ORIGINAL ARTICLE

# A comparison between over-the-head and lateral cardiopulmonary resuscitation with a single rescuer by bag-valve mask

*Ebrahim Nasiri, Reza Nasiri*[1]

*Department Anesthesiology and Emergency Medicine, Faculty Member, Traditional and Complementary Medicine Research Center, Mazandaran University of Medical Sciences, Sari, [1]Medical Student, Medical Student Research Committee, Ramsar, Mazandaran University of Medical Sciences, Iran*

**Address for correspondence:**
Mr. Ebrahim Nasiri,
Department Anesthesiology and Emergency Medicine, Faculty Member, Traditional and Complementary Medicine Research Center, Mazandaran University of Medical Sciences, Sari, Iran.
Email: enasiri@mazums.ac.ir

## ABSTRACT

**Context:** mask fixation in the lateral position is difficult during CPR. **Aim:** the aim of this study is to compare the lateral CPR for the use of bag-valve mask by single paramedic rescuer as well as over-the-head CPR on the chest compression and ventilation on the manikin. **Settings and Design:** Mazandaran University of Medical Sciences. The design of this study was a randomized cross-over trial. **Methods:** participants learned a standardized theoretical introduction CPR according to the 2010 guidelines. The total number of chest compressions per two minutes was measured. Total number of correct and wrong ventilation per two minutes was evaluated. **Statistical Analysis:** we used Wilcoxon signed-rank test to analyze the non-normally distributed data in dependence groups A. *P*-value of more than 0.05 was considered to show statistical significance. **Results:** there were 100 participants (45 women and 55 men) who participated in the study from September to March, 2011. The compression and ventilation rate in lateral CPR was lower than OTH CPR. Around 51% of participants had correct chest compression rate more than 90 beats per minute in lateral CPR and 65% of them had equal or more than ten correct ventilations per minute. **Conclusions:** in conclusion, this study confirmed that in a simulated CPR model over-the-head position CPR led to a better BLS than the lateral position CPR by a single paramedic student with a BVM device. We also concluded that by this new BVM fixation method on the face of the patients in the lateral position CPR can be a good alternative over-the-head mask fixation by a single trained rescuer.

**Key words:** *Bag-valve mask ventilation, lateral CPR, over-the-head CPR, standard CPR, single rescuer*

## INTRODUCTION

Basic life support (BLS) and early cardiopulmonary resuscitation (CPR) are important achievements in the chain of survival for patients suffering from cardiac arrest.[1-3]

The guidelines by European Resuscitation Council for CPR suggested the usage of equipments such as the bag-valve mask (BVM) by two health care professionals during CPR.[4,5] Also, all rescuers should offer external cardiac massage to victims of cardiac arrest. These guidelines recommend pushing to the rate of at least 100 chest compressions per minute. Chest compression along with breathing support is a better choice. Therefore, this method for training lay rescuers and professionals is a choice for delivering CPR.[6]

| Access this article online | |
|---|---|
| Quick Response Code: | Website: www.saudija.org |
| | DOI: 10.4103/1658-354X.125923 |

Although two-rescuer CPR is considered the best method for training BLS personnel, in many cardiac arrest situations such as during prehospital care, or inside the ambulance or train, one rescuer has to start CPR alone.[7] In this condition, while using a BVM for breathing support as a replacement for giving mouth-to-mouth ventilation, it is recommended that the rescuer position himself/herself at the head of the patient (i.e., over the head).[6,8,9]

The use of self-inflating bag or BVM versus mouth to mouth breathing has many benefits including

administering oxygen, preventing bacterial infections transmission, and lower fatigue.[8,10,11]

Personnel and place limitation can affect the rescuer position. Over-the-head CPR enables the rescuer to convey chest compression and breathing support without altering location.[12] It is believed that the chest compression beside the patience is easier to be done than over-the-head CPR.

