J Anesth (2011) 25:770–772
DOI 10.1007/s00540-011-1196-2

SHORT COMMUNICATION

Backboard insertion in the operating table increases chest compression depth: a manikin study

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Received: 12 April 2011 / Accepted: 20 June 2011 / Published online: 8 July 2011

Abstract The quality of chest compression (CC) is influenced by the surface supporting the patient. The present study compared chest compression depth with and without a rigid backboard on an operating table with a pressure-distributing mattress. We hypothesized that the presence of a backboard would result in an increased depth of chest compression on the operating table with a pressure-distributing mattress. In a randomized crossover trial, we simulated in-hospital cardiac arrest in a Resusci Anne SkillReporter model placed on a standard operating table with a 6-cm-thick pressure-distributing mattress. A total of 25 male doctors performed CC 30 times, with or without the rigid backboard. Mean chest compression depth increased from 4.9 ± 0.4 to 5.4 ± 0.3 mm ($P < 0.0001$) when a backboard was present. Mean proportion of compressions >50 mm increased significantly with the presence of a backboard (53.6% ± 32.3%–81.8% ± 15.0%, $P < 0.0001$). Applying a backboard significantly increased CC depth during cardiopulmonary resuscitation of a manikin model on an operating table with a pressure-distributing mattress.

Keywords Chest compression · Cardiopulmonary resuscitation · Cardiac arrest · Chest compression

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The 2010 American Heart Association (AHA) and European Resuscitation Council (ERC) guidelines for resuscitation emphasize the importance of high-quality chest compression (CC) [1, 2]. Unfortunately, the depth of CC during in-hospital cardiac arrest is often insufficient according to published guidelines, which state that the sternum should be compressed at least 5 cm [3–5]. Quality of CC can be influenced by a number of variables including the support surface. Soft support surfaces, such as foam and inflated or deflated mattresses, adversely affect the quality of CC [6]. Theoretically, a backboard provides stability and decreases compliance of the thorax and underlying mattress, thus increasing CC depth [7].

With the intent to prevent bedsores, a recent practice has been to place a thin foam or sponge mattress on the operating table. The effect of a backboard on CC quality in an operating table with such a mattress has not been evaluated.

We investigated the efficacy of a backboard during CC on an operating table with a standard pressure-distributing mattress. We hypothesized that application of a backboard on the operating table would significantly increase CC depth.

We obtained approval for this study from the Research Ethics Committee at our institution. From November 2010 to April 2011, we recruited 25 male doctors under the age of 40 who occasionally but not routinely engage in cardiopulmonary resuscitation. They had received training in providing CC from our hospital's Basic Life Support course and were updated on the 2010 guidelines. All doctors provided us with their written consent as well as information about their age, height, weight, and prior experience with CC before participating in the study.

The study was performed in the operating room. We used the Alphamaquet (Maquet; Maquet, Germany) as an operating table and placed a 6-cm-thick pressure-distributing mattress (Softnurse; LacHealthcare, Japan) on the bed (Fig. 1a). The Resuci Anne SkillReporter model (Laerdal; Sentrum, Stavanger, Norway) was used as a manikin to measure CC depth. The manikin contains a measuring function that can measure the depth of CC digitally. A 1-cm-thick backboard (Navis, Tokyo, Japan) was applied (Fig. 1b). Participants were instructed to perform CC according to recent guidelines, at a rate of more than 100/min, complete chest recoil, and at a depth of more than 5 cm. To minimize any learning effect during the trial, the order of interventions was randomized for each participant, who drew tickets from an opaque envelope. We measured compression depth, proportion of compressions of the correct depth (depth >50 mm), compression rate, with or without a backboard.

Results obtained from each trial were compared by a paired t test. Data are presented as mean ± SD. $P < 0.05$ was considered statistically significant. Sample size was calculated from a preliminary study including 10 anesthesiologists who performed CC with or without a backboard. Our preliminary study identified a SD of 5 mm in compression depth, which was taken into account in the present study. A power of at least 90% and a significance level of 0.05 calculated a sample size of 23 participants. We decided to include all 25 doctors employed in the department.

The average length of participant clinical experience in anesthesia was 3.2 ± 3.3 years. All participants were male, with a mean age of 28.4 ± 3.6 years, and had performed CPR an average of 13.4 ± 9.2 times per person. Mean height and weight were 172.1 ± 3.8 cm and 68.0 ± 9.5 kg, respectively.

