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Effects of Chest Compression Fraction on Return of Spontaneous Circulation in Patients with Cardiac Arrest; a Brief Report

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Abstract

Introduction: The association between chest compression fraction (CCF) and return of spontaneous circulation (ROSC) has been a controversial issue in literature; and both positive and negative correlations have been reported between CCF and survival rate.

Objective: The present study was conducted to determine the relationship between the rate and outcomes of chest compression and between CCF and ROSC in patients with cardiac arrest.

Method: The present prospective observational study was conducted during 2018 on patients with cardiac arrest aged 18-80 years. Participants with end-stage renal diseases, malignancies and grade IV heart failure were excluded. A stop watch was set upon the occurrence of a code blue in the emergency department, and time was recorded by the observer upon the arrival of the code blue team leader (a maximum permissible duration of 10 minutes). The interruptions in chest compressions were recorded using a stopwatch, and CCF was calculated by dividing the duration of chest compression by the total duration of cardiac arrest observed.

Results: Totally, 45 participants were enrolled. Most of the patients had non-shockable rhythms and underwent CPR based on related algorithm. Hypoxia and hypovolemia were the two probable etiology of cardiac arrest; and coronary artery disease was the most prevalent underlying disease. All patients with ROSC had CCF more than 70%. A CCF below 70% was observed in 21 cases (46.7%), and a fraction of at least 70% in 24 cases. All patients with ROSC had CCF more than 70%. A CCF below 70% was observed in 21 cases (46.7%), and a fraction of at least 70% in 24. A significantly higher duration and fraction of chest compression was observed in the participants who attained ROSC (P<0.001).

Conclusion: Based on the findings of current study, it seems that significantly higher chest compression durations and fractions were found to be associated with ROSC, which was achieved in the majority of the participants with a CCF of at least 80%.

Key words: Cardiopulmonary Resuscitation; Heart Massage; Outcome; Quality Indicators, Health Care

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INTRODUCTION

The American Heart Association (AHA) and the American College of Cardiology (ACC) define sudden cardiac arrest as an abrupt cessation of cardiac activity in a way that the victim becomes unresponsive with no normal breathing and no signs of circulation (1). The global annual prevalence of sudden cardiac arrest is estimated at 4-5 million cases worldwide (2). Cardiopulmonary resuscitation (CPR) remains the single most viable emergency management alternative for patients with cardiac arrest, and its current version was developed approximately fifty years ago (3). Given that chest compression produces only about 25% of normal perfusion, correctly performing CPR is vital. The quality of CPR has been highlighted in the recent years by focusing on elements such as the depth and rate of chest compression and the pauses between compressions (4, 5). A poor CPR quality has deleterious effects on patient survival, with commonly observed mistakes being pauses in chest compression and at worst, patients receiving chest compressions only half of the time (6). Interruptions in chest compression reduce coronary perfusion, thereby worsening the patients' outcome (7). The proportion of time chest compression is performed at each minute of CPR is a significant modifiable dimension of the CPR quality and a potentially-important contributor to successful outcomes. International guidelines for basic adult life support recommend a compression rate of 100-120 per minute and a chest compression depth of 50-60 mm during CPR. Both these parameters are associated with patients' outcomes (8, 9). The association between chest compression fraction (CCF) and return of spontaneous circulation (ROSC) has been a controversial issue in literature; and both positive and negative correlations have been reported between CCF and survival rate (10-13). Several hypotheses have been proposed to explain this seemingly-counterintuitive observation. This discrepancy of results can be explained by the time dependency of the relationship of CCF with survival outcomes, i.e. ROSC, survival up to hospital discharge and survival with favorable neurological outcomes (14). In addition, deliberately introducing breaks between compressions during the initial minutes of CPR was associated with survival benefits referred to as post conditioning, which is postulated to prevent reperfusion injuries to the myocardium and brain (15, 16). The present study was conducted to determine the relationship between the rate and outcomes of chest compression and between CCF and ROSC in patients with cardiac arrest.

METHODS

The present prospective observational study was conducted during 2018 on patients with cardiac arrest aged 18-80 years presenting to the emergency department of Kerala Institute of Medical Sciences, Trivandrum, Kerala, India. Participants with end-stage renal diseases, malignancies and grade IV heart failure were excluded. The sample size was calculated as 37 assuming ROSC in 72% of the participants and a relative ROSC precision of 20% with an $\alpha=0.05$, $\beta=0.2$ and 80% power. Ethics aspects of the study were approved by the University review board.

A stop watch was set upon the occurrence of a code blue in the emergency department, and time was recorded by the observer upon the arrival of the code blue team leader (a maximum permissible duration of 10 minutes). The interruptions in chest compressions were recorded using a stopwatch, and CCF was calculated by dividing the duration of chest compression by the total duration of cardiac arrest observed. Ventricular fibrillation and pulseless ventricular tachycardia (VT) were considered the shockable rhythm, and asystole and pulseless electrical activity (PEA) the non-shockable rhythms.