Hendley *et al.* reported that one person over-the-head CPR was the same as the time when the two-person standard CPR was done, but fewer chest compressions were delivered each minute in the former case.[9] Therefore, the position of the rescuer may affect the physical work and performance of the CPR outcome.[13] The use of BVM enables the rescuer to administer a larger inspiratory oxygen concentration better than mouth-to-mouth breathing.[7] Rescuers mostly fear that the fixation of the mask on the side position for single rescuer is impossible. But the recommended technique in this study is to help removing the doubt for using BVM in mask fixation and chest compression techniques.

The purpose of this study was to compare, on a manikin, the effect of lateral (standard) position CPR performed over-the-head CPR with the bag-valve mask by single paramedic rescuer.

## METHODS

### Participants and setting

The study was performed at the department of anesthesia and emergency medicine of Mazandaran University of Medical Sciences, Iran. This study was conducted after informed consent and obtaining required permission from the ethics committee of the Mazandaran University. Participants were paramedical students (anesthesiology and emergency medicine students).

Inclusion criteria were male or female students, who are 35 or younger, with previous CPR training and passed CPR exam.

Exclusion criteria were: (1) musculoskeletal disease and (2) systemic disease or cardiovascular condition precluding the ability to perform a chest compressions and ventilation or moderate effort.

### Study design

The design of this study was a randomized cross-over trial. Randomization was done using the table of statistic randomization and number of participants. Random numbers were allocated to two positions: over-the-head or lateral CPR.

The participants learned a standardized theoretical introduction to CPR according to the 2010 guidelines as well as 1-hour single rescuer over-the-head (OTH) and standard (lateral) CPR by BVM at least 4 month earlier.[14] All of them performed and reviewed methods for 30 min.

Hundred participants learned and the passed exam. They got above 75% of the total score. Participants did not have clinical experience of BLS and CPR.

Participants were informed about the general aim of the study but were blinded to the specific outcome assessments. They were acted to administer CPR with the best possible presentation.

Each participant performed both CPR techniques. All participants were asked to perform for 2 min of CPR on a manikin with the 30:2 compressions to the ventilation ratio in each position.[6] There was a 5-min resting period between the apply trial and the start of the study. The manikin was placed on the floor.

Demographic data contain age, weight, arm length, height, and sex of participants that were evaluated. The satisfaction and fatigues of each participant were evaluated by the visual analog scale (VAS), (0-100) that they were asked to fill that questionnaire after each procedure and preferred single rescuer chest compression and ventilation with BVM in two positions.

The participant's attitude for satisfaction and fatigues on a Visual Analogue Scale (VAS) was obtained strongly agree versus strongly disagree. We want to indicate opinion by marketing a vertical mark on the line your agreement or disagreement. Participant's problem or his/her fatigue report on liner VAS after each position CPR (strongly disagree score = 0, strongly agree = 100). This position of CPR was comfortable and satisfaction opinion between the strongly disagree score = 0 and strongly agree score = 100).

The quality of CPR, hand position, and mask fixation for chest rising during CPR directly evaluated by experienced anesthetist and marked his opinion on a VAS. The rate of correct chest compression and ventilation was observed by two anesthesiologists at the end of each stage and recorded on a data collection form. Agreement between observers was done to evaluate chest compression and breathing support condition in two positions CPR using the Kappa statistic. Reliability after pilot study on 12 cases was above 80%. After the performance of each technique by participants, they were asked subsequent questions: How do you think about quality of the CPR technique and how her/his hand position is for chest compression? The hand position was recorded as correct if force is performed in the center of the lower part of the sternum in the same way as in the standard technique.[15,16]

The correct mask fixation evaluated by chest rising during each ventilation by BVM in OTH and lateral position method and OTH, CPR was prepared while kneeling, and the head of the manikin was between the rescuer's knees or thighs [Figure 1].[7,15] The technique of lateral CPR by BVM by single rescuer was prepared that fingers thump located and attached the beneath of the mandible and the index finger placed on the base of mask. Consequently, the thumb placed on the lower part of the mask. While, middle and two other fingers of the hand placed on top of the mask. Whilst, in the OTH procedure, the fingers were opposite to the aforementioned method, because, the thumb is placed on the higher part of the mask [Figure 1].

