Unsuccessful	P-value	OR, CI 95%
Apex movement in the start of CPR	Yes	8 (38.10)	10 (21.30)	0.146	-

Mitral valve movement in the start of CPR	No	13 (61.90)	37 (78.70)	0.049	-
	Yes	11 (52.40)	13 (27.70)		
Apex movement 15 minutes after CPR	No	10 (47.60)	34 (72.30)	0.0001	26.88 (6.8-10.50)
	Yes	16 (76.20)	5 (10.60)		
Mitral valve movement 15 minutes after CPR	No	5 (23.80)	42 (89.40)	0.0001	24.28 (6.2-93.90)
	Yes	17 (81.00)	7 (14.90)		
Apex movement 30 minutes after CPR	No	4 (19.00)	40 (85.10)	0.0001	136.60 (15-1213)
	Yes	20 (95.20)	6 (12.80)		
Mitral valve movement 30 minutes after CPR	No	1 (4.80)	41 (87.20)	0.0001	-
	Yes	21 (100)	8 (17.00)		
Mechanical activity in the start of CPR	No	0 (0.00)	39 (83.00)	0.020	3.48 (1.1-19.20)
	Yes	12 (57.10)	13 (27.70)		
	No	9 (42.90)	34 (72.30)		

The results for relationship between sexuality, age, place and electrical shock with life situation 24 h after CPR in the studied patients are shown in Table 6. The results did not show significant relationship between

sexuality (P=0.752), age (P=0.839), place (P=1.00) and electrical shock (P=1.00) with life situation 24 h after CPR in the studied patients.

Table 6 The results for relationship between sexuality, age, place and electrical shock with life situation 24 h after CPR in the studied patients

Variables	Subgroups	Alive	Death	P-value
Sexuality	Male	9 (69.20)	33 (60.00)	0.752
	Female	4 (30.80)	22 (40.00)	
Age	Year	56.84	56.30	0.839
Place	Inside	3 (23.10)	13 (23.60)	1.00
	Outside	10 (76.90)	42 (76.40)	
Shock	Yes	2 (15.40)	10 (18.20)	1.00
	No	11 (84.60)	45 (81.80)	

The results for relationship between electrocardiography results with life situation in the studied patients, 24 h after CPR are shown in Table 7.

The results showed that life situation was 47.40% in patients that were not asystole, but successful rate was 8.20% in asystole patients (P=0.001).

Table 7 The results for relationship between electrocardiography results with life situation in the studied patients

Variables	Subgroups	Alive	Death	P-value
Start	Arrhythmia	9 (47.40)	10 (52.60)	<0.0001
	Asystole	4 (8.20)	45 (91.80)	
During resuscitation	Sinusoid	9 (69.20)	7 (12.70)	<0.0001
	Arrhythmia	4 (30.80)	7 (12.70)	
	Asystole	0 (0)	41 (74.50)	

The relationship between echocardiography with life situation 24 h after CPR in the studied patients are presented in Table 8. There was not significant relationship between life situation with apex movement (P=0.074) and mitral valve movement (P=0.120) in the start of CPR. It was observed a significant relationship between heart mechanical activity in the start of CPR

with life situation 24 h after CPR in the studied patients (P=0.039), so that survival rate was 3.57 higher in group that had cardiac mechanical activity in the start of resuscitation. Additionally, the movements of apex and mitral valve in 15 and 30 min had significant relationship with life situation 24 h after CPR (P<0.001).

Table 8 The relationship between echocardiography with life situation 24 h after CPR in the studied patients

Variables	Subgroups	Alive	Death	P-value
Apex movement in the start of CPR	Yes	6 (46.20)	12 (21.80)	0.074
	No	7 (53.80)	43 (78.20)	
Mitral valve movement in the start of CPR	Yes	7 (53.80)	17 (30.90)	0.120
	No	6 (46.20)	38 (69.10)	
Apex movement 15 minutes after CPR	Yes	10 (76.90)	11 (20.00)	0.0001
	No	3 (23.10)	44 (80.00)	
Mitral valve movement 15 minutes after CPR	Yes	11 (84.60)	13 (23.60)	0.0001

Apex movement 30 minutes after CPR	No	2 (15.40)	42 (76.40)	0.0001
	Yes	13 (100)	13 (23.60)	
Mitral valve movement 30 minutes after CPR	No	0 (0.00)	42 (76.40)	0.0001
	Yes	13 (100)	16 (29.10)	
Mechanical activity in the start of CPR	No	0 (0.00)	39 (70.90)	0.039
	Yes	8 (61.50)	17 (30.90)	
	No	5 (38.50)	38 (69.10)	OR=3.57

The relationship between heart mechanical activity in the start of CRP with CRP results and life situation on the basis of age are shown in Table 9. The results did

not show significant relationship between heart mechanical activity with CPR results ($P=0.698$) and life situation ($P=0.220$).

