

# The effect of distraction by dual work on a CPR practitioner's efficiency in chest compression

## A randomized controlled simulation study

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### Abstract

**Background:** In the clinical setting, the dispersed practitioners' attention often leads to decreased competence in their performance. We aimed to investigate the effect of distracted practitioners on the quality of chest compression during cardiopulmonary resuscitation.

**Methods:** A randomized controlled crossover simulation study was conducted. Participants were recruited from among doctors, nurses, and paramedics working in a university tertiary hospital. The paced auditory serial addition test (PASAT) was used as a tool for distracting participants. In the crossover design, each participant played 2 scenarios with a 20-minute time gap, by a random order; 2-minute continuous chest compressions with and without PASAT being conducted. The primary outcome was the percentage of compression with an adequate compression rate. Secondary outcomes were the percentage of compression with adequate depth, the percentage of compression with full chest wall recoil, mean compression rate (per minute), mean compression depth, and subjective difficulty of chest compression.

**Results:** Forty-four participants were enrolled, and all of them completed the study. It was found that the percentage of compression with an adequate compression rate was lower when the PASAT was conducted. Although there was no difference in the percentage of compression with adequate depth ( $P = .88$ ), the percentage of compression with complete chest recoil was lower when PASAT was conducted. In addition, while the mean compression rate was higher when PASAT was conducted, the mean compression depth was not significantly different ( $P = .65$ ). The subjective difficulty was not different ( $P = .69$ ).

**Conclusions:** Health care providers who are distracted have a negative effect on the quality of chest compression, in terms of its rate and chest wall recoil.

**Trial registration:** www.ClinicalTrials.gov, NCT03124290.

**Abbreviations:** AHA = American Heart Association, CPR = cardiopulmonary resuscitation, ERC = European Resuscitation Council, PASAT = paced auditory serial addition test, SD = standard deviation, VAS = visual analogue scale.

**Keywords:** attention, cardiopulmonary resuscitation, heart arrest, quality improvement

## 1. Introduction

The quality of cardiopulmonary resuscitation (CPR) is known to be closely related with the outcome of patients with cardiac

arrest.<sup>[1]</sup> The need for high-quality CPR is emphasized as crucial, according to CPR guidelines by the American Heart Association (AHA) and the European Resuscitation Council (ERC).<sup>[2,3]</sup> Of all the components of CPR, chest compression is a one of the key components and can be qualified by various objective parameters such as compression rate, depth, and chest wall recoil.<sup>[11]</sup> Although the ideal goals for these parameters have been suggested by guidelines,<sup>[4,5]</sup> conducting adequate chest compressions without the assistance of devices that offer real-time feedback on these parameters is challenging. Considering that these devices are not often available, an effort to improve the CPR practitioner's ability to conduct appropriate chest compression is important. Hence, CPR training programs usually give feedback on the performance of trainees with the use of simulation manikins equipped with feedback tools.

In the clinical setting, the resuscitation process for critical patients is usually carried out under very pressing and complicated situations, and multiple tasks are assigned to rescuers. For example, practitioners usually conduct various critical procedures and other intellectual tasks such as ordering drugs, taking down patients' history, as well as seeking diagnoses simultaneously. It is highly likely that the practitioners' attention will be dispersed in such situations, leading to decreased competence in their performance. Results of a previous

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simulation study suggested that a clinician's divided attention (by performing 2 tasks-dual work) is associated with poor performance and increased subjective workload in airway management.<sup>[6]</sup> In that study, the paced auditory serial addition test (PASAT) was used as an instrument of dual work. The PASAT is known to be very sensitive to the evaluation of attention, distraction, and dual tasking.<sup>[7]</sup>

Previous studies have evaluated the effect of distractors on the quality of CPR. In a simulated situation, external distractors such as noise and scripted family members impeded the CPR performance, regardless of the clinician's experience, rated using a score based on ERC guidelines.<sup>[8]</sup> Another simulation study showed that the presence of a family witness affected the clinicians' ability to perform critical actions such as electric shock delivery.<sup>[9]</sup> However, no studies have assessed the objective parameters of chest compression in distractive situations that warrant the performance of various intellectual tasks simultaneously. Therefore, we performed a simulation study using a manikin to evaluate the effect of distraction (performing 2 tasks: chest compression and PASAT) on the quality of chest compression.