Data were recorded during a 2-min period of CPR with 30:2 chest compressions to the ventilation rate in each group by two experienced anesthesiologists' observers. They were demonstrated separately by chronometer that attended and allowed continuous recording of the following data (Chest compression and ventilation parameters data).

1. The total number of chest compressions per 2 min (according to the 2010 guidelines for CPR),[17]
2. The correct number of chest compressions per 2 min, time of each cycle compression (when they had consensus to rate of correct). Incorrect chest compression could be due to one or more errors such as wrong hand position and deep chest compression and do not equal deep chest compression and complete release of pressure after each compression.[4]
3. Hand positioning on the chest, correct (4-5 score) or incorrect (0-3 score) (mean score VAS (0-5) between two observer records) (care the heal of the rescuer hand positioning during CPR, equal 2 score and pressure on the lower half part of sternum, equal 3 score),[9,16]
4. The total number of ventilation per 2 min, correct (with chest rising) and wrong ventilation (with no chest rising), and time of each ventilation cycle (when they had consensus to rate of correctness).
5. The mask position on the face (mean score VAS (0-5) between two observer were recorded) (position of mask on face = 1 score, position of fingers on mask = 2 score, pressure on mask and head tilt chin lift during ventilation = 2 score), correlation between two observers with this test was 86% with Pearson's correlation coefficient.

The score of hand place and mask position divided to: correct score = 5 and 4 acceptable and score = 4 and 3 or less was incorrect. These variables were evaluated during primary and secondary stage of the cross-over study. Practical experience satisfaction and exhaustion of the participants evaluated after each part in the study. Ventilation was administered with a bag-valve mask device (Laerdal Silicone Resuscitator with an Adult mask size 4, Laerdal Medical AS, Norway).

