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Original Contribution

Effectiveness and feasibility of assistant push on improvement of chest compression quality: a crossover study☆,☆☆

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ABSTRACT

Purpose: To improve the quality of chest compression (CC), we developed the assistant-push method, whereby the second rescuer pushes the back of the chest compressor during CC. We investigated the effectiveness and feasibility of assistant push in achieving and maintaining the CC quality.

Methods: This was a randomized crossover trial in which 41 subjects randomly performed both of standard CC (single-rescuer group) and CC with instructor-driven assistant push (assistant-push group) in different order. Each session of CC was performed for 2 minutes using a manikin. Subjects were also assigned to both roles of chest compressor and assistant and together performed CC with subject-driven assistant push. Depth of CC, compression to recoil ratio, duty cycle, and rate of incomplete recoil were quantified.

Results: The mean depth of CC (57.0 [56.0-59.0] vs 55.0 [49.5-57.5], $P < .001$) was significantly deeper, and the compression force (33.8 [29.3-36.4] vs 23.3 [20.4-25.3], $P < .001$) was stronger in the assistant-push group. The ratio of compression to recoil, duty cycle, and rate of incomplete chest recoil were comparable between the 2 groups. The CC depth in the single-rescuer group decreased significantly every 30 seconds, whereas in the assistant-push group, it was comparable at 60- and 90-second time points ($P = .004$). The subject assistant-push group performed CCs at a depth comparable with that of the instructor assistant-push group.

Conclusion: The assistant-push method improved the depth of CC and attenuated its decline, eventually helping maintain adequate CC depth over time. Subjects were able to feasibly learn assistant push and performed effectively.

1. Introduction

Adequate chest compression (CC) is a crucial determinant of successful outcomes over the restoration of spontaneous circulation (ROSC) in cardiac arrest victims because the perfusion during cardiopulmonary resuscitation (CPR) depends on CC [1,2]. Therefore, guidelines have placed more emphasis on the importance of CC during CPR, the current recommendation being to push the chest to a depth of at least 5 cm [3,4]. However, many trained health care providers still perform inadequate depth of CC regardless of in-hospital or out-of-hospital settings [5,6].

Several studies investigated the factors affecting the quality of CC [7-13]. Women, children, and lightweight rescuers often have difficulty producing enough physical strength to push the chest to the recommended depth. Moreover, the act of CC can easily cause physical fatigue in these rescuers, which results in a rapid decline in CC quality [7-13]. Hasegawa et al [7] suggested that lightweight rescuers should rotate at 1-minute intervals to maintain high quality of CC. In another study, Krikscionaitiene et al [14] reported that a 5-second intervention in which the instructor pushed on the trainee's shoulders improved the quality of CC during training exercises. Whether special attention is given during training or intervention is performed, there are still limitations to achieving and maintaining adequate quality of CC because sex, age, and physical fitness factors (such as weight and height) are fixed.

We developed a method similar to that of Krikscionaitiene et al [14] who reported to improve the quality of CC. The approach requires that the second rescuer simultaneously pushes on the back of the first rescuer, who performs CC. We investigated the feasibility of this method and hypothesized that it would be effective in achieving and maintaining CC quality, especially among rescuers for whom achieving adequate CC depth may prove challenging.

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2. Methods

2.1. Participants

We recruited 41 college students majoring in emergency medical technology to participate in this study. A minimum sample size of 16 is required for an effect size of 0.89 and statistical power of 90%; these parameters are necessary to detect a 5% difference in preliminary data. Ethical approval was obtained from the institutional review board (CNUH-2014-052). Written informed consent was obtained from all subjects.

2.2. Study design and protocol

This was a randomized crossover trial. Subjects were assigned to 2 groups and performed 2 methods of CC on a Resusci Anne (Laerdal, Stavanger, Norway) manikin placed on the floor in different order: standard continuous single-rescuer CC (single-rescuer group) and continuous CC with assistant push (assistant-push group). The assistant-push method was performed by an instructor with basic life support (BLS) certification from the American Heart Association. In this approach, the instructor pushed the subject's upper back with 1 hand, while they performed CC (Fig. 1). Each CC method was performed without ventilation for 2 minutes using a metronome at a rate of 110 min^{-1}. No visual or acoustic feedback was permitted during CC. Each CC method was performed on a load cell (CAS Korea, Seoul, South Korea) to obtain and compare the compression force [15].

After the completion of both methods of CC, the assistant-push method was introduced to the subjects, at which point they were assigned to both roles of chest compressor and assistant. The randomly assigned 41 pairs of subjects performed CC with assistant push without instructor assistance for 2 minutes to identify the feasibility of assistant push during CC.

2.3. Data collection

The data for demographics of all participants were obtained, including age, sex, weight, height, body mass index (BMI), frequency of BLS training, and time since most recent BLS education. Chest compression performance data were collected using the Laerdal SkillReporter (Laerdal), including compression rate, depth of CC, correct depth of CC, ratio of compression to recoil, duty cycle, and incomplete recoil rate. Performance of CC on a load cell was recorded to obtain the compression force for every CC. Mean depth of CC by a single rescuer was dichotomized; mean compression depth greater than or equal to 50 mm was defined as "correct" and mean compression depth less than 50 mm defined as "incorrect" [4]. Difference in mean CC depth was calculated as the difference between mean depth of CC by assistant push and by a single rescuer. Rate of CC depth difference was also calculated as the difference in mean CC depth divided by mean CC depth by a single rescuer.

2.4. Data analysis

The categorical variables were expressed as numbers (%). The continuous variables were expressed as means ± SD or medians (interquartile range) as a result of the normality test. The paired comparison of continuous variables was performed with the paired *t* test or Wilcoxon signed rank test as appropriate. The comparison of continuous variables between independent groups was performed using the independent *t* test or Mann-Whitney *U* test as appropriate. The effect of assistant-push CC over time was assessed using repeated-measures analysis of variance, where the response variables were set as mean CC depth and mean CC depth difference at 30-second intervals. Post hoc analysis at each time point (25-30, 55-60, 85-90, and 115-120 seconds) was performed using the paired *t* test with the Bonferroni correction. The association between continuous variables was evaluated by Spearman correlation coefficient. Multivariate forward stepwise linear regression was used to identify variables affecting the depth of CC.

Fig. 1. Assistant-push method. While the primary chest compressor is performing CCs, the second rescuer simultaneously pushes on the primary chest compressor's upper back with 1 hand.