## 2. Materials and methods

### 2.1. Study design and setting

This prospective randomized, crossover simulation study was conducted in a simulation room of a university tertiary hospital (Inje University Ilsan Paik Hospital, Goyang, Korea) from April 27 to May 14, 2017. This study was conducted after being approved by the ethics committee of Inje University Ilsan Paik Hospital, Goyang, Korea. The protocol of this study was registered in ClinicalTrials.gov (NCT03124290) and conformed to the tenets of the Declaration of Helsinki.

### 2.2. Study participants

We recruited healthy volunteers from among doctors, nurses, and paramedics in a university tertiary hospital, through e-mail. All of them had already completed a basic life support training course. The primary investigator (JMP) explained the details of the study, including its objectives and simulation protocols to all the volunteers. Volunteers who agreed to participate after this information was provided to them were enrolled to this study; written consent was obtained. We excluded pregnant volunteers.

### 2.3. Study protocol

The Resusci Anne QCPR manikin (Laerdal, Stavanger, Norway) was used for this experiment. We defined appropriateness of the parameters with regards to the quality of chest compression suggested by 2015 AHA and ERC guidelines<sup>[4,5]</sup>; depth of 50 to 60 mm, rate of 100 to 120 compressions per a minute, and full chest wall recoil. After the actual study protocol was explained by a researcher (KL), participants practiced chest compression with the manikin on the floor, for a minute; a visual feedback device enabled them to measure the depth, rate, and chest wall recoil of each compression. Next, a researcher (KL) explained the concept of PASAT and participants practiced it without chest compression for a minute, in order to learn how to perform. After 10 minutes, each participant took part in 2 simulated chest compression scenarios; performing 2 minutes of continuous chest compression while PASAT was conducted (dual work) and

performing 2 minutes of only continuous chest compression (single work). There was a 20-minute washout period between the 2 scenarios. Randomization was implemented by the primary investigator (JMP) as follows. The order of the 2 scenarios in each participant was designated by blocked randomization using random permuted blocks, and the allocation concealment was secured by sequentially numbered radiopaque sealed envelopes.

### 2.4. Data collection

A researcher blinded to the implemented scenarios (WJ) collected all the data in a preset form. Information pertaining to general characteristics, such as sex, age, height, weight, designation (physician, nurse, or paramedics), and clinical experience in years, was gathered with a questionnaire, before simulation. Parameters pertaining to compression quality, such as compression rate, depth, and full chest wall recoil, were recorded automatically by SimPad PLUS with SkillReporter (Laerdal, Stavanger, Norway). Data with regards to the subjective difficulty of chest compression in both scenarios—rated by 100 mm visual analogue scale (VAS) (0: easiest and 100: hardest)—were gathered from each participant through a questionnaire, after completion of simulation.

### 2.5. Statistical analysis

There are no studies that have evaluated the objective indicators pertaining to chest compression under distractive situations; therefore, an effect size for the sample size calculation was set as 0.5 (medium effect).<sup>[10,11]</sup> At least 37 participants were required, with alpha, 0.05 and power, 0.85. The primary outcome was the percentage of compressions with an adequate rate during the 2-minute chest compressions. The percentage of compressions with adequate depth, percentage of compressions with full chest wall recoil, mean compression rate (per minute), mean compression depth (mm), and subjective difficulty were the secondary outcomes. On the basis of the criterion from a previous study, if the accuracy of PASAT was 50% or more, we judged that participants put in enough effort for conducting PASAT.<sup>[6]</sup> Thus, if a participant's accuracy was less than 50%, we decided not to include the result for the analysis. Continuous variables were described with means and standard deviations (SDs), and categorical variables were described with numbers and percentages. The difference in the outcomes between the 2 scenarios was performed using the paired *t* test. The SPSS Statistics for Windows ver. 21 (IBM, Armonk, NY) was used for statistical analysis, and a *P* value less than .05 was considered statistically significant.

