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Original Research Article

Utility of opening rhythms in predicting time to return of spontaneous circulation in cardiac arrest victims in a resource constrained setting: a single centre prospective observational study

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ABSTRACT

Background: Time to ROSC has been shown to be an important and independent predictor of mortality and adverse neurological outcome. In resource limited situations judicious deployment of resources is crucial. Prognostication of arrest victims may aid in better resource allocation. This study aimed to assess the time to Return of Spontaneous Circulation (ROSC) in cardiac arrest victims and its relationship with opening rhythms.
Methods: Consecutive victims of cardiopulmonary arrest who presented to a single center were included in this study if they met the inclusion and exclusion criteria. Time at which opening rhythm was analyzed and time at which ROSC was achieved was noted. This was done for all cases and mean time to ROSC was calculated for each opening rhythm. All those patients who achieved ROSC were followed up till hospital discharge or death. Primary outcome measured was achievement of ROSC and the secondary outcome was the survival to hospital discharge.
Results: A sample size of 100 was calculated to yield a significance criterion of 0.05 and a power of 0.80 based on prior studies. Out of 100 patients studied. 58% had shockable rhythms and 42% had non-shockable rhythms. Mean time to ROSC for shockable rhythm was 5.55±3.51 minutes, and for non-shockable rhythm is 17.29±4.18 minutes. There was a statistically significant difference between opening rhythms in terms of survival to hospital discharge (p=0.0329).
Conclusions: Cardiac arrests with shockable rhythms attained ROSC faster when compared to nonshockable rhythms. Shockable rhythms have a better survival to hospital discharge when compared to shockable rhythms. Opening rhythms may aid the clinician in better utility of resources in a resource constrained setting.

Keywords: Cardiac arrest, Cardiopulmonary resuscitation, Non-shockable rhythm, Returns of spontaneous circulation, Shockable rhythm

INTRODUCTION

Cardiac arrest is the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation.[1] Cardiac arrest is reversible if the victim is administered prompt and appropriate emergency care.[2] The main components of CPR are chest compressions, ventilation and defibrillation.[2] The purpose of CPR is to temporarily provide effective oxygenation of vital organs, especially the brain and heart, through artificial circulation of oxygenated blood until the restoration of normal cardiac and respiratory activity occurs.[2] Opening rhythm in cardiac arrest refers to the first monitored rhythm, which is analysed by the person interpreting it on

the monitor or defibrillator.[1] Cardiac arrest rhythms can be divided into shockable rhythms and nonshockable rhythms.[3] In general, shockable cardiac arrest rhythms are further divided into Ventricular Fibrillation (VF) and pulseless Ventricular Tachycardia (VT) and non-shockable cardiac arrest rhythms are divided in to asystole and Pulseless Electrical Activity (PEA).[1] Defibrillation is attempted in case of shockable rhythms.[4] Survival to hospital discharge is more common in case of shockable rhythms (VT/VF) than asystole or PEA as per previous studies.[5]

Signs of Return of Spontaneous Circulation (ROSC) include evidence of a palpable pulse or a measurable blood pressure.[1,6] Time to ROSC is defined as time from cardiac arrest to first recorded time point of sustained spontaneous circulation.[7]

Time to ROSC has been shown to be an important and independent predictor of mortality and adverse neurological outcome in several case series.[8] We undertook the present study to prospectively find the relationship between opening rhythms and time to ROSC.

METHODS

Study design and setting

The study was conducted in Calicut Government Medical College situated in, South India, after the approval from the Institutional Research Body and Institutional Ethics Committee of Government Medical College (GMC), Kozhikode (IEC ref no: GMC KKD/IEC/02/13).

Prospectively patients who presented with cardiopulmonary arrest were included in the study if they met the inclusion and exclusion criteria till a pre-defined sample size was met. Duration of the study was from April 2014 to August 2015. Resuscitation attempts in cardiac arrest patients who satisfied the inclusion and exclusion criteria were prospectively observed and data collected on a preset proforma. All resuscitation procedures were as per the Advance Cardiac Life Support (ACLS) by American Heart Association (AHA) ® 2010 guidelines which were the current guidelines during the study period.[4] All resuscitations were done by residents or consultants trained in ACLS.[4]

Opening rhythm was documented from the monitor and the time noted. Resuscitation was continued till the achievement of ROSC (i.e. till evidence of a palpable pulse). Time at which ROSC achieved was noted. The time interval between the two was taken as the Time to ROSC. This was done for all cases and mean time to ROSC was calculated for each opening rhythm.

