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THE IMPORTANCE OF VICTIM CHEST EXPOSURE DURING CARDIOPULMONARY RESUSCITATION: A SIMULATION STUDY

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☐ **Abstract—Background: During cardiopulmonary resuscitation (CPR), inaccurate positioning of the rescuer's hand might damage internal organs due to compression around the xiphoid process. Objective: This study aimed to determine whether exposing the victim's chest during CPR would help adequate positioning of a rescuer's hand on the chest. Methods: This simulation study included 187 participants. We gave them four photographs each of exposed chests and unexposed chests. Participants were then asked to mark a cross at the center of the chest (CoC) and at the inter-nipple line (INL), and we measured the width of participants' palms to estimate the range of hand contact with the victim's chest. Finally, we compared the position and distribution of the CoC and INL markings and analyzed whether the hand contact range on the victim's chest involved the xiphoid process. Results: The participants' CoC markings were similar regardless of whether the pictures showed an exposed or unexposed chest ($p = 0.638$). However, the level of INL marking was significantly lower in pictures of an exposed chest ($p < 0.001$). When exposing the chest, the distribution of markings was narrower for both CoC ($p = 0.001$) and INL ($p < 0.001$). The proportion of CoC markings involving the xiphoid process were lower when the chest was exposed (10.7%) than when was clothed (12.3%) ($p < 0.001$). Similarly, INL markings involving the xiphoid process followed the same trend in exposed vs. unexposed chest images (0% vs. 1.6%, respectively). Conclusions: Exposing the chest during CPR can improve the rescuer's ability to recognize the CoC and INL, leading to more intense chest compression and reducing the risk of inaccurate compression. © 2015 Elsevier Inc.**

☐ **Keywords—cardiopulmonary resuscitation; chest compression; chest exposure**

INTRODUCTION

Immediate cardiopulmonary resuscitation (CPR) by a layperson is critical for the successful resuscitation of persons who experience cardiac arrest outside of the hospital setting (1,2). The American Heart Association (AHA) 2010 guidelines emphasize the importance of high-quality CPR performed early during cardiac arrest (3). These guidelines also stress that adequate chest compression is a key component of high-quality CPR.

The quality of chest compressions can be affected by the following factors: the position and number of rescuers, the position of the victim, and position of the rescuer's hands (4). International guidelines have used the center of the chest (CoC) and the inter-nipple line (INL) as anatomical landmarks for hand position in adult CPR since the 2000, although there is little scientific evidence regarding the optimum hand position for chest compression (3,5–8).

However, it could be difficult for laypersons or even health-care professionals to identify these landmarks (9). This difficulty can delay the first chest compression

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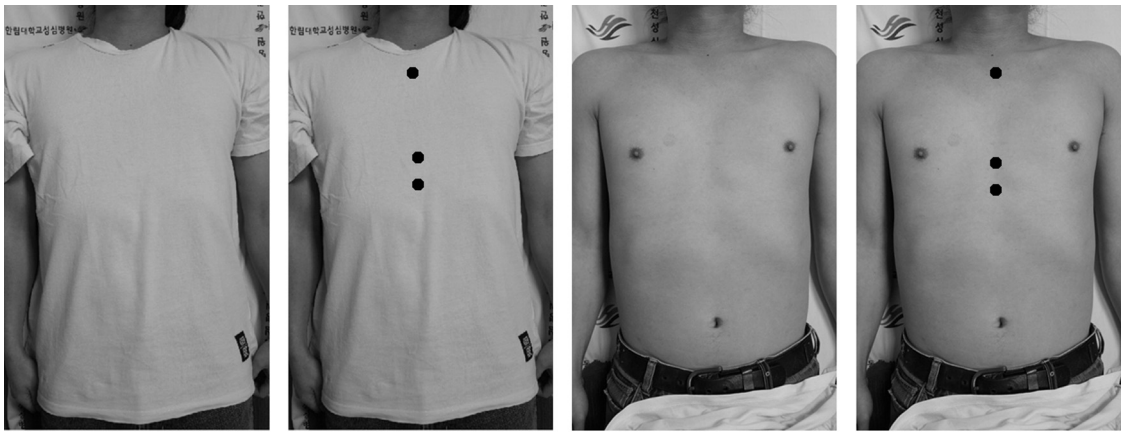

Figure 1. Subject chest photographs taken for the survey. For this study, we included four photographs: the chest clothed and unmarked, clothed and marked, unclothed and unmarked, and unclothed and marked. The participants were asked to mark a cross at center of chest and inter-nipple line.

after ventilation and result in fewer compressions delivered per minute (10–12). In addition, Yeung et al. reported that most rescuers do not expose the victim's chest before commencing CPR (13). Failure to expose the victim's chest might cause inaccurate positioning of the hand. If the hand position is too high, chest compressions are less effective due to the inelastic nature of the upper thoracic cage. Compressions here might cause fractures of the first and second ribs and at the sternochondral junction (14). If the hand position is too low, compressions might damage internal organs near the xiphoid process, such as the liver, lungs, and spleen (15,16). Most importantly, suitable hand positioning during CPR improves the victim's chance of survival by providing effective blood circulation to the heart and brain (3).

Until now, no studies have examined the usefulness of exposing a victim's chest to improve the hand positioning of rescuers during CPR. Here, we aimed to determine whether chest exposure aids in the adequate positioning of the hands for chest compressions.

MATERIALS AND METHODS

Enrolled Participants

This prospective observational study was conducted with participants at a basic life support (BLS) course at our hospital. This study was conducted during a 5-month period between January 2013 and May 2013. We recruited 187 participants for the study. After receiving approval for the study protocol from our Institutional Review Board, informed consent was obtained from each participant. All participants were asked to complete a questionnaire, which included their sex, weight, height, and information about the number of previous CPR training courses they had completed. We also asked participants whether they would expose victim's chest in a life-saving situation and, if not, their reason for not exposing the chest.

STUDY DESIGN AND SETTING

For this study, we took photographs of a normal chest. The photographs were taken from a standard distance of 1 m using a digital camera (D70 DSLR 6.1 megapixel; Nikon, Tokyo, Japan) with the field adjusted. The photo subject was a 36-year-old, healthy male resident of our department (178 cm/78 kg). He was placed in a supine position with both arms parallel to the body on the resuscitation table. After taking clothed chest photographs, a radiologist determined anatomical position of the breast bone using ultrasonography (M-turbo Ultrasound System; Sonosite Inc. Bothell, WA). Then, we marked the positions of the sternal notch, the xiphisternal junction, and the lower tip of xiphoid process with pen on the subject's clothing and took another picture to obtain a marked version for accurate anatomical reference. To avoid discrepancies between photos, the camera was fixed by a pan head. After taking pictures of the subject clothed, we undressed the subject's chest and repeated the process. The end result included four photographs: the chest clothed and unmarked, clothed and marked, unclothed and unmarked, and unclothed and marked (Figure 1). We also measured the length of the sternum and the xiphoid bone with accurate paper rulers. The length of the sternum was 22.3 cm and the xiphoid bone was 2.7 cm. Before the start of the BLS course, we gave participants four of the unmarked chest photos, two each with an exposed or clothed chest, and we asked them to put a cross mark to indicate the CoC and INL, assuming