## 3. Results

A total of 44 volunteers were enrolled to be part of the study and they completed both scenarios without any dropouts at the end (Fig. 1). There were 21 males (47.7%) and 23 females (52.3%), and the mean age (SD) was 27.6 (3.7) years (Table 1). The participants comprised 24 physicians, 15 nurses, and 5 paramedics. The mean clinical experience (SD) was 3.6 (2.8) years, and only 8 participants had clinical work experience of more than 5 years (Table 1). The accuracy of PASAT was more than 50% in all the participants, and hence, all their data were analyzed.

The percentage of compressions with an adequate rate was lower in the dual work scenario than in the single work scenario; 47.4±42.4% versus 67.8±36.1%, *P*=.009 (Table 2). The

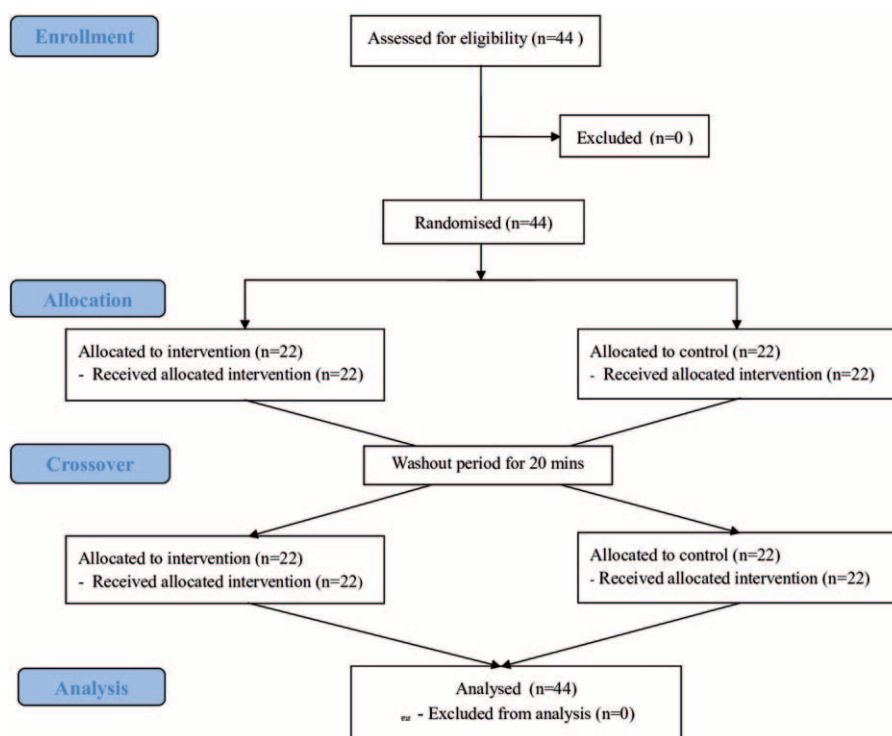


Figure 1. Flow diagram of study.

percentage of compressions with adequate depth did not differ, but the percentage of compressions with full chest wall recoil was significantly lower in the dual work scenario;  $75.0 \pm 34.1\%$  versus  $86.3 \pm 23.3\%$ ,  $P = .01$  (Table 2). A post hoc analysis for adequacy of compression depth (adequate depth defined as  $\geq 50$  mm) revealed that the percentage of compressions with adequate depth was  $67.5 \pm 38.4\%$  in the dual work scenario and  $71.7 \pm 36.0\%$  in the single work scenario ( $P = .15$ ). While the mean compression rate (per a minute) was higher in the dual work scenario ( $121.9 \pm 11.8$  vs  $114.0 \pm 10.0$ ,  $P < .001$ ) (Fig. 2), the mean compression depth was not significantly different ( $52.1 \pm 6.6$  vs  $52.3 \pm 7.5$  mm,  $P = .65$ ) (Fig. 3). The subjective difficulty

was not different;  $56 \pm 19$  mm in the dual work scenario and  $58 \pm 17$  mm in the single work scenario ( $P = .69$ ).

