Injuries in Manual and Mechanical CPR

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INTRODUCTION

There are over 550,000 cardiac arrests in the US every year.[1]
Cardiopulmonary resuscitation (CPR) is the mainstay of treatment, which is a life-saving procedure to restore circulation in victims of cardiac arrest through the combination of chest compressions and ventilations.
Manual chest compressions vary by rate and depth according to the provider's training, size, and strength.[2] In addition, provider fatigue, psychological factors, and difficult settings all play a role in the outcome of CPR. The latter are particularly evident in emergency medical services (EMS), where compressions are often performed on a moving vehicle with transitions between many providers.
The Lund University Cardiopulmonary Assist System (LUCAS™) is an automated device that provides mechanical compressions to combat the variability in manual CPR. The device contains a central arm with a suction cup that attaches to the patient's sternum and provides compressions at a consistent rate and depth, which can be adjusted to meet the provider's local protocol.[3]

The LUCAS™ device applied to a patient

Mechanical compressions are more effective than manual CPR because they eliminate provider fatigue and differences in skill and training. The LUCAS™ device leads to better CPR outcomes but may cause more injury to the patients since it adjusts to provide adequate pressure despite the patient's size and is often left on for longer.[4]

OBJECTIVES

The aim of this study is to conduct a meta-analysis using multiple retrospective cohort studies examining the nature and incidence of injuries sustained in manual CPR and mechanical CPR using the LUCAS™ through post-mortem autopsy analysis of cardiac arrest patients.

METHODS

A literature search was conducted under PubMed.
Research terms: "cardiopulmonary resuscitation, adverse effect, classification, method, mortality, statistical and numerical data, trends, complication, epidemiology, etiology."
Initial screening contained 146 reports with no duplicates. Limitations of inclusion and exclusion eliminated studies before the year 2000, individuals under 18 years of age and living individuals, removing 136 articles for eligibility. 10 studies fit the inclusion and exclusion criteria, with the final 4 being the most relevant to our topic.

RESULTS

Study1: Skeletal and soft tissue injuries after manual and mechanic chest compression.[5]

Results: High rates of skeletal injuries of the chest were present in the LUCAS and manual compression study group. Bi-lateral fractures were noted in both with a significant majority belonging to the LUCAS™ 1 and 2 device group. 12% of the mechanical group presented with sternal fractures, 1.9% were seen in the manual CPR group.

Study 2: CPR-related injuries after manual or mechanical chest compressions with the LUCAS™ device: a multi-centered study of victims after unsuccessful resuscitation.[6]

Results: Rib fractures and sternal fractures demonstrated similar trends. Manual CPR resulted in at least 1 rib fracture 64.6% of the time and 57.3% of the time there were multiple rib fractures. Mechanical compression groups demonstrated 78.8% fractures of at least 1 rib and 65% that had multiple rib fractures. (p=0.02, CL 2.0 Cl 1.11-3.75). Sternal fractures were found in 54.2% of patients with manual CPR and 58.3% of the patients with mechanical CPR. (p=0.56 1.18 cl 0.68-2.04)

Study 3: Traumatic injuries after mechanical cardiopulmonary resuscitation (LUCAS2): a forensic autopsy study.[4]

Results: Frequency of rib fractures and anterior chest lesions were the only statistically significant differences between the groups. There was no significant difference in the rate of sternal fractures between the two groups. Both groups experienced several traumatic injuries to internal organs, including the heart, lungs, and liver, but none were deemed life-threatening. There was no significant difference in the rate of internal organ injuries.

Study 4: Chest compression-associated injuries in cardiac arrest patients treated with manual chest compressions versus automated chest compression devices (LUCAS II).[7]

Results: Manual compression injuries were more common compared to automated compressions, showing an increase in the mean number of rib fractures. The mean was 6.5 in the manual group and 5.9 in the mechanical. However, a higher percentage of patients in the automated group (74.3%) had rib fractures compared to the mechanical group (59.7%). These results were not statistically significant.

RESULTS

	Individuals with sternal fractures	Individuals with rib fractures
Friberg et a..	LUCAS™: 291 (80%) Manual: 20 (38%) P < 0.001	LUCAS™: 349 (96%) Manual: 40 (77%) P < 0.001
Smekal et al.	LUCAS™: 81 (58.3%) Manual: 45 (54.2%) P < 0.555	LUCAS™: 108 (78.8%) Manual: 53 (64.6%) P < 0.021
Lardi et al.	LUCAS™: 9 (35%) Manual: 7 (22%) P = 0.38	LUCAS™: 21 (81%) Manual: 20 (63%) P = 0.07
Ondruschka et al.	LUCAS™: 54 (47.8%) Manual: 136 (27.2%) P not significant	LUCAS™: 84 (74.3%) Manual: 299 (59.7%) P not significant

CONCLUSIONS

Friberg et al. demonstrated higher rates of soft-tissue, muscular, and skeletal injuries among LUCAS™ patients.
Smekal et al. and Lardi et al. demonstrated higher rates of rib fractures among LUCAS™ patients.
Ondruschka et al. demonstrated a non-significant higher incidence of rib injuries among LUCAS™ patients.

There is a higher rate of chest injuries amongst patients receiving CPR with the LUCAS™ device. However, the LUCAS™ device delivers better compressions[8], and the benefits should be considered with the risk of injury.

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