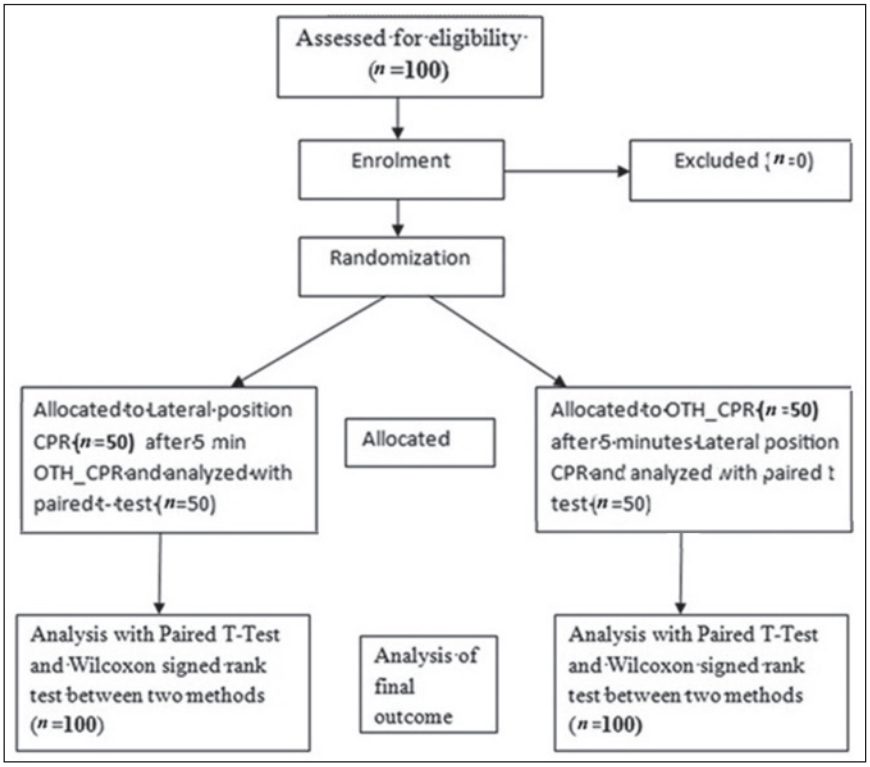


**Figure 1:** Randomization of participants and analysis condition

**Figure 2:** Lateral and over the head technique for chest compression and bag valve mask ventilation by single rescuer

### Statistical analysis

We used the previous study and calculated that we would need 99 participants to demonstrate a 5% difference in the chest compression rate between groups at the significance level of 0.05 with 80% power.[3,7] According to Hupfl *et al.*, it was determined that 99 participants were needed to have an 80% power of detecting as significant (at the two-sided 5% level) 5% difference between groups.[7]

Data were entered into Microsoft Excel 2007 and all data were analyzed using SPSS 15.0. Normally distributed continuous variables such as total number or mean rate of chest compression and ventilation rate were analyzed by the paired *t*-test between dependence of groups and t test used to analyze the independence groups. Nominal variables were analyzed with either the Chi-squared test between independence groups. We used Wilcoxon signed-rank test to analyze non-normally distributed data in dependence groups. We used descriptive statistics to report subjective measures of rescuer fatigue. Compared these changes between groups using a paired t-test with 95% confidence intervals. The means and standard deviation of the demographic and outcome variables were obtained and presented. A *P*-value of <0.05 was considered to show statistical significance.

## RESULTS

There were 100 participants (45 women and 55 men) who participated in the study from September to March 2011. There was no exclusion of participants from enrollment or analysis [Figure 2].

**Table 1: Comparison demographic variables between two groups after randomization**

| | Lateral CPR (mean ± sd) n=50 | Over-the-head CPR (mean ± sd) n=50 | *P*-value |
|---|---|---|---|
| Age (year) | 23.9±3.5 | 23.2±3.4 | 0.528 |
| Weight (kg) | 68.9±11.9 | 69.1±14.2 | 0.964 |
| Height (cm) | 172.2±8.5 | 172.3±10.8 | 0.959 |
| Length of arm (cm) | 58.5±4 | 58.6±5.9 | 0.984 |
| Time of firs cycle 30 chest compression (s) | 17.1±4.5 | 16 ±3.3 | 0.176 |
| Time of first cycle 2 breathing (s) | 6.4±2.6 | 6.2±2.7 | 0.822 |
| Score of carotid pulse checking (0-5) | 4.6±0.6 | 4.8±0.4 | 0.178 |

The demographics of the participants were as follows. The mean age was 24 ± 3.7 years (range: 19-39 years), the average of height was 172 ± 10 cm (range: 158-198 cm), the average length of arm was 59 ± 6 cm (range: 50-75 cm) and the average weight was 69 ± 13 kg (range: 44-118 kg). Sixty-four participants were anesthesia students and 36 participants were emergency medicine students. All of them had studied third of four terms during the second year. No participant had extensive prior clinical experience in CPR. There was no difference in characteristics between the two methods of CPR after randomization [Table 1].

The average correct chest compression and ventilation rate during 2 min CPR is shown in Table 2. The average chest compression and ventilation rate in lateral CPR was lower than OTH CPR. Around 51% of participants have correct chest compression rate upper than 90 beats per minute

**Table 2: Comparison of chest compression (CC) and ventilation rate (VR) during 2-min in two position CPR by single rescuer with BVM**

| Group | Mean | SD | Median | *df* | Interquaretile range | 95% CI | *P*-value |
|---|---|---|---|---|---|---|---|
| Lateral _CC | 168.9 | 22 | 180 | 99 | 26.8 | (165-173) | 0.001 |
| OTH _CC | 176.9 | 19.7 | 180 | 99 | 21.5 | (173-181) | |
| Lateral _VR | 10.2 | 2 | 10 | 99 | 3 | (9.8-10.6) | 0.005 |
| OTH_VR | 10.9 | 2.3 | 12 | 99 | 2.8 | (10.4-11.3) | |

**Table 3: Comparison of mean chest compression rate between sexes in each position CPR**

| | Male (no = 55) | Female (no = 45) | *P* value |
|---|---|---|---|
| Lateral position – CPR | 175.3±17.6 | 161.3±24.5 | 0.001 |
| OTH CPR | 181.8±16 | 171±22.2 | 0.005 |

in lateral CPR and 65% of them have upper ten correct ventilations per minute. This study result shows 39% of participants have upper correct chest compression and 75% of them have more than ten ventilations per minute in the OTH CPR position.

