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Comparison of Chest Compression to Ventilation Outcome Ratio during Basic Life Support and CPR in 2009

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Abstract: The aim of this study was to compare the effect of a 40:2, 15:2 versus 30:2 Compression: Ventilation (C: V) ratio on rate of Chest Compression (CC), rescuer fatigue and satisfaction. We measured the BP and pulse. Fifty three persons performed BLS and CPR using C: V of 15:2, 30:2 and 40:2 on an adult resuscitation lardal manikin for 2 min. Two researchers measured the above mentioned variables. Data were analyzed by ANOVA, student's t-test or Mann-Whitney U test between groups. The value of $p<0.05$ was considered as significant. The results revealed fatigue after 2 min and satisfaction from the performed technique in the groups differed ($p<0.05$). Number of breathing in two minutes was 8.8±4.7(1-24). Total cardiac massage in 2 min. in the study groups was 131.7±40.6 (20-265), of this number in130.6±40.5 was done correctly. The number of compression per 2 min increased with C: V ratio of 40:2 than to other C: V ratio. Most of participants (71.7%) prefer using 30:2 ratios to achieve the primary goal of Cardiopulmonary Resuscitation (CPR). The PR and systolic, diastolic BP of rescuers before and 2 min after resuscitation had insignificant difference ($p<0.001$) and SBP differed between groups ($p<0.04$). Although the rescuers prefer to perform the C: V ratio 30:2, but number of CC is less than standard recommended by AHA. Alternative C: V ratio of 40:2 methods, is equal to the AHA recommended 80 compressions/minute and also highest number of CC is done in 2 min, While, in the other methods is less than the recommended number.

Key words: Chest compression, rescuer fatigue, CPR, ventilation, BLS

INTRODUCTION

Approximately 1000,000 sudden cardiac deaths occur yearly in the United State of America (USA) and Europe. Despite a dramatic improvement in many aspects treatment strategies for emergency clinical situations, the survival from both out-of-hospital and in- hospital cardiac arrest remains poor (Yannopoulos and Aufderheide, 2007).

Outcome after Sudden Cardiac Arrest (SCA) dependents on critical interventions, particularly effective Chest Compression (CC), early defibrillation and advanced life support (Kelley *et al*., 2006). A recent studies from Japan and Singapore involving withnessed out-of-hospital cardiac arrests reports statically improved survival with bystander chest compression only Cardio Pulmonary Resuscitation (CPR) versus chest compression CPR with ventilation (Kelley *et al*., 2006; SOS-KANTO Study Group *et al*., 2007; Marcus Eng *et al*., 2008).

A simple change in the compression to ventilation ratio from 15; 2 to 15; 1 resulted in an increase in diastolic aortic pressure and cerebral perfusion pressure. This study recommend a reduced ventilation rate during Basic Life Support (BLS) to only 8-10 breaths/min that each breath should be delivered with a tidal volume of only 500 cc and over a period of only 1 sec (Kelley *et al*., 2006).

The new guidelines is to prevent excessive excessive ventilation rates, which have been shown to be life- threatening, if not deadly (Aufderheide *et al*., 2004). The previous study for CPR recommended compression: ventilation ratio of 30:2 for lay rescuers with emphasis on chest compression depth and minimal time without chest compressions. The change from a 15:2 ratio is partly due to findings that lay persons need approximately 15 between chest compression to deliver two breaths (Odegaard *et al*., 2006).

In 2005, the new guidelines by the American Heart Association (AHA) recommended to initiate two minutes

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of chest compression prior to the first defibrillation attempt in patients with delayed CPR (Haque *et al*., 2008).

The optimal compression-to-ventilation ratio remains unknown (Hostler *et al*., 2005).

Provision of effective chest compression and rescue ventilation are the most important interventions during CPR new guidelines for pediatric basic life support changed the compression to ventilation ratio (C: V) to 30:2 from 15:2 for a single rescuer across all age groups. The guidelines emphasized maintaining high quality chest compression including compression (CR), Compression Depth (CD), complete chest recoil and minimizing time without compressions (Haque *et al*., 2008; ARC, 2006).