Table 9 The relationship between heart mechanical activity in the start of CRP with CRP results and life situation on the basis of age

Mechanical	Variable	Results	Mean±SD	N	F-value	P-value
Yes	CPR results	Successful	57.83±26.68	12	0.152	0.698
Yes	CPR results	Unsuccessful	56.76±21.74	13		
No	CPR results	Successful	52.86±24.33	9		
No	CPR results	Unsuccessful	56.70±21.61	34		
Yes	Life situation	Alive	51.87±28.58	8	1.536	0.220
Yes	Life situation	Death	59.82±21.58	17		
No	Life situation	Alive	64.80±11.03	5		
No	Life situation	Death	54.73±22.85	38		

Discussion

More than 356,000 out-of-hospital cardiac arrests yearly occur, but overall risk-adjusted survival remains by 8.3% (17-19). Cardiac arrest is defined as the absence of a palpable pulse and respiratory effort in unresponsive patients (1) that is resulted in a cessation of circulation due to an underlying etiology and annually kills much people (2). This study investigated the relationship between Echocardiography findings with prognosis and response to the treatment during CPR in patients with cardiac-pulmonary arrest referred to the ED. The results showed the most patients referred to the ED were male. Similarly, Memtsoudis et al., (20) investigated the usefulness of trans esophageal echocardiography during intraoperative cardiac arrest in non-cardiac surgery and showed the most patients were male (15 vs 7). Another study compared Echocardiography integrated ACLS protocol versus conventional cardiopulmonary resuscitation in patients and showed the most patients were male (56% vs 44%) (21). The results showed that mean of age was 56.40 year and are in agreement with the results of Chardoli et al. (21) and Atkinson et al., (16) that reported 56 to 60 years as age for cardiac arrest. The most cardiac arrests were occurred in outside of the hospital. The results showed that 72.10% of patients were asystole in the start of resuscitation, 63.20% did not have mechanical activity. It means that some patients were asystole in electrocardiogram but did not have mechanical activity in echocardiogram. Similar to our findings, Atkinson et al., (16) reported that out of 186 patients, 140 cases were asystole and 46 cases were cardiac electrical activity. Flato et al., (22) studied echocardiography for prognostication during the resuscitation and showed 17 patients (34.70%) were

asystole and 32 patients were PEA. The difference between our findings and the results of Flato and co-authors is due to care type. The patients in work of Flato et al. were in ICU part and monitored their heart. Blaivas and Fox (23) studied outcome in cardiac arrest patients in the patients referred to the ED by echocardiogram and showed that 52.20% of patients had identifiable rhythm. The results also showed that 30.90% of patients had successful results for initial CPR. There were not significant relationship between successful rate in CRP in patients with cardiopulmonary arrest inside hospital was 50% and outside hospital was 25%, but the differences were not significant ($P<0.05$). The results showed that 73.70% of patients that were asystole in the start of resuscitation, but patients that were asystole in the start of resuscitation, successful rate were 14.30%. The rate of life situation in patients with cardiopulmonary arrest that were not asystole was 47.4%, but patients that were asystole had value of 39.2%. It means that presence of cardiac rhythm increases successful in CRP and higher rate for life situation. The results also showed that mechanical activity was found with a successful result in 57.1% of patients, while it was found with unsuccessful in 27.7% of patients. This difference was not significant. The results showed that CPR successful was 3.48 times higher in patients that had mechanical activity compared to those did not have mechanical activity. The presence of Apex and mitral valve movements in times 15 and 30 minutes had positive relationship with CPR successful. It means that existence the mechanical activity can have positive effects on mechanical activity. However, the results did not confirm significant relationship between mechanical activity in the start of CPR with CPR

results and life situation based on age. In contrast to our findings, Blaivas & Fox (23) showed that patients with electrical activity could not be alive. Blaivas and Fox (23) have studied the prognostic value of ultrasound during the initial assessment of patients requiring CPR and showed all patients lack of cardiac movement in ultrasound have died regardless of their initial heart rhythm. Bolvardi et al. (6) studied patients and showed that all patients without cardiac movement in ultrasound have died regardless of their initial cardiac rhythm. Similarly, Tomruk et al., (24) investigated the presence of sonographic cardiac activity at the start of resuscitation and showed significant relationship with a successful outcome (19/27 [70.4%] versus 55/122 [45.1%] patients without cardiac activity at the beginning of resuscitation).

Conclusion

In sum, the presence of mechanical activity in echocardiography during cardio-pulmonary resuscitation in patients with cardiac arrest is associated with better success rate and awareness. It is a profitable tool for patients with cardiopulmonary arrest and it can be used as tool for prognosis.

Conflict of interest

The authors declared no conflict of interest.

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