Inclusion criteria

- Victims of Cardiac arrest in hospital or out of hospital, between 18 and 80 years of age were included if resuscitation was started within five minutes of unresponsiveness and ROSC was achieved (Figure 1).
- The next of kin were approached to procure consent. An immediate verbal consent and a delayed written informed consent was sought. Even if resuscitation happened as per protocol, the patient data was included only if the consent form was signed.

Exclusion criteria

- The patients who presented with signs of irreversible death: rigor mortis, decapitation, or dependent lividity were excluded.[9]
- Cases in which ROSC could not be achieved or if the ROSC was ill sustained were also excluded from the study.[1]
- Patients having a previous history of cardiac arrest and from whom the consent was not sought were also excluded from the study (Figure 1).

Follow up

All those patients who achieved ROSC were followed up till their Hospital discharge or Death and all the findings were documented as per proforma.

Outcomes measured

- Primary outcome: Achievement of ROSC.
- Secondary outcome: Survival to Hospital discharge.

Sample size calculation

Sample size was calculated using the formula N = 4 SD2 $(Z_{crit}+Z_{pwr})^2$ / D^2 which is used for comparative studies in which N is the total sample size(the sum of the sizes of both comparison groups), SD is the Standard Deviation of each group(assumed to be equal for both groups) D is the minimum expected difference between the two means. Z_{crit} is the Standard normal deviate corresponding to selected significance criteria. Z_{pwr} is the standard normal deviate corresponding to selected statistical powers. SD is taken as 18 and D as 10(30-20) as reported by the previous studies.[7,10,11] A significance criterion of 0.05 and a power of 0.80 are chosen.$(Z_{crit}+Z_{pwr})^2$ is calculated to be 7.8.Therefore sample size(N) = 4 * 18^2 * 7.8 / 10^2 which is calculated to be 98.7 which rounded to the nearest even number 100.

Statistical methods

All the data collected were added and entered in Microsoft Excel® sheet which was rechecked and analyzed using the statistical software namely the International Business Machines Statistical Package for the Social Sciences (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp).Quantitative variables were presented as mean/median and standard deviation. Qualitative

variables were presented as frequency (percentage). Quantitative variables are compared using independent t-test and analysis of variance (ANOVA) test. Qualitative variables were compared using Chi-square test. A p value of <0.05 is considered as statistically significant.

RESULTS

Total 100 victims of cardiac arrest were studied during the predefined study period after meeting inclusion and exclusion criteria (Figure 1) of which 80% were above 50 years of age. In this study, 64 were out of hospital cardiac arrests and 36 were in hospital cardiac arrests. The study population included predominantly males (79%).

There was no statistically significant difference between opening rhythms with relation to age (p=0.371) or gender (p =0.324) (Table 1).

Frequencies of opening rhythm

Statistically 58% had shockable rhythms and 42% had non-shockable rhythms. 30% of the subjects had VT and 28% had VF.

The frequencies of PEA and asystole were 23% and 19% respectively (Figure 2).

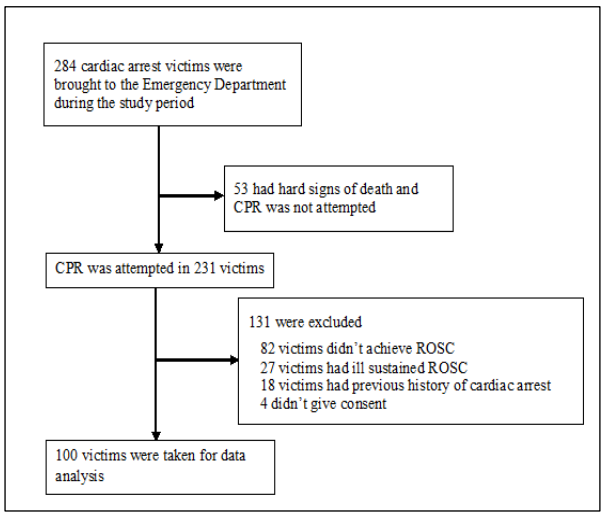

Figure 1: Depicting the selection of cardiac arrest victims for the study after meeting the inclusion and exclusion criteria.

Table 1: Age and gender vs opening rhythm.