#### 4. Discussion

The resuscitation of cardiac arrest patients is generally conducted in chaotic situations in which CPR rescuers usually have to perform multiple tasks simultaneously. Therefore, team-based resuscitation is emphasized for the administration of high-quality CPR.<sup>[4]</sup> However, this is often not possible, especially in cases of out-of-hospital cardiac arrest and even in the initial phases of in-hospital cardiac arrest. As a result, rescuers are prone to be distracted and are unable to offer high-quality management. Although previous studies have investigated the effect of external distractors on the quality of CPR, their distractors mainly operated as emotional stressors, with resuscitation circumstances being modified by the addition of noises or interference by actors.<sup>[8,9,12]</sup> However, we hypothesized that distracting participants by making them perform an intellectual task (PASAT) at the same time as CPR administration might impede high-quality chest compression. PASAT is a serial addition test for evaluating short-term memory, attention, and concentration.<sup>[13]</sup> It was evaluated as a quantifying method for deficit of neurocognitive

**Table 1**  
General characteristics of participants (N = 44).

|                          | n (%) / Mean $\pm$ SD |
|--------------------------|-----------------------|
| Sex                      |                       |
| Male                     | 21 (47.7)             |
| Female                   | 23 (52.3)             |
| Age, y                   | 27.6 $\pm$ 3.7        |
| Height, cm               | 168.8 $\pm$ 9.1       |
| Weight, kg               | 63.8 $\pm$ 12.9       |
| BMI, kg/m <sup>2</sup>   | 22.2 $\pm$ 2.7        |
| Job                      |                       |
| Doctor                   | 24 (54.5)             |
| Nurse                    | 15 (34.1)             |
| Paramedic                | 5 (11.4)              |
| Clinical work experience |                       |
| <5 y                     | 36 (81.8)             |
| $\geq 5$ y               | 8 (18.2)              |

BMI=body mass index, N=number, SD=standard deviation.

**Table 2**  
Difference in the quality of chest compression according to the presence of a distractor.

|                                | Dual work       | Single work     | P    |
|--------------------------------|-----------------|-----------------|------|
| Adequate compression rate (%)  | 47.4 $\pm$ 42.4 | 67.8 $\pm$ 36.1 | .009 |
| Adequate compression depth (%) | 52.7 $\pm$ 35.1 | 52.1 $\pm$ 36.5 | .88  |
| Adequate chest recoil (%)      | 75.0 $\pm$ 34.1 | 86.3 $\pm$ 23.3 | .01  |