The previous studies found that the rate and depth of compressions are inadequate and tat ventilation is unreliable. Excessive ventilation has been associated with increased intra thoracic pressure that can adversely affect hemodynamics during CPR. Likewise, interrupting chest compression is associated with less effective coronary perfusion pressure during CPR (Aufderheide *et al*., 2004; Haque *et al*., 2008; Kern *et al*., 2002; Hostler *et al*., 2007; Makinen *et al*., 2007).

According to international resuscitation guidelines published in 2000, every member of health care personnel should be able to perform BLS (Cummins and Hazinski, 2000). To date, no study has evaluated the effects of increased C: V ratio to 40:2 on chest compression and ventilation by single rescuer and rescuer Blood Pressure (BP), Pulse rate (PR) and Fatigue, Satisfaction during adult BLS.

We designed this study to compare the effect of a 40:2, 30:2 versus 15:2 C:V ratio on (A): rate of correct chest compression (rate, depth) and (B): rate of rescuer fatigue, satisfaction as judged by rescuer to VAS (0-100) and rescuer BP, PR measurement. We hypothesized than an increased C:V ratio will result increased chest compression to suggested rate of approximately 100b/min (ARC, 2006) and increased rescuer fatigue, BP and pulse rate.

MATERIALS AND METHODS

This prospective Quasi-experimental was approved by the Mazandaran University of Medical Sciences in 2009. Fifty-three anesthetic and emergency technicians participated in the standard basic life support program of American Heart Association (AHA) by adult lardal manikin. Data collection performed by two experience persons with corn meter during basic life support and CPR in 2 min period. One person evaluated Systolic and Diastolic blood pressure and pulse rate related to rescuer prior doing CPR, also asked about her/his fatigue. Another person helped them for evaluated and calculated rate of chest compression and mouth to mouth ventilation during 2 min CPR and how his/her doing was evaluated. We want to rescuer that performed basic life support for one victim that has coma condition.

The CPR training programme consisted of a BLS course according indexes of AHA. This is included theory on heart disease, sudden death, sudden cardiac and respiratory arrest and basic life support process. The skills taught included adult one-rescuer CPR and manage management of foreign-body airway obstruction and basic life support (A, B, C) with and without instruments three months following the CPR program. A knowledge test was conducted to assess technicians CPR knowledge. Included criteria are related to their that had above 75% of total score.

Each rescuer performed 2 min chest compression and ventilation with 15:2 and after 5 min rest, started CPR among 30:2 and after 5 min resting, 40:2 performed 2 min.

We evaluated pulse rate, systolic and diastolic blood pressure of the rescuer before CPR was done and rate, depth of chest compression and ventilation calculated by direct observation by two observers each chest rising was shown as a good ventilation. Early after CPR, BP and pulse rate of rescuer was measured by experienced person. We use a scoring system was developed for evaluating student, s CPR psychomotor skills drawing on an approach by Berden *et al.* and AHA guide line (Catherine, 2006; AHA, 2005).

A combination of the CPR skill components from the observation checklist (Table 1). Value labels were assigned to each skill component, identifying whether the skill was performed correctly, penalty points were given.

The validity and reliability of the scoring system technique, where expert consensus was invited from an answer to question of five members from the Babol and Mazandaran universities of Medical Sciences, Anesthesia Department. The CPR performance on the manikin and the researchers enabled calculation of chest compression rate, depth, chest rising and the duration of the chest compression/relaxation cycles to identify correct C:V for 2 min.

Data were analyzed using the statistical soft ware package, SPSS, version 15 for windows. Normally distributed data are presented as Mean±SD, otherwise

Table 1: Mean distribution of Hemodynamic variables and fatigue in the rescuer prior to and after 2 min CPR

Variables	Mean (before CPR)	Two min after CPR	p-value	t	Df
Fatigue rate (1-100)	9.6± 2	38.9±24.5	0.001	-7	52
Pulse rate/min	99±17	120.6±25.6	0.001	52	-8
SBP in rescuer	120±14.4	133.5±21.6	0.001	52	-4
DBP in rescuer	78.8±10.1	82.9±11.3	0.014	52	-2.5

median. ANOVA and unpaired student's t-test or Mann-Whitney U test were used to analysis differences between the groups. The value of $p<0.05$ was regarded as significant. Linear regression was used to evaluate changes in chest compression rate and BP, pulse rate rescuer after 2 min CPR.