Parameters	Frequency	%	VT	VF	PEA	Asystole	p value
Age (Yrs.)							
<50	20	20	6	8	2	4	0.371
≥50	80	80	24	20	20	16	
Sex							
Male	79	79	26	19	18	16	0.324
Female	21	21	4	9	5	3	

Table 2: Mean time to ROSC of opening rhythm in minutes.

Opening rhythm	Meantime of ROSC	Standard deviation	95% of CI	p value
VT	3.87	2.67	(2.87-4.87)	<0.001
VF	7.36	3.44	(6.02-8.69)	
PEA	14.7	3.55	(13.33-16.41)	
Asystole	20.21	2.80	(18.85-21.57)	

Table 3: Mean Time to ROSC of Shockable/Non-shockable Rhythms.

Opening Rhythm	Mean time to ROSC		Standard Deviation	95% CI
Shockable	5.55		3.51	(4.63-6.48)
Non-shockable	17.29		4.18	(15.98-18.59)
Comparing Mean Time to ROSC of Shockable/Non-shockable rhythms		t	df	p value
Time to ROSC	Equal variances assumed	-15.199	98	<0.001

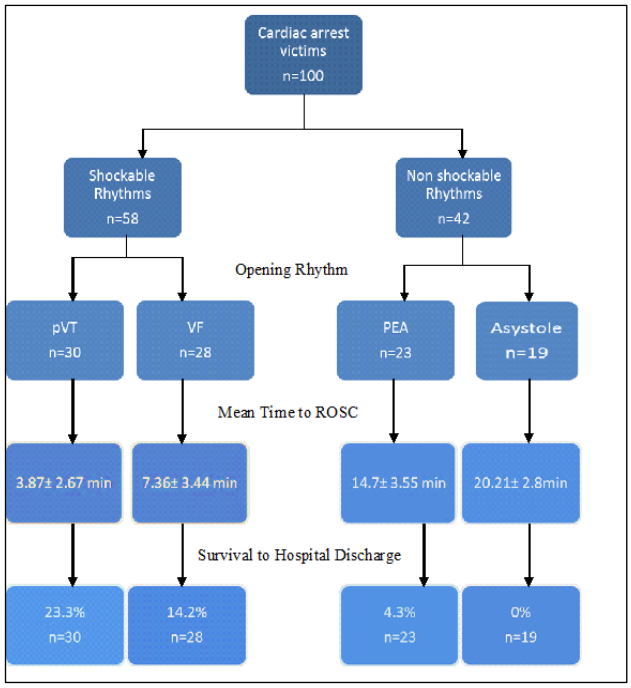

Figure 2: Depicting the distribution of opening rhythms and their mean time to ROSC and survival to hospital discharge. pVT- Pulseless ventricular tachycardia, VF-ventricular fibrillation, PEA-Pulseless Electrical Activity.

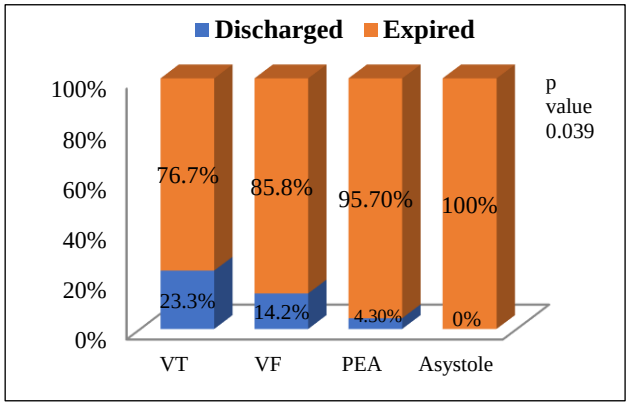

Figure 3: Comparing survival to hospital discharge and mortality of shockable and non-shockable rhythms.

Mean time to ROSC for opening rhythms (in minutes).

Mean time to ROSC for VT was 3.87±2.67 minutes (95% CI 2.87-4.87) and for VF is 7.36±3.44 minutes (95% CI 6.02-8.69). Mean time to ROSC for PEA was 14.7±3.55 minutes (95% CI 13.33-16.41) and for asystole 20.21±2.80 minutes (95% CI 18.85-21.57) (Table 2).

Mean time to ROSC for shockable and non-shockable rhythms

Mean time to ROSC of shockable rhythms was 5.55± 3.51minutes (95% CI 4.63-6.48) and of non-shockable rhythms 17.29±4.18 minutes (95% CI 15.98-18.59). Student t test results showed a significant difference between the mean time to ROSC of shockable and non-shockable rhythms (p<0.001) (Table 3).