The data were expressed as mean ± standard deviation (SD) and frequency. The values were rounded off to the closest decimal, and the independent t-test was used as the test for assessing significance. The data collected were analyzed in R, and $P<0.05$ was set as the level of statistical significance.

RESULTS

Totally, 45 participants were enrolled. Table 1 shows descriptive statistics of studied patients. Based on the findings, most of the patients had non-shockable rhythms and underwent CPR based on related algorithm. Hypoxia and hypovolemia were the two probable etiology of cardiac arrest; and coronary artery disease was the most prevalent underlying disease of the studied patients.

Figure 1 shows proportion of the patients with different CCF percent in those with ROSC vs. deceased ones. Based on the findings, all patients

Table 1: Descriptive statistics of studied patients

Variable	Frequency (%)
Cardiac rhythm	
Shockable	10 (22.2)
Non shockable	35 (77.8)
Etiology of cardiac arrest	
Coronary thrombus	4 (8.9)
Hyperkalemia	6 (13.3)
Hyperkalemia with acidosis	1 (2.2)
Hyperkalemia with hypoxia	1 (2.2)
Hyperkalemia with hypoxia and VT	1 (2.2)
Hypovolemia	8 (17.8)
Hypovolemia and acidosis	3 (6.7)
Hypoxia	5 (11.1)
Hypoxia and acidosis	4 (8.9)
Hypoxia and hypovolemia	12 (26.7)
Comorbidity	
Coronary artery disease	20 (44.4)
Chronic kidney disease	9 (20)
Hypertension	4 (8.9)
Type II diabetes mellitus	4 (8.9)
Chronic obstructive pulmonary disease	3 (6.7)
Chronic liver disease	3 (6.7)
Hypothyroidism	1 (2.2)
Interstitial lung disease	1 (2.2)
Outcome	
ROSC	23 (51.1)
Deceased	22 (48.9)

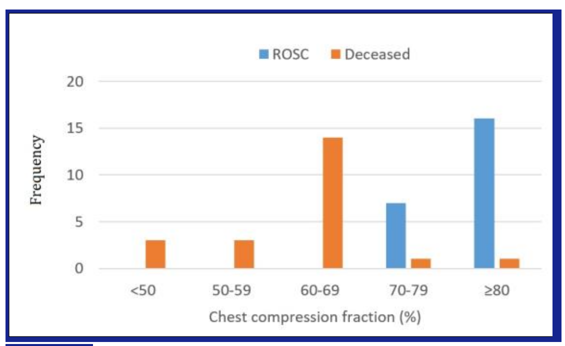

Figure 1: Proportion of the participants with different chest compression fractions in patients with ROSC vs. deceased ones

Table 2: Comparing the studied patients in terms of duration of chest compression and chest compression fraction in patients with ROSC vs. deceased ones

Variable	Outcome		p
	ROSC (n=23)	Deceased (n=22)	
	mean ± SD		
Duration of chest compression (seconds)	486.3 ± 12.1	371.1 ± 54.5	<0.001*
Chest compression fraction	81.0 ± 2.1	61.3 ± 9.8	<0.001*

*suggests significant differences between the groups based on the independent t test

with ROSC had CCF more than 70%. A CCF below 70% was observed in 21 cases (46.7%), and a fraction of at least 70% in 24.

Table 2 shows comparing the studied patients in terms of duration of chest compression and CCF in patients with ROSC vs. deceased ones. A significantly higher duration and fraction of chest compression was observed in the participants who attained ROSC (P<0.001).

Discussion

An alarming CCF below 46.7% was observed in the participants. In case a relatively high or low CCF is associated with ROSC, emergency physicians are recommended to receive appropriate training with an emphasis on the importance of CCF and its association with ROSC. The mean chest compression duration was significantly longer in the participants who attained ROSC, which had not been reported in humans although lower survival rates had been observed in models of pigs receiving CPR for longer durations (17). This finding is recommended to be further evaluated in terms of the relationship between chest compression duration and ROSC. A CCF of at least 80% associated with higher rates of ROSC was previously described as higher rates of chest compression (121-130/minute) with the most significant association with ROSC (18). A significantly higher CCF was observed in the participants attaining ROSC, which is inconsistent with previous reports suggesting negative relationships between CCF and ROSC (19). This finding is required to be further evaluated in larger samples.

Conclusions

Based on the findings of current study, it seems that significantly higher chest compression durations and fractions were found to be associated with ROSC, which was achieved in the majority of the participants with a CCF of at least 80%.

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Authors' contribution

All the authors met the standards of authorship based on the recommendations of the International Committee of Medical Journal Editors.