There were significant differences between female and male chest compression rate per 2 min CPR in the each position [Table 3]. There is no significant ventilation rate between them. (Lateral position, male: VR = 10.7 ± 1.8 and female, VR = 9.5 ± 2.1, $P = 0.162$ and OTH CPR, male: VR = 11.2 ± 2.3 and female: VR = 10.4 ± 2.2, $P = 0.676$).

The participant preferred the CPR position for a single rescuer doing chest compression and ventilation with BVM was 31% for the lateral position, 28% for OTH position and 41% had no different position for CPR.

The rate of incorrect chest compression and ventilation rate in the OTH-CPR was more than lateral CPR position. Twenty three percent of the participants have one to four error in chest compression in the lateral CPR position a contrast 37% of them had one to eight error in the OTH CPR. The percentage of the ventilation error was more than chest compression error in two positions CPR [Table 4].

The lateral and over-the-head position ventilation with bag-valve mask and fixation of the mask are shown in Figure 2.

The result shows that there were low linear association between the weight of the participants and compression rate for lateral position CPR ($r = 0.262$, $P = 0.008$) and over-the-head CPR ($r = 0.264$, $P = 0.008$). There were slightly more associations between the arm length and chest compression rate for lateral position CPR ($r = 0.316$, $P = 0.001$) and over-the-head CPR ($r = 0.189$, $P = 0.06$).

These results show some associations between the height of the participants and compression rate for the lateral position CPR ($r = 0.340$, $P = 0.001$) and for over-the-head CPR ($r = 0.24$, $P = 0.016$).

These results show significant associations between weight, arm length, and height of the participant with ventilation rate. Almost, all of the participants' demographics show significant associations with the rate of ventilation [Figure 3].

## DISCUSSION

The main result of this study is that the chest compression and ventilation rate in the over-the-head position CPR is significantly more than the lateral position CPR by one rescuer alone with the bag-valve mask. The average rate of correct chest compression was around 88 per minute in OTH CPR and 84 per minute for lateral CPR. Over-the-head cardiopulmonary resuscitation is a technique of chest compression, which is possibly easier to perform than standard CPR in a confined space.[13] Although all these techniques have a slower optimum recommended rate (at least 100 per minute), this is suggested in existing guiding principle.[6,10,18,19] We observe the ventilation cycle time, especially first cycle (more than 6s delay) in two techniques was associated with fall of the total time for CPR. This time is longer than optimum recommended time.[6,20-22] This study found that the mean of chest compression in two positions for each cycle was below the recommended time (lower 23s).[3] Although this condition can save time for CPR, but may be caused by incorrect chest compression.

Concerning the quality of chest compressions (hand poisoning and pressure) and ventilations in the over-the-head position CPR resulted in more incorrect chest compression and ventilation with lateral position CPR. The quality of ventilation and mask fixation did not differ between the two methods of CPR.

We found that the incorrect rate and error of the hand position or pressure on the chest compressions by participants were higher in number in the OTH CPR position in comparison to the lateral position. Lateral position CPR error was 23% and ventilation error was

**Table 4: Error of chest compression rate (CC-R) and ventilation rate (V-R) in two positions CPR/2min**

| | CC-R (%) | | | | V-R (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | 1-2 | 3-4 | 5< | | 1-2 | 3-4 | 5< | |
| Lateral_CPR | 23(23%) | 0 | 0 | 23% | 32(32%) | 5(5%) | 0 | 37% |
| OTH_CPR | 17(17%) | 7(7%) | 2(2%) | 26% | 24(24%) | 11(11%) | 6(6%) | 41% |