Survival to hospital discharge.

Data wise 12% of the study participants (N=100) survived to hospital discharge, 23.3% (7/30) patients with VT, 14.2% (4/28) with VF and 4.3% (1/23) who had PEA as their opening rhythm survived to hospital discharge.

None of the nineteen with asystole as the opening rhythm survived to hospital discharge.

There was a statistically significant difference between opening rhythms in terms of survival to hospital discharge (p=0.039) (Figure 3).

DISCUSSION

The study intended to find the relation between time to ROSC and opening rhythms and to predict the survival based on that. A total number of 100 victims of cardiac arrests were studied during the study period (Figure 2). 80% of the study population belonged to the age group of 50 years and above and the study population was predominantly males, comprising of 79%.But there was no association between age or gender with the opening rhythm in attaining ROSC (Table 1).

Mean time to ROSC for shockable rhythms was 5.55±3.51 minutes and for non-shockable rhythms was 17.29±4.18 minutes and there was statistically significant difference between the two groups (p=0.0001). Shockable rhythms achieved ROSC faster in comparison to non-shockable rhythms (Table 3).

Nielsen N et al, reported that longer time to return of spontaneous circulation was a predictor of bad outcome.[12] Targeted temperature management-trial also substantiates the study by stating that time to ROSC remains a robust predictor of adverse outcome, possibly acting as marker of severity of brain injury.[13] No In this study, eleven out of the 58 shockable rhythms (19.96%), with mean time to ROSC 5.55±3.51 (95% CI 4.63-6.48), survived to hospital discharge and out of 42 non shockable patients with mean time to ROSC of 17.29±4.18 (95% CI 15.98-18.59), only 1(2.4%) survived to hospital discharge (p= 0.0001). This shows that opening rhythms with a shorter time to ROSC have a good outcome in terms of survival to hospital discharge (Figure 3).

The Emergency medicine department of Government Medical College, Kozhikode where this study was held is a high-volume center that caters to nearly 900 patients on average 24-hour period. There exists no formal prehospital notification system in the state. The emergency services though are provided free of cost to the insured and uninsured alike, the resources in terms of personnel, equipment are

severely limited with respect to the demand. Multiple individuals requiring resuscitation brought in simultaneously leads to acute scarcity in resources. In such resource limited situations where judicious deployment of resources is crucial, any tool to aid prognostication helps. Opening rhythms may therefore also aid in better utilization of the available resources. The results are comparable to the previous studies of Soga T, Nagao K, Sawano H et al, who also got longer mean time to ROSC for non-shockable rhythms (30 minutes) and shorter (22 minutes) for shockable rhythms with significant difference (p value=0.008).[11] Similar finding was also reported by Oddo et al, which reported a time-to-ROSC interval of 34.6±11.9 minutes (mean±SD) in non-shockable cases, and 23.1±9.0 minutes (mean±SD) in shockable cases with significant difference (Table 4).[14]

Table 4: Comparing with the previous studies.

Mean time to ROSC/time of ROSC (in minutes)	Oddo, 2006	Soga T, 2009	Present study, 2014 (time of ROSC)
Shockable rhythms	23.1±9.0	22 (95%CI 20-40)	5.55±3.51(95%CI 4.63-6.48)
Non-shockable rhythms	34.6±11.9	30 (95% CI 16-35)	17.29±4.18(95%CI 15.98-18.59)

The OHCA included were only the ones in which the unresponsiveness was recorded within 5 minutes of first medical contact in the Emergency Department at GMC, Calicut. Recall bias was unavoidable as we had to rely on the bystander's history with regards to OHCA. Most of the OHCA got excluded if the victim's bystanders claimed that the patient was unresponsive for more than 5 minutes.

The resuscitation attempts were as per 2010 ACLS guidelines of AHA which were the current guidelines followed at the time of the study. But AHA have come up with latest 2015 guidelines after the study period. So, there is a probability that the disparity in the guidelines might have affected the study.

CONCLUSION

Shockable rhythms attain ROSC faster when compared to non-shockable rhythms and has better survival to hospital discharge than non-shockable rhythms. Among shockable rhythms VT attains ROSC faster when compared to VF and among non-shockable rhythms PEA attains ROSC faster than Asystole.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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