RESULTS

The results of this study in three non-independent groups orderly were in group, 15:2 (53 persons), group 30:2 (53) and group 40:2 26.

Results shows that 26 persons in each group (49.1%) were of anesthesia personnel and 27 persons (50.9%) were of Emergency Medical Technicians. 32 participants in each group were men and 21 women. 46 (86.8%) participants before breathing operations did head tilt and chin lift correctly and the 13.2% of them did not do this movement correctly.

Stage of evaluation, 32 (60.4%) could breath twice in less time than 4 seconds correctly and 39.6% could perform same in the same time. The results showed that the evaluation process injured, 44 people (83%) carotid pulse just to touch and 17% succeeded in doing touch carotid pulse were not correctly.

Results of this research showed that 44 (83%) participants could sense carotid.

Pulse correctly and 17% could not sense carotid pulse correctly.

The 44 (83%) participants had appropriate position for chest compression with mouth to mouth breathing together and 30 (37.7%) of participants did not place in proper position of their hands on the chest of manikin.

The results shows that 48 (90.6%) participants could identify to exist of breathing by listening, touching or seeing of chest rising techniques during 5-10 sec.

The results shows that the knowledge training before and after the education has significant differences 8±2.6 versus 17.3±1.6 of total twenty scores of knowledge.

Rate of anxiety in the participants before resuscitation has been 17.4±3.2 of total hundred scores of anxiety. Fatigue variables, pulse rate, systolic and diastolic BP of them prior and 2 min after CPR are given in Table 1.

The results of this study shows average number of respiratory done in two minutes in the total group are 11.8±3.9 with the range of 1-24, of this number, respiration with correct of chest rising was 8.8±4.7 (1-24). Total cardiac massage was done in two minutes in the study groups was 131.7±40.6 with the range of 20-265 of this number between 130.6±40.5 was done correctly.

Results show that pulse rate and Systolic, diastolic blood pressure of rescuers in 2 min after resuscitation had in significant difference, the results are shown in Table 2.

Table 2: Distribution of mean number of Pulse, Systolic, Diastolic blood pressure in the groups under study two min after CPR

Groups/variables	15:2 (n = 53)	30:2 (n = 53)	40:2 (n = 26)	p-value
PR	119.8±24.0	123.9±27.0	115.5±26.0	0.39
SBP	130.0±12.3	135.3±18.6	141.0±28.5	0.04
DBP	83.6±7.8	84.6±10.3	81.0±11.6	0.29

Table 3: No. of correct breathing mean distribution and external cardiac massage by the rescuer in two minutes are given

Groups	15:02 (n = 53)	30:02:00 (n = 53)	40:02:00 (n = 26)	p-value
No. of total breathing	14.5±3.7	10.2±3.2	9.7.0±2.1	0.005
No. of total massage	102.2±30.3	144.3±32.3	166.1±33.9	0.001
No. of correct breathing	10.7±5.6	7.4±4	7.8±2.9	0.002
No. of correct massage	100.6±32.6	141/.9±30	165.3±28.3	0.001

Table 4: The degree of tiredness and comfort of rescuers two minutes giving after CPR based on the study groups

Groups	15:02 (n = 53)	30:02:00 (n = 53)	40:02:00 (n = 26)	p-value
Fatigue (1-100)	30.4±20.2	36±20.9	60.7±25.2	
Satisfaction rate (1-100)	72.8±21.1	60.2±30.8	29.2±17.4	

Total and correct cardiac massage and breathing in two minutes are shown in Table 3.

Number of external correct and wrong external cardiac massage done after 2 min are not had in significant difference ($p<0.431$).

Total number of respiration performed and the number of correct breathing after 2 min had significant difference ($p<0.002$).

The results showed the amount of fatigue after 2 min and satisfaction from the carried out technique in the groups had differed, the results are given in Table 4.