Conflict of interest

The authors declared no conflicts of interest regarding the publication of the present article.

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References

1. Patel K, Hipskind J. Cardiac Arrest. [Updated 2019 Jan 9]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2019. Available from: https://www.ncbi.nlm.nih.gov/books/NBK534866.
2. Chugh SS, Reinier K, Teodorescu C, Evanado A, Kehr E, Al Samara M, et al. Epidemiology of sudden cardiac death: clinical and research implications. Prog Cardiovasc Dis. 2008;51(3):213-28.
3. Kouwenhoven WB, Jude JR, Knickerbocker GG. Closed-chest cardiac massage. JAMA. 1960;173:1064-7.
4. Lerjestam K, Willman A, Andersson I, Abelsson A. Enhancing the quality of CPR performed by laypeople. Australas J Paramed. 2018;15(4):1-5.
5. Kramer-Johansen J, Edelson DP, Losert H, Kohler K, Abella BS. Uniform reporting of measured quality of cardiopulmonary resuscitation (CPR). Resuscitation. 2007;74(3):406-17.
6. Wik L, Kramer-Johansen J, Myklebust H, Sorebo H, Svensson L, Fellows B, et al. Quality of cardiopulmonary resuscitation during out-of-hospital cardiac arrest. JAMA. 2005;293(3):299-304.

7. Berg RA, Sanders AB, Kern KB, Hilwig RW, Heidenreich JW, Porter ME, et al. Adverse hemodynamic effects of interrupting chest compressions for rescue breathing during cardiopulmonary resuscitation for ventricular fibrillation cardiac arrest. Circulation. 2001;104(20):2465-70.
8. Perkins GD, Handley AJ, Koster RW, Castren M, Smyth MA, Olasveengen T, et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 2. Adult basic life support and automated external defibrillation. Resuscitation. 2015;95:81-99.
9. Kleinman ME, Brennan EE, Goldberger ZD, Swor RA, Terry M, Bobrow BJ, et al. Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2015;132(18 Suppl 2):S414-35.
10. Cheskes S, Schmicker RH, Rea T, Powell J, Drennan IR, Kudenchuk P, et al. Chest compression fraction: A time dependent variable of survival in shockable out-of-hospital cardiac arrest. Resuscitation. 2015;97:129-35.
11. Vadeboncoeur T, Stolz U, Panchal A, Silver A, Venuti M, Tobin J, et al. Chest compression depth and survival in out-of-hospital cardiac arrest. Resuscitation. 2014;85(2):182-8.
12. Wik L, Olsen JA, Persse D, Sterz F, Lozano M, Jr., Brouwer MA, et al. Why do some studies find that CPR fraction is not a predictor of survival? Resuscitation. 2016;104:59-62.
13. Perkins GD, Jacobs IG, Nadkarni VM, Berg RA, Bhanji F, Biarent D, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of the Utstein Resuscitation Registry Templates for Out-of-Hospital Cardiac Arrest: a statement for healthcare professionals from a task force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation Council of Asia); and the American Heart Association Emergency Cardiovascular Care Committee and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation. Circulation. 2015;132(13):1286-300.
14. Rea T, Olsufka M, Yin L, Maynard C, Cobb L. The relationship between chest compression fraction and outcome from ventricular fibrillation arrests in prolonged resuscitations. Resuscitation. 2014;85(7):879-84.
15. Ovize M, Baxter GF, Di Lisa F, Ferdinandy P, Garcia-Dorado D, Hausenloy DJ, et al. Postconditioning and protection from reperfusion injury: where do we stand? Position paper from the Working Group of Cellular Biology of the Heart of the European Society of Cardiology. Cardiovasc Res. 2010;87(3):406-23.
16. Zhao ZQ, Corvera JS, Halkos ME, Kerendi F, Wang NP, Guyton RA, et al. Inhibition of myocardial injury by ischemic postconditioning during reperfusion: comparison with ischemic preconditioning. Am J Physiol Heart Circ Physiol. 2003;285(2):H579-88.
17. Rittenberger JC, Suffoletto B, Salcido D, Logue E, Menegazzi JJ. Increasing CPR duration prior to first defibrillation does not improve return of spontaneous circulation or survival in a swine model of prolonged ventricular fibrillation. Resuscitation. 2008;79(1):155-60.
18. Kilgannon JH, Kirchhoff M, Pierce L, Aunchman N, Trzeciak S, Roberts BW. Association between chest compression rates and clinical outcomes following in-hospital cardiac arrest at an academic tertiary hospital. Resuscitation. 2017;110:154-61.
19. Talikowska M, Tohira H, Inoue M, Bailey P, Brink D, Finn J. Lower chest compression fraction associated with ROSC in OHCA patients with longer downtimes. Resuscitation. 2017;116:60-5.