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Influence of CPR feedback device on chest compression quality. Pilot study

Wpływ zastosowania asystenta resuscytacji na jakość uciskania klatki piersiowej. Badanie pilotażowe

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Abstract

Background. Each year, thousands of people worldwide suffer from sudden cardiac arrest (CSA) and require cardiopulmonary resuscitation (CPR). High quality chest compressions with minimal interruption are essential for successful CPR following a cardiac arrest. The aim of the study was to evaluate the impact of various chest compression techniques on the quality of cardiopulmonary resuscitation performed by physicians during post-graduate internship. ***Material and methods.*** Participants during the study performed a 2-minute CPR (TrueCPR) and manual chest compression (MCC). *Depth and rate of chest compressions as well as the degree of chest recoil were analyzed.* ***Results.*** The median compression depth with MCC was 47 [IQR; 40-49]mm *vs.* 55 with TrueCPR [IQR; 51-57]mm ($p < 0.001$). The chest compression rate was 126 [IQR; 118-130]mm^{-1} for MCC, and 106 [IQR; 102-113] mm^{-1} for TrueCPR ($p < 0.001$). Percentage of incorrect decompression with MCC was 23 [IQR; 20-41]% and this result was higher than with TrueCPR - 11 [IQR; 6-15]% ($p < 0.001$). ***Conclusions.*** In a simulated study, participants were able to perform better chest compressions when using TrueCPR compared to standard manual chest compressions. *Anestezjologia i Ratownictwo 2017; 11: 363-367.*

Keywords: chest compression, quality, technique, medical simulation

Streszczenie

Wstęp. Each year, thousands of people worldwide suffer from sudden cardiopulmonary arrest (CPA) and require cardiopulmonary resuscitation (CPR). High quality chest compressions with minimal interruption are essential for successful CPR following a cardiac arrest. Celem pracy była ocena wpływu różnych technik uciskania klatki piersiowej na jakość resuscytacji krążeniowo – oddechowej wykonywanej przez lekarzy w trakcie stażu podyplomowego. ***Materiał i metody.*** Podczas badania uczestnicy wykonywali 2-minutową resuscytację krążeniowo-oddechową z wykorzystaniem TrueCPR (TrueCPR) oraz bezprzyrządowe uciskanie klatki piersiowej

(MCC). Analizowano głębokość i częstość ucisków oraz stopień relaksacji klatki piersiowej. ***Wyniki.*** The median compression depth with MCC and TrueCPR was 47 [IQR; 40-49]mm *vs.* 55 [IQR; 51-57]mm ($p < 0.001$). The chest compression rate was 126 [IQR; 118-130]mm^{-1} for MCC, and 106 [IQR; 102-113] mm^{-1} for TrueCPR ($p < 0.001$). Percentage of incorrect decompression with MCC was 23 [IQR; 20-41]% and this result was higher than with TrueCPR - 11 [IQR; 6-15]% ($p < 0.001$). ***Wnioski.*** W przeprowadzonym badaniu symulacyjnym, uczestnicy badania byli w stanie prowadzić wyższej jakości uciśnięcia klatki piersiowej w przypadku zastosowania urządzenia TrueCPR aniżeli w przypadku standardowego - bezprzyrządowego uciskania klatki piersiowej. *Anestezjologia i Ratownictwo 2017; 11: 363-367.*

Słowa kluczowe: uciskanie klatki piersiowej, jakość, technik, symulacja medyczna

Introduction

The ability to perform cardiopulmonary resuscitation is one of the basic skills for medical practitioners. As indicated by numerous studies [1], and the cardiopulmonary resuscitation guidelines of both the American Heart Association and the European Resuscitation Council, the quality of chest compression during resuscitation is a major factor influencing the effectiveness of resuscitation and thus the return of spontaneous circulation [2,3].

The quality of chest compressions is influenced by the rate of chest compressions, the depth of compression and the degree of chest relaxation after each compression [4,5]. Despite numerous training sessions, a large proportion of rescuers performs chest compressions during resuscitation suboptimally.

As a result, the devices are designed to improve the quality of chest compression. Among these, we can list numerous devices that indicate the rate of chest compressions as well as the depth of compression in real time, which allows the rescuer to modify the above parameters to be consistent with the resuscitation guidelines. An example of such a device is TrueCPR, which allows continuous monitoring of the quality of chest compression [6].

The aim of the study was to evaluate the impact of various chest compression techniques on the quality of cardiopulmonary resuscitation performed by novice physicians during postgraduate internship.

Material and methods

- **Study group**

60 novice physicians participated in the study. The survey was conducted between June 2017 and August 2017. 38.3% of the study participants were women (n = 23). The median age of the study participants was 25.5 [IQR, 24.5-25.5] years.

- **Chest compression methods used in the study**

During the study participants performed cardiopulmonary resuscitation using two methods of chest compression:

1. Manual chest compressions (MCC). Chest compression technique recommended by the European Resuscitation Council Guidelines 2015.
2. Chest compression using TrueCPR (TrueCPR; Physio-Control, Inc., WA, USA). TrueCPR uses Triaxial Field Induction (TFI) technology to accurately measure the depth of chest compressions in a patient. TrueCPR is made up of two components: one is laid under the patient's arm and the other is on the sternum (figure 1). The overlay on the chest is enabled with a display showing the quality of the chest compression, including the rate of chest compression, the depth of the compression, and the measure of the target of the chest relaxation.

In each case, participants did not have any insight into the parameters indicated by the manikin. In case of TrueCPR, they could only use the parameters indicated by the device display.

