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ORIGINAL RESEARCH

Effect of a New Cardiac Massage Facilitator Device on the Fatigue of Rescue Workers in Cardiopulmonary Resuscitation

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ABSTRACT

Introduction: Cardiopulmonary resuscitation is a direct intervention for the prevention or postponement of death in patients with cardiac arrest. The fatigue of rescue workers is of high significance when performing cardiopulmonary resuscitation effectively. The present study aimed to investigate the effect of a cardiac massage facilitator device on the fatigue of rescue workers in cardiopulmonary resuscitation. **Materials and Methods:** This experimental study was carried out on 30 emergency medical aid non-continuous bachelor students, divided equally into two groups: one group performed cardiac massage using the device and the other without the device. Fatigue levels were assessed using a visual analog scale to evaluate fatigue severity. **Results:** The mean age of participants was 23.42 ± 2.02 years, the mean height was 175 ± 4.43 cm, and the mean weight was 65.45 ± 5.02 kg. There was a statistically significant difference between the mean fatigue scores of the two groups: 0.06 with the device vs. 0.57 without the device. **Conclusion:** Our results suggest that the cardiac massage facilitator device presented in this study could be effective in improving the quality of cardiac massage and be helpful in cardiopulmonary resuscitation.

Keywords: fatigue, cardiac massage, cardiopulmonary resuscitation

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INTRODUCTION

The aim of cardiopulmonary resuscitation (CPR) is to restore the vital functions of two essential organs: the heart and the lung.[1] CPR is an important link in the chain of survival of those who suffer a cardiac arrest,[2] preventing the shortage of nutrients and oxygen in the brain and, consequently, brain death.[3] This vital operation can be performed without any additional means, and its timely and correct execution saves many lives annually.[3] Since the time interval between contacting an emergency medical service and the arrival of medical personnel is usually longer than 5 minutes, the survival rate depends heavily on non-medical individuals with knowledge of CPR.[4] Unfortunately, according to published research, only one percent of patients with cardiopulmonary arrest are resuscitated by those around them outside of the hospital, and every minute of delay adds 10% to the death probabil-

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ity of the patient. If CPR is initiated immediately after the cardiopulmonary arrest, the patient's chance of survival is two to three times higher.[5]

An automated external defibrillator is a lightweight portable device that delivers an electrical shock through the chest, to the heart. This electrical shock is able to stop the arrhythmia and restore the heart's normal rhythm during a sudden cardiac arrest. A computer inside the belt detects the patient's cardiac rhythm through adhesive electrodes,[6] and decides if there is a need for defibrillation (electric shock). If needed, a recorded voice tells the resuscitator to push the button and apply the electrical shock.[7]

In cardiopulmonary arrest, survival of the patient is highly dependent on the onset time of CPR – the sooner the procedure starts, the better.[8] At the same time, the quality of CPR is also an important determinant of a successful resuscitation and survival.[9] In order to be effective, chest compressions should be firm and fast, with a rate of at least 120 per minute and a depth of 5–6 cm. One of the barriers to a successful resuscitation is the fatigue of the person performing the CPR.[10] Various studies have shown that fatigue is observable in rescue workers after 1 minute, although they may deny it up to 5 minutes. Fatigue may prevent proper cardiac massage and may result in the rescuer's inefficiency.[11]

Considering the critical importance of CPR, factors that facilitate the procedure could also improve its quality. Studies regarding ventricular assist devices have found that structural complexity, bulkiness, non-portability, and high-costs are factors that may limit the effective use of these devices.[12] Therefore, it is important to design simple, lightweight, portable, low-cost devices that can be effective in cardiac massage. Based on the above, the aim of this study was to investigate the effect of a cardiac massage facilitator device on the fatigue of rescue workers during CPR.

MATERIAL AND METHODS

This experimental study was conducted at the North Khorasan University of Medical Sciences on a group of emergency medical aid non-continuous bachelor and midwifery students. Thirty participants were divided into two groups of 15 members each, then one group performed cardiac massage using the facilitator device (device group) and the other without the device (no device group). Inclusion criteria were studying in semester 4 and experience in CPR. Exclusion criteria were history of cardiac and respiratory diseases, and upper extremity fractures in the last year. The purpose of the study was explained to the participants, and informed written consent was obtained.