## Mean compression rate (/min)

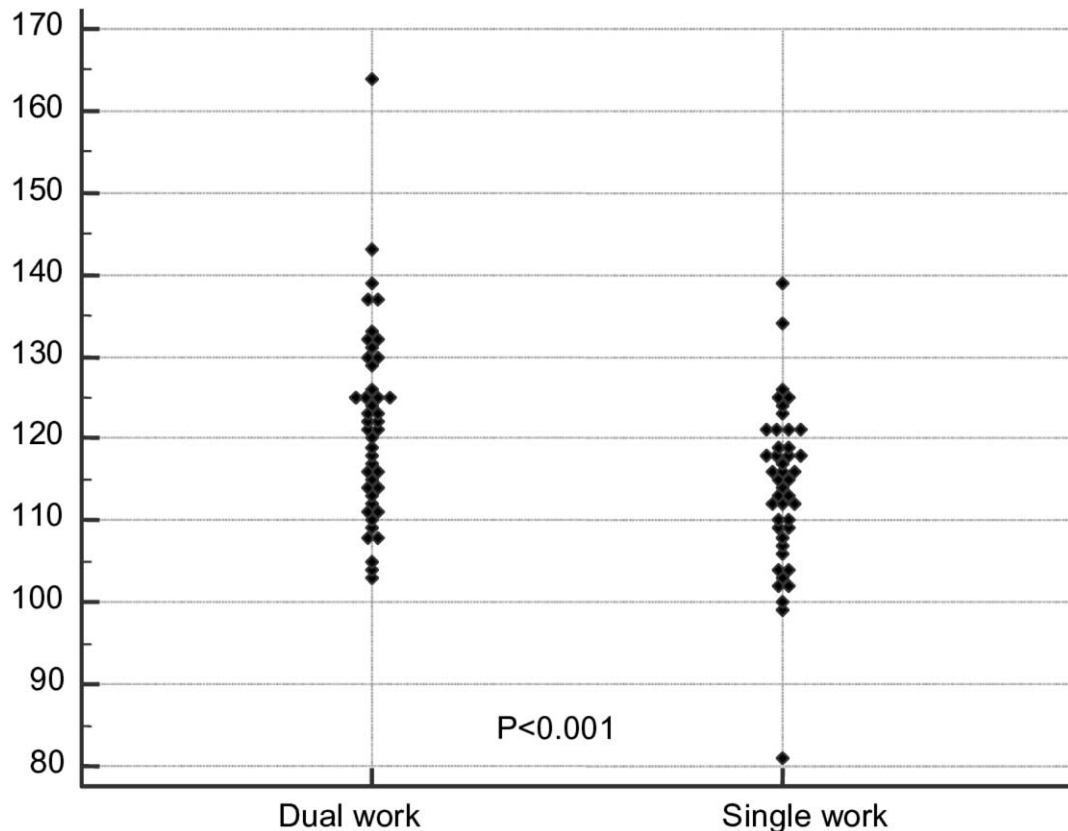


Figure 2. Distribution of mean compression rate according to the presence of a distractor.

function in several diseases,<sup>[14,15]</sup> and validated as a tool for dividing attention during airway management.<sup>[6]</sup>

In our study, distracting participants' attention through a dual work scenario significantly lowered compression quality in terms of compression rate. Although the proportion of compression with an adequate rate (100–120/min) was relatively lower, the mean compression rate was relatively higher in the dual work scenario (122/min vs 114/min) than in the single work scenario. This suggested that introducing extra work played a role in enforcing the administration of chest compression in a hurry. Considering the result of a previous study which stated that the compression depth became shallower in a dose-dependent manner, as the mean compression rate became higher,<sup>[16]</sup> the tendency to make compression faster may also be problematic in terms of achieving optimal compression depth. The only previous study that investigated the effect of external distractors on compression quality with objective parameters reported no significant differences in the compression rate when a distractor was present.<sup>[12]</sup> In that study, increasing the psychological pressure of participants through a directed script was used as a distractor, and the discrepancy in the distracting method might have induced results that were different from ours.

Distracting attention through a dual work scenario did not affect the quality of compression with regards to the depth, as suggested by our study. Compressions with adequate depth occupied slightly over half of all the compressions in both arms; an average of 52.7% with a distractor and 52.1% without a distractor. This coincided with the findings of a previous study

that investigated the effect of external distractors on compression quality with objective parameters.<sup>[12]</sup> We believe that the relatively low level of correctness, in terms of compression depth, in our study might be due to the narrow windows for adequate depth (50–60 mm). Considering that the most imperfect chest compression, with regards to depth, originated from shallow depth even in professionals,<sup>[17]</sup> if we set a low limit of the adequate depth ( $\geq 50$  mm) as recommended in the 2010 AHA guideline,<sup>[18]</sup> the proportions of adequate compression in both scenarios increased, but still did not show a significant difference.

Incomplete chest wall recoil is known to impede compression quality by reducing venous return, coronary perfusion pressure, and myocardial blood flow.<sup>[19,20]</sup> The percentage of compression with full chest recoil was relatively lower when attention was dispersed by dual work, in our study. One possible explanation of this might be that when performing dual work, there was a tendency to lean toward the chest wall during chest compression.