Twelve participants performed the first CC sequence with a backboard, and 13 participants commenced without a backboard. Mean compression depth significantly increased with the backboard (4.9 ± 0.4–5.4 ± 0.3 cm, $P < 0.0001$) (Table 1), and the mean difference in compression depth between the two groups was 5 mm. This difference corresponded to a significantly higher mean proportion of compressions >50 mm for individual participants with the backboard (53.6% ± 32.3%–81.8% ± 15.0%, $P < 0.0001$) (Table 1). No significant differences were observed in compression rate (105.3 ± 5.0–106.0 ± 5.4 per min) (Table 1).

The AHA or ERC guidelines traditionally recommend the use of a backboard, despite insufficient evidence for or against the use of backboards during CPR in soft hospital beds [5]. Air-filled mattresses should be deflated when performing CPR. Several studies showed increased depth of chest compression with the use of a backboard [8, 9]. Mattresses used in the operation room are generally thinner than those used in a standard hospital bed. The effect of the slight mattress on the depth of CC has not yet been validated, and no study has examined this factor for an operating table with a relatively thin pressure-distributing mattress [10]. We simulated operating room cardiac arrest on a resuscitation manikin placed in a standard operating table with a pressure-distributing mattress. The principal finding in this study was a significant increase in chest compression depth [mean difference, 5 mm (49 vs. 54 mm)] with the application of a backboard.

There are some limitations to this study. The use of a resuscitation manikin introduces variation in weight, stature, and compliance of the thorax compared to humans. The fact that no extra weight was added to the manikins to simulate the weight of an average adult is also disadvantageous, as this could affect load distribution on the operating surface.

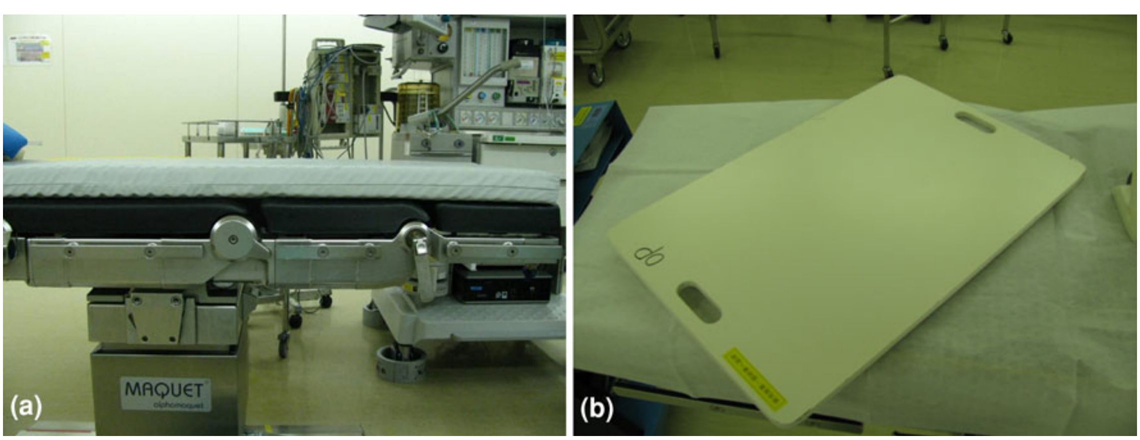

Fig. 1 **a** Operation bed with pressure-distributing mattress. **b** Backboard used in our study

Table 1 Chest compression data recorded during 30 times of external chest compressions performed by male doctors ($n = 25$) on a resuscitation manikin

	Without backboard	With backboard	*P* value
Compression depth (cm)	4.9 ± 0.4	5.4 ± 0.3	$P < 0.000001$
Proportion of compressions of the correct depth[a] (mean %)	53.6 ± 32.3	81.8 ± 15.0	$P < 0.00001$
Compression rate (per minute)	105.3 ± 5.0	106.0 ± 5.4	$P = 0.31$

All data are presented as mean ± SD

[a] Correct depth was defined as a chest compression depth >50 mm

In conclusion, a rigid backboard significantly increases CC depth for CPR performed on an operating table with a pressure-distributing mattress.

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