The cardiac massage facilitator device used in this study was a glove registered with the Iranian Patent Organization (patent no. 80797). The glove weighs 120 grams and features a sensor that changes its electrical resistance when force is applied. The force is converted to voltage and shown on the built-in display. The applied force can be adjusted between 5–10 N. The glove also features a compression counter and a cycle time counter.

Data was collected in a form divided into two sections, one for demographic data (gender, age, height, and weight) and the other for fatigue assessment, where each question received a score between 0 and 10 (0: no fatigue, 1–3: mild fatigue, 4–7: moderate fatigue, and 8–10: severe fatigue). After completing the demographic data and going over the correct technique of cardiac massage (position of the hands, proper depth and number of compressions), students in the device group were asked to perform cardiac massage for 2 minutes using the facilitator device with a minimum rate of 120 compressions/minute at a depth of 5–6 cm, in accordance with the 2015 guideline. A visual analog scale to evaluate fatigue severity was then completed by all participants. In all statistical tests, the confidence level was set to 95% and the test power to 0.8. Data analysis was performed using SPSS version 21.0 (IBM Corp, Armonk, NY).

RESULTS

All students participating in the study were males, with a mean age of 23.42 ± 2.02 years, a mean height of 175 ± 4.43 cm, and a mean weight of 65.45 ± 5.02 kg.

The validity of the device was determined using the concurrent validity method, comparing the glove to a standard cardiopulmonary massage monitor. The Pearson correlation coefficient was 0.95 for the number of compressions ($p = 0.001$) and 0.91 for massage depth ($p = 0.001$). There were no significant differences between the mean number of compressions and massage depth between the two devices ($p > 0.05$). Also, the reliability of the facilitator device was reported at 90% by Cronbach's alpha. When using the cardiac massage facilitator device, the results showed that 98% of the subjects achieved proper depth (at least 5 cm), and 93% made at least 100 compressions per minute (Table 1).

There was a statistically significant difference between the mean fatigue scores of the two groups: 0.06 with the device vs. 0.57 without the device, indicating the effectiveness of the massage facilitator device on the fatigue induced by long-term massage (Table 2).

TABLE 1. Comparison between the cardiac massage facilitator device and a standard cardiopulmonary massage monitor

	Number of compressions/min (mean ± SD)	Correlation coefficient	Massage depth (cm, mean ± SD)	Correlation coefficient
Standard cardiopulmonary massage monitor	103.72 ± 15.18	0.954	5.58 ± 1.32	0.917
Cardiovascular massage facilitator device	105.23 ± 11.67		5.43 ± 1.84	
p value	0.323	0.001	0.457	0.001

TABLE 2. Fatigue scores of the participants based on a visual analog scale to evaluate fatigue severity

	No fatigue n (%)	Mild fatigue n (%)	Moderate fatigue n (%)	Severe fatigue n (%)
Device group	5 (33.3%)	9 (60%)	1 (6.6%)	0
No device group	1 (6.6%)	6 (40%)	4 (26.6%)	4 (26.6%)
p value	0.0001	0.0001	0.0001	0.0001

DISCUSSIONS

The aim of this study was to assess the effectiveness of a cardiac massage facilitator device in CPR. Our results have shown that the device had significantly reduced the fatigue of rescue workers during the cardiovascular resuscitation procedure.

One of the first cardiac massage facilitator devices was designed by Givertz *et al*. Similarly to our study, their device was effective in reducing the fatigue induced by cardiac massage; however, it was bulky and complex.[12] Another device, designed by Trivedi *et al*., was also useful in generating the appropriate amout of pressure at the depth required for an effective cardiac massage, but it was large and could not be used easily in the CPR process.[13] The device designed in the present study is small, simple, and low-cost. With its unique design, the device could easily assist rescue workers during cardiac massage, reducing the pressure they need to apply on the chest and increasing the number of compressions before fatigue appears. Another advantage of this device is the ability to show the number of compressions on the display. Based on the above, we consider that this device can be placed in the emergency box and used in CPR.

CONCLUSION

Our results suggest that the cardiac massage facilitator device presented in this study could be effective in improving the quality of cardiac massage and be helpful in CPR.

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CONFLICT OF INTEREST

Nothing to declare.

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