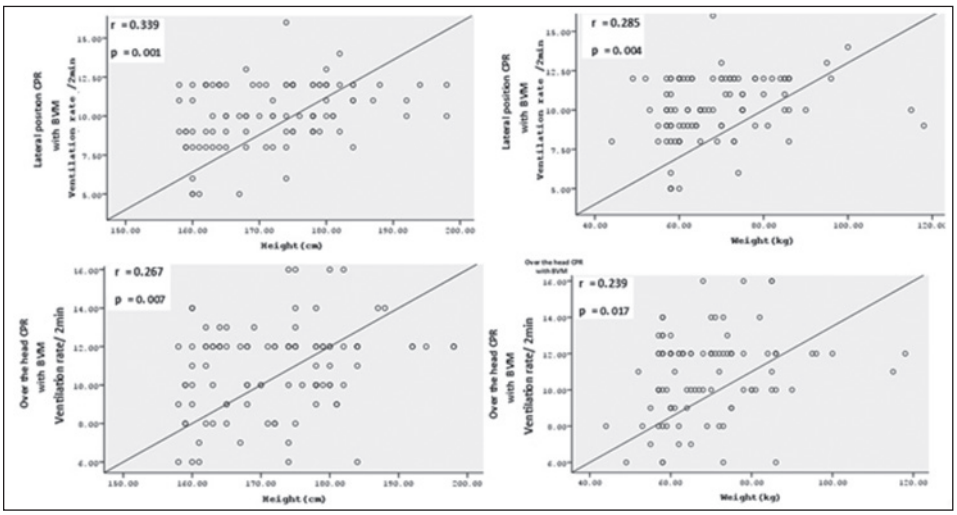


**Figure 3:** Linear association between height and weight of participants with the ventilation rate

37% in comparison to over-the-head CPR 26% and 41% was ventilation error during 2 min CPR in each techniques. The previous studies investigated the difference between OTH CPR and standard CPR.[3,7,23]

Gavin *et al.* in their study that compared OTH CPR and standard CPR found that incorrect chest compression was greater in the STD CPR group but they concluded that this was related to a higher number of low-positioned compressions in this group. On the contrary this study found different results because the OTH CPR have more incorrect chest compression and ventilation rate. This may be due to the different structures of two studies that present studies included only BLS, and we founded that the number of delivered correct chest compressions and ventilation rate was significantly higher in the OTH CPR.[3]

Anthony *et al.* in their study found that the error rate of hand positioning in the OTH CPR was more than standard CPR; they concluded that the incorrect hand placements for this technique were low and common.[16] It is potentially severe error in view of the risk of internal organ damage if pressure is performed to the epigastrium.[9] This result is the same as that of what this study discovered.

Handley *et al.* in their study in which two CPR techniques were performed by 20 health care students found the frequency of wrong hand position in the over-the-head CPR more than standard CPR position (30.4% vs. 7.7%). These results were lower than that found in this study in lateral position CPR. It may be related to the kind of devices for ventilation and difference of compression – ventilation ratio between two studies. This study uses BVM for ventilation in lateral CPR but their study performed mouth to mask ventilation via the pocket mask.[9] They did not show the same result as compared to this study.

Perkins *et al.* in their study compared over-the-head CPR without previous experience and standard CPR in a group of BLS instructors. Ventilation was done by the pocket mask.[3,24] Their study found no differences in quality of chest compression and ventilation between two techniques; however, they were recorded that hand positioning during chest compressions was better in the over-the-head group. In contrast to the present results, the percentage of incorrect chest compression and ventilation in the lateral position CPR were better (incorrect chest compressions 23% vs. 37% and incorrect ventilation by participants 26% vs. 41% in the over-the-head position CPR). While the correct chest compression and optimal ventilation rates were better in the over-the-head CPR versus lateral CPR.