The results showed that most of study subjects prefer to use 30:2 ratio to achieve the primary goal of Cardiopulmonary Resuscitation, 38 participants (71.7%) and 11 participants (20.8%) would like to use 15:2 ratio and 4 participants 40:2 ratio to prefer.

DISCUSSION

The main results of the study showed that the mean number of external cardiac massage of that time to the number of respiration in group 40:2 was more than 30:2, 15:2 and two min was equal to 166±34, 144±32 and 102±30, respectively ($p<0.001$).

The number of correct respiration in the group 15:2 was more than the groups of 40:2 and 30:2, which, respectively were equal to 11±6, 8±3 and 7.5±4 ($p<0.002$).

Kern *et al.* (2002), in a similar study, suggested very important number of cardiac massage at the time of giving CPR and recommended the number of cardiac massage to 100 beat/min.

That finding was approximately similar to our results and the number of massage in group 30:2 was 72 and in group 15:2 was 31 compression/min. In both studies, the

number of external cardiac massage basic life support and CPR was lower than the standard which is 80-100 compression/min. In this study in the ratio of 40:2, this number was obtained 83 compression/min which is close to the standard level.

In present study, the mean number of performed respirations in different group had significant difference. But no difference was observed, between groups 30:2 and 40:2 ratio. In anyway, in the three groups the number of respiration was not enough. The criteria of the correct respiration were chest rise. American Heart Association in 2005 recommended that, the non professional individuals at the time of giving base CPR, regardless of respiration, start giving external cardiac massage, because, first the time in basic life support and CPR is very important and mouth to mouth breathing is difficult and may not be successful. And the main heart out put factor depended to the number of external cardiac massage (ARC, 2006; Cummins and Hazinski, 2000). Current American heart association guidelines recommend time of ventilation not exceeding 4 sec (2 sec per ventilation 0 to achieve 80 compressions/min) (Hostler *et al*., 2005).

In this study we found that skillful personals who have good knowledge on BLS and CPR, could not give 8-10 respiration per minute that recommended (Odegaardab *et al*., 2006).

In fact for the trained staff this performance is difficult and wastes the time. In this study 90% of the trained personnel's could not given 2 respiration in 2 sec recommended by the AHA. Also these were significant difference between the total number of the given breathing in 2 min and number of the correct breathing.

Silse O *et al*. in their study concluded than giving two respirations during resuscitation may take 15 sec (Odegaard *et al*., 2006). Therefore, 2 sec for one or two breathing seems difficult.

Based on the American Heart Association, 2005, the number of external cardiac massage to breathing that is 15:2 modified to 30:2 and recommended to all of the results (Haque *et al*., 2008).

We found that number of correct performed external cardiac massage in the ratio of 15:2, is much less than 30:2, also considering the lack of difference in number of correct mouth to mouth breathing in the study groups to the ratio of 30:2 and 40:2 it seems that in the professional personnel to obtain the proper number of external cardiac massage considering the significant of external cardiac massage and heart out put during CPR, ratio of 40:2 is more suitable than the other groups under study. It was noticed that giving two months regular CPR training leads to improves in over 90% of the participants to a satisfactory level.

In the present study, pulse rate and systolic and diastolic blood pressure of the rescuers had significant change compared to the prior CPR. The systolic blood pressure of the rescuers among the groups had significant difference in comparison.

Higher change and pressure rise was seen in the 40:2 group, (141.2±28.5). But diastolic blood pressure and pulse rate had no significant change among the groups.
Feeling of fatigue in the rescuers 2 min after giving external cardiac cardiac massage and breathing in the ratio of 40:2 was more than 30:2 and 15:2. The degree of fatigue among the groups after giving CPR was significant.

The final conclusion is that, though the rescuers prefer the ratio of 30:2 but the number of cardiac massage in 2 min is 142 times and though in 40:2 method, maximally 7.5% is preferred and adopt this method routinely but is followed by much tiredness and also highest number of cardiac massage is done in 2 min which is more close to the standard number. Therefore, alternative C:V ratio of 40:2 equaled the AHA recommended 80 compressions/min.

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