The subjective workload with chest compression was not significantly different between the 2 scenarios. This result was different from other studies, which suggest that external distractors or socioemotional stressors increased the clinician's perceived workload.<sup>[12,21]</sup> Over half of the participants (26 of 44 participants) in our study felt that it was easier or took equal effort to perform chest compression in the dual work scenario than in the single work scenario. Most of them said that the concentration of chest compression was dispersed through dual work and the workload of chest compression decreased. One possible explanation for this is that the time spent for each

## Mean compression depth (mm)

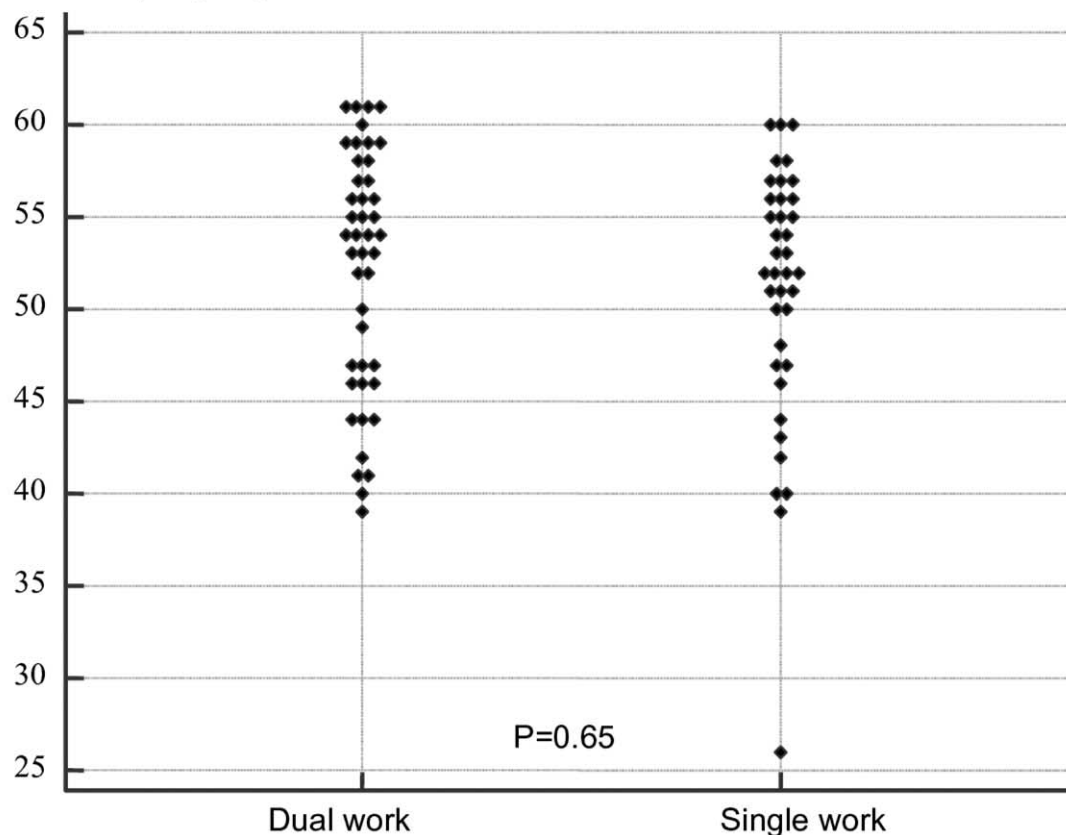


Figure 3. Distribution of mean compression depth according to the presence of a distractor.

compression scenario was only 2 minutes and dual work did not significantly affect the subjective workload in 2-minute chest compressions. To investigate the effect of distraction through a dual work scenario on the quality of compression along with time, further studies are warranted.

The present study has 2 limitations. First, CPR components other than chest compression, such as ventilation and electric shock delivery, were not implemented in our simulation. Thus, consideration of their effects on chest compression quality was not available. This was out of our scope and investigation on this topic is required in future studies. Second, the study participants as well as the researcher who controlled the actual simulation could not be blinded; this could be a source of performance bias.

## 5. Conclusion

Distracting attraction through a dual work scenario affected the quality of chest compression in terms of its rate and full chest recoil. When participants were distracted, the chest compression rate was more inappropriate and became faster, and compressions with full chest recoil were much lesser. Considering that rescuers frequently encounter complicated situations during resuscitation wherein multiple tasks are to be resolved simultaneously, we believe that a more systems-oriented approach for cardiac arrest response should be emphasized. This will aid in reducing the effects of distractions experienced by the practitioners and securing appropriate chest compressions.

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