- **Study protocol**

Prior to the study, all participants participated in a 3-minute pediatric resuscitation training (CPR) based on the current AHA 2015 guidelines [7]. At the end of the training, the instructor demonstrated the correct cardiopulmonary resuscitation and respiratory resuscitation using the TrueCPR system. Study participants practicing resuscitation with each method to ensure they were familiar with the correct use of the devices.

In order to simulate the patient, the Advanced Skill Trainer (Laerdal, Stavanger, Norway) was used to train advanced resuscitation. During the test, the manikin was placed in a back position on a hard surface in a well-lit room.

Figure 1. TrueCPR feedback device

Participants in the target study were asked to perform a 2-minute cardiopulmonary resuscitation of the child. Both participants order and chest compression methods were randomly assigned. For this purpose, ResearchRandomizer was used to divide participants into two groups. The first group started performing CPR (MCC), the second using the TrueCPR. After a 2 minute scenario, participants had a 20-minute pause, followed by CPR with another technique of chest compression.

- **Measurements and statistical analysis**

The measurement included parameters such as the depth of chest compressions (mm), the frequency of chest compressions per minute, the percentage of correctly performed chest relaxation. In addition, participants were asked to evaluate which chest compression technique the would choose in real resuscitation settings.

Results

Overall, only 56.5% of correct chest compressions were performed when resuscitation was performed without TrueCPR, which significantly increased to 87% with TrueCPR feedback device. Median compression depth and compression rate were within the recommended range in control group.

In the case of TrueCPR use, the median depth of chest compressions was 55mm [IQR; 51-57]. The difference in the median depth of chest compressions with and without TrueCPR was statistically significant ($p < 0.001$). The rate of chest compressions was 106 [IQR; 102-113] min^{-1} in case of using TrueCPR, and in the case of manual chest compression was 126 [IQR; 118-130] min^{-1} (figure 2).

Chest compressions were performed on an incorrect compression point in 23 [IQR; 20-41]% in the manual chest compression group, which is significantly more than in the TrueCPR® ($p < 0.001$) (table I).

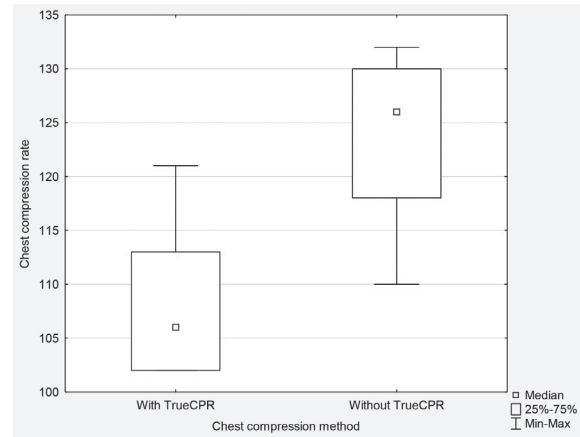

Figure 2. Median chest compression rate

Table I. Chest compression parameters

Chest compression parameters	Without TrueCPR (TrueCPR)	With TrueCPR (MCC)	p value
Correct chest compressions (%)	56.5 [IQR; 50-59]	87 [IQR; 71-90]	P < 0.001
Compression depth (mm)	47 [IQR; 40-49]	55 [IQR; 51-57]	P < 0.001
Compression rate (min^{-1})	126 [IQR; 118-130]	106 [IQR; 102-113]	P < 0.001
Incorrect decompressions (%)	23 [IQR; 20-41]	11 [IQR; 6-15]	P < 0.001
Incorrect pressure point (%)	0 [IQR; 0-0]	1 [IQR; 0-2]	NS
NS = Not statistically significant			

Discussion

Guidelines of both the American Heart Association and the European Resuscitation Council place great emphasis on the quality of chest compressions [7,8]. The guidelines recommend that the chest should be compressed at a rate of 100-120 compressions per minute, however, as many simulation studies show, a large proportion of staff perform chest compressions at frequencies exceeding 120/min^{-1} [9]. Too high chest compression rate may lead to excessive fatigue of the rescuer, and thus lead to insufficient chest compression and more in the Alderman studies [10], it was shown that chest compressions with a frequency of approximately 90min^{-1} are the most optimal for achieving normal perfusion pressure.

In the study, the difference in chest compressions in the examined groups was statistically significant. By using a feedback device providing the feedback on the quality of chest compressions (TrueCPR), the participants were able to correct the rate of chest compression to be within the resuscitation guidelines.

Another aspect contributing to the quality of chest compressions is the depth of the compression that directly affecting the degree of perfusion through mediastinal compression and thus pressing the blood from the myocardium into the peripheral blood vessels [11,12]. Also in this aspect, the depth adjustment in case of using TrueCPR resulted in a more accurate depth of chest compressions. The use of CPR feedback devices has also been recognized by other researchers who noticed significant improvement in chest compression using this type of device. Also, both the compression/relaxation ratio and the degree of full chest relaxation affect the quality of the organ perfusion obtained [13]. In the case of incomplete chest relaxation there is no possibility to ensure large differential pressure in the chest which is a "driving force" that forces blood to circulate [14].

The study has several limitations. Firstly, the study was performed under medical simulation conditions and not in real cardiac arrest settings, but in real life, it would be impossible to measure specific parameters and the lack of resuscitation activities can impede the quality of resuscitation, including delays in life-saving procedures. The second limitation is the research group of 60 novice physicians, the choice was deliberate - the novice physicians completing the Medical University should have practical knowledge and skills in cardiopulmonary resuscitation for both adults and pediatric patients.

Conclusions

In a simulated study, participants were able to perform better chest compressions when using TrueCPR compared to standard manual chest compression. Further studies are needed to verify the results.

Conflict of interest
None

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