Bolling *et al.* in their study that compared over-the-head CPR with lateral CPR by paramedic students and found that there were no differences between chest compression and ventilation groups in both experienced in standard CPR delivered chest compressions and ventilations while the other rescuer performed additional tasks.[12,24] They do

not show the same result.[8] The foundlings of this study showed the difference in chest compression and ventilation variables between two positions CPR.

All the studies cited earlier were performed using compression ventilation ratio 15:2 according to the 2000 guidelines.[24] Therefore, the results might differ if studies were performed using 2005 or 2010 guidelines with emphasis on compression and ventilation ratio 30:2 and importance of chest compression.

The funding of this study shows that the chest compression rate by male is more than that of female but regarding ventilation rate there is no difference between two genders. The reasons for such differences can be the difference of height, weight, length of arm, hands-off time, and physical power between genders in this study.

### Limitations

This study has some limitations such as other resuscitation simulator studies.[4,24] Number of limitations in this study has to be taken into account when present results are extended to a clinical situation. The study was performed on a resuscitation manikin, which did not provide any difference in patient's size, chest wall compliance, or simplicity of achieving a mask face seal. Second, this study was impossible to blind participants to which technique they were doing. Third, we do not evaluated depth of chest compression. Fourth, the manikin was positioned on the floor and we compared two techniques during 2 min of CPR. This condition may be different with prehospital setting. This time may be short to evaluate the rescuer fatigue or their satisfaction because real CPR has stress and perhaps it is longer than this time. This time is short for additional tasks such as attaching the ECG monitor and IV access.

## CONCLUSION

In conclusion, we confirmed in a simulated CPR model that over-the-head position CPR led to a better BLS than lateral position CPR by a single paramedic student with a BVM device. We also concluded that by new BVM fixation method on the face of the patients in lateral position CPR can be a good alternative over-the-head mask fixation by a single trained rescuer.

## ACKNOWLEDGMENTS

The authors wish to thank the paramedical students for participating in this study.

We thanks dr. H. Akbari, S. Padashi, Dr. F. Bezorghi, faculty members of department of anesthesiology and emergency medicine of paramedical college of Mazandaran University of Medical Sciences for their valuable help during study and Dr mohammadpour for his statistical help. This study was supported by a chancellor of research of Mazandaran University of Medical Sciences. The author wish to thank him for his support and his kind English editing the find version of this manuscript.

