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Selected Topics: Prehospital Care

EFFECT OF AUTOMATED SIMULTANEOUS STERNOTHORACIC CARDIOPULMONARY RESUSCITATION DEVICE ON HEMODYNAMICS IN OUT-OF-HOSPITAL CARDIAC ARREST PATIENTS

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□ **Abstract—Background: An automatic simultaneous sternothoracic cardiopulmonary resuscitation (SST-CPR) device is an apparatus that performs CPR by providing simultaneous cyclic compressions of the thorax with a thoracic strap and compression of the sternum with a piston. Objective: This study was conducted to compare the hemodynamic effects of CPR with an automatic SST-CPR device to those with standard CPR (STD-CPR) in cardiac arrest patients. Methods: A randomized trial was performed on victims of out-of-hospital cardiac arrest resistant to initial 20 min of CPR after emergency department (ED) arrival. Patients were instrumented with femoral arterial and internal jugular venous lines before enrollment. Informed consent was waived per protocol. Patients were randomized to SST-CPR or STD-CPR based on the day of the month. The primary outcome was a comparison of the mean estimated coronary perfusion pressure (CPP) between SST-CPR and STD-CPR. The secondary outcome was a comparison of compression arterial systolic pressure, compression arterial diastolic pressure, right atrial systolic pressure, right atrial diastolic pressure, return of spontaneous circulation rate, survival to hospital admission, survival at 30 days, favorable neurologic outcomes at 30 days, and adverse events between two groups. Results: Of 62 patients with non-traumatic, adult, out-of-hospital cardiac arrest who presented to the ED, 24 received CPR with an automatic SST-CPR device (SST-CPR group), and 38 received standard CPR (STD-CPR group). Acquisition and analysis of hemodynamic data were completed in 11 (46%) patients in the SST-CPR group and 14 (37%) patients in the STD-CPR group. Compression arterial systolic pressure, right atrial systolic/diastolic pressures, and end-tidal carbon dioxide tension were not different between the two groups. Median compression arterial diastolic pressure (femoral arterial pressure during relaxation) was 20 mm Hg (mean 22 mm Hg; 95% confidence interval [CI] 5 to 38 mm Hg) and 0 mm Hg (mean −2 mm Hg; 95% CI −21 to 18 mm Hg) in the SST-CPR group and the STD-CPR group ($p = 0.002$), respectively. Median estimated CPP was 10 mm Hg (mean 16 mmHg; 95% CI 1 to 31 mm Hg) and 2 mm Hg (mean 4 mm Hg; 95% CI −4 to 12 mm Hg) in the SST-CPR group and the STD-CPR group ($p = 0.017$), respectively. Conclusions: CPR with an automatic SST-CPR device results in higher estimated CPP compared to standard CPR in patients with non-traumatic, out-of-hospital cardiac arrest.**

□ **Keywords—cardiopulmonary resuscitation; heart arrest; coronary circulation**

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INTRODUCTION

Recently, new medical equipment, diagnostic techniques, and drugs have been developed for the treatment of cardiac arrest. However, despite efforts for improvement in the survival rate of sudden cardiac arrest patients after cardiopulmonary resuscitation (CPR), this rate remains poor (1,2).

During CPR, vital organ perfusion should be adequately maintained. In particular, coronary perfusion pressure (CPP) needs to be maintained above 20 mm Hg to achieve a return of spontaneous circulation (ROSC) (3).

Standard CPR (STD-CPR) (the conventional method of supporting circulation in cardiac arrests) involves repetitive external chest compressions on the lower third of the sternum. Even though the mechanism of blood flow has been debated, it is well accepted that external chest compressions generate only about 15–25% of the normal cardiac output, which is inadequate to achieve ROSC in the majority of patients (4–9).

Since 1980, in an effort to increase the survival rate of sudden cardiac arrest patients, a number of investigators have worked to develop new techniques and new CPR devices that can help generate higher blood flow and improve the survival rate of sudden cardiac arrest patients (10–16).

Hwang et al. developed a new device for automatic sternothoracic cardiopulmonary resuscitation (SST-CPR) composed of two main elements: a central piston and a circumferential thoracic strap (17). The central main piston depresses the sternum at the same time that the thoracic strap circumferentially constricts the thorax (Figure 1). This device was developed based on the hypothesis that simultaneous sternal compression and chest constriction would produce an additive hemodynamic effect (17). We have shown that an automatic SST-CPR device generates higher mean arterial pressure, CPP, and end-tidal carbon dioxide tension ($ETCO_2$) in a canine cardiac arrest model (18).

We performed the present study to determine the hemodynamic effect of SST-CPR vs. STD-CPR in nontraumatic cardiac arrest patients.

MATERIALS AND METHODS

Study Design

This study received the approval of the local ethics committee with a waiver of informed consent. The present study was a prospective, randomized study of patients who presented with cardiac arrest to the tertiary emergency department (ED) between October 2008 and October 2010.

All nontraumatic out-of-hospital cardiac arrest (OHCA) patients aged older than 18 years were eligible for this study. Exclusion criteria were patients aged 18 years or younger, traumatic cardiac arrest, congenital heart anomaly, and admission to the ED by someone other than the Korean emergency medical services.

Randomization and CPR Methods

All cardiac arrest patients who met the criteria were moved horizontally onto a custom bed with an automatic SST-CPR device (X-CPR®; CU Medical Systems, Wonju, Republic of Korea). CPR was initiated by skilled physicians with valid Basic Life Support Provider Certification.

During CPR, endotracheal intubation was achieved, and a mainstream capnograph (Philips M2051A; Phillips Medical Systems, Andover, MA) was connected to measure

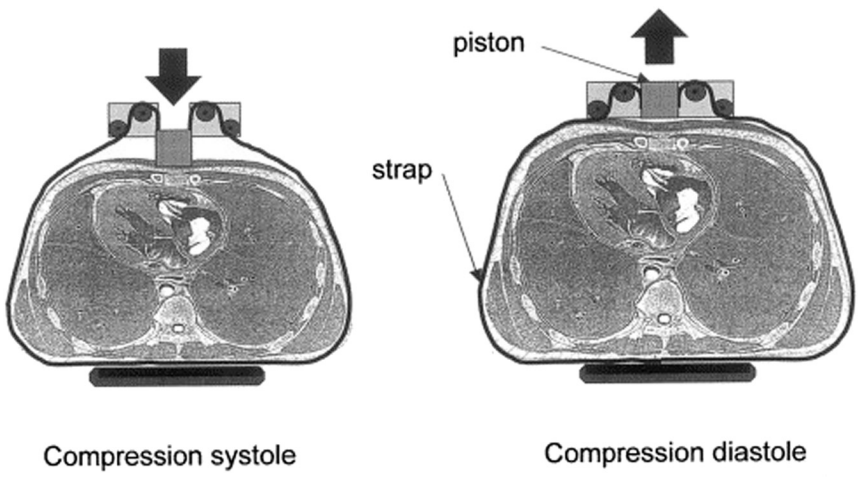

Figure 1. Simultaneous sternothoracic cardiopulmonary resuscitation device.