## REFERENCES

1. Chi CH, Tsou JY, Su FC. Comparison of chest compression kinematics associated with over-the-head and standard cardiopulmonary resuscitation. Am J Emerg Med 2009;27:1112-6.
2. Perkins GD, Stephenson BT, Smith CM, Gao F. A comparison between over-the-head and standard cardiopulmonary resuscitation. Resuscitation 2004;61:155-61.
3. (this refrence is used by us. If that is to be removed, I don,t know, any good you know.) Maisch S, Issleib M, Kuhls B, Mueller J, Horlacher T, Goetz AE, *et al*. A Comparison between Over-The-Head and standard cardiopulmonary resuscitation performed by two rescuers: A simulation study. J Emerg Med 2010;39:369-76.
4. Hazinski MF, Nadkarni VM, Hickey RW, O'Connor R, Becker LB, Zaritsky A. Major Changes in the 2005 AHA Guidelines for CPR and ECC. Circulation 2005;112(24 suppl):IV-206-11.
5. Nolan JP, Soar J, Zideman DA, Biarent D, Bossaert LL, Deakin C, *et al*. European Resuscitation Council guidelines for resuscitation 2010 section 1. Executive summary. Resuscitation 2010;81:1219-76.
6. Hüpfl M, Duma A, Uray T, Maier C, Fiegl N, Bogner N, *et al*. Over-the-head cardiopulmonary resuscitation improves efficacy in basic life support performed by professional medical personnel with a single rescuer: A simulation study. Anesth Analg 2005;101:200-5.
7. Nagele P, Hüpfl M. Over-the-Head CPR. Anesth Analg 2006; 103:498-9.
8. Handley AJ, Handley JA. Performing chest compressions in a confined space. Resuscitation 2004;61:55-61.
9. Ong EH. Improving the quality of CPR in the community. Singapore Med J 2011;52:586-91.
10. Nasiri E, Vahedi M, Jafari H, Nasiri R. Comparison of chest compression to ventilation outcome ratio during basic life support and CPR in 2009. Pak J Biol Sci 2010;13:1006-10.
11. Bollig G, Steen PA, Wik L. Standard versus over-the-head cardiopulmonary resuscitation during simulated advanced life support. Prehosp Emerg Care 2007;11:443-7.
12. Chi CH, Tsou JY, Su FC. Comparison of chest compression kinematics associated with over-the-head and standard cardiopulmonary resuscitation. Am J Emerg Med 2009;27:1112-6.
13. Koster RW, Baubin MA, Bossaert LL, Caballero A, Cassan P, Castrén M, *et al*. European Resuscitation Council Guidelines for Resuscitation 2010 Section 2. Adult basic life support and use of automated external defibrillators. Resuscitation 2010;81:1277-92.
14. Maisch S, Issleib M, Kuhls B, Mueller J, Horlacher T, Goetz AE, *et al*. A Comparison between over-the-head and standard cardiopulmonary resuscitation performed by two rescuers: A simulation study. J Emerg Med 2010;39:369-76.
15. Handley AJ. Teaching hand placement for chest compression--a simpler technique. Resuscitation 2002;53:29-36.
16. Koster RW, Baubin MA, Bossaert LL, Caballero A, Cassan P, Castrén M, *et al*. European Resuscitation Council Guidelines for Resuscitation 2010 Section 2. Adult basic life support and use of automated external defibrillators. Resuscitation 2010;81:1277-92.

17. Falcão LF, Ferez D, do Amaral JL. Update on cardiopulmonary resuscitation guidelines of interest to anesthesiologists. Rev Bras Anesthesiol 2011;61:624-40, 341-50.
18. Bjørshol CA, Søreide E, Torsteinbø TH, Lexow K, Nilsen OB, Sunde K. Quality of chest compressions during 10 and # xa0; min of single-rescuer basic life support with different compression: Ventilation ratios in a manikin model. Resuscitation 2008;77: 95-100.
19. Deakin CD, Nolan JP, Soar J, Sunde K, Koster RW, Smith GB, *et al*. European Resuscitation Council guidelines for resuscitation 2010 section 4. Adult advanced life support. Resuscitation 2010;81:1305-52.
20. Berg MD, Schexnayder SM, Chameides L, Terry M, Donoghue A, Hickey RW, *et al*. Pediatric basic life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Pediatrics 2010;126:e1345-60.
21. Handley AJ, Koster R, Monsieurs K, Perkins GD, Davies S, Bossaert L. European Resuscitation Council guidelines for resuscitation 2005. Section 2. Adult basic life support and use of automated external defibrillators. Resuscitation 2005;67(Suppl 1):S7-23.
22. Higdon TA, Heidenreich JW, Kern KB, Sanders AB, Berg RA, Hilwig RW, *et al*. Single rescuer cardiopulmonary resuscitation: Can anyone perform to the guidelines 2000 recommendations? Resuscitation 2006;71:34-9.
23. Maisch S, Gamon E, Ilisch A, Goetz AE, Schmidt GN. Comparison of the over-the-head, lateral and alternating positions during cardiopulmonary resuscitation performed by a single rescuer with a bag–valve–mask device. Emerg Med J 2011;28:974-8.
24. Handley AJ, Monsieurs KG, Bossaert LL. European Resuscitation Council guidelines 2000 for adult basic life support. Resuscitation 2001;48:199-205.

**How to cite this article:** Nasiri E, Nasiri R. A comparison between over-the-head and lateral cardiopulmonary resuscitation with a single rescuer by bag-valve mask. Saudi J Anaesth 2014;8:30-7.
**Source of Support:** Mazandaran University of Medical Sciences,
**Conflict of Interest:** None declared.