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CASE REPORT

Complications of mechanical chest compression devices

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Case

A 77-year-old woman was found on the street, next to her bike. She appeared to be unconscious, suffering from head injury and had no detectable pulse. Chest compressions were initiated by bystanders until the ambulance arrived. Pulse-less electrical activity (PEA) was observed and a mechanical chest compression device (LUCAS: Lund University Cardiopulmonary Assist System, Jolife, Sweden, Fig. 1) was positioned to deliver chest compressions. Manual mask ventilation was difficult to apply and several attempts were required for tracheal intubation. After two doses of 1 mg of epinephrine return of spontaneous circulation (ROSC) was established.

Upon arrival at the hospital, she remained haemodynamically unstable and a swollen and firm abdomen was observed. Chest radiography revealed massive subdiapharmatic free air (Fig. 2). Emergent laparotomy was performed, which showed a few holes in the stomach indicating blowout injury. At that time, there was no injury to the liver, spleen, or intestines. After performing a resection of the gastric minor curvature, she became clinically stable.

During the following days, however, progressive clinical deterioration ensued due to intestinal ischaemia and two more laparotomies were performed. Because of ongoing deterioration, further treatment was terminated after which she died.

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Discussion

Mechanical chest compression devices (MCCDs) are increasingly used during cardiopulmonary resuscitation (CPR) and they ensure continuous compressions of high quality, even during transportation [1] or during procedures such as percutaneous interventions [2]. Experimental trials have shown improved organ perfusion compared with manual chest compressions in pigs, [3, 4] but a pilot study in humans did not indicate improvement in early survival in out-of-hospital cardiac arrest [5]. Two larger, prospective clinical trials on outcome are ongoing: the LINC trial (NCT00609778) and the PARAMEDIC trial (ISRCTN08233942) [6].

Buschmann et al. described an association between manual chest compressions and various injuries. Rib and

Fig. 1 LUCAS device, with permission of Physio-Control

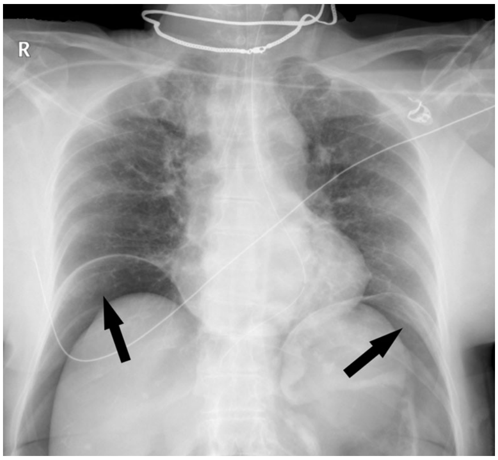

Fig. 2 Chest radiography showing massive air content beneath both diaphragms. (*arrows*)

sternum fractures were reported frequently, as well as injury to the trachea. Much more rare were lesions of the pleura, pericardium and myocardium. Perforations of abdominal organs were also rare, with an incidence of less than 1 % [7].

Among the use of mechanical devices for CPR, injuries are more rare and less well described. In order to put together a complete list of these complications, we conducted a Medline search, which provided 1482 results. After screening on title and abstract, and thereafter on full text, 12 studies were selected. Table 1 presents an overview of the incidence of complications of CPR with the use of MCCDs. Injuries of the skin and fractures of sternum or ribs comprise a high incidence. Only a few case reports mention more serious injuries after mechanical chest compressions [8–10].

Table 1 Complications of mechanical chest compression devices

Injury	Device	Incidence	Reference	Year
Skin lesions	Cardiopump	31 %	Luiz [15]	1996
	LUCAS	42 %	Smekal [11]	2009
Sternal fracture	Cardiopump	0 %	Luiz [15]	1996
	Cardiopump	81 %	Rabl [16]	1996
	Cardiopump	93 %	Baubin [17]	1999
	LUCAS	Case series	Englund [12]	2006
	LUCAS	29 %	Smekal [11]	2009
Rib fractures	Cardiopump	12 %	Luiz [15]	1996
	Cardiopump	81 %	Rabl [16]	1996
	Cardiopump	86 %	Baubin [17]	1999
	LUCAS	Case series	Englund [12]	2006
	LUCAS	47 %	Smekal [11]	2009
Mediastinal bleeding	LUCAS	Case series	Englund [12]	2006
	LUCAS	8 %	Smekal [11]	2009
Epicardial bleeding	LUCAS	10 %	Smekal [11]	2009
Pericardial bleeding	LUCAS	8 %	Smekal [11]	2009
Severe cardiac injuries	Cardiopump	6 %	Rabl [16]	1996
Thoracic aorta injury	LUCAS	Case series	Englund [12]	2006
	LUCAS	3 %	Smekal [11]	2009
Pneumothorax	LUCAS	3 %	Smekal [11]	2009
	LUCAS	Case report	Hutchings [9]	2009
Lung injury	LUCAS	3 %	Smekal [11]	2009
Liver injury	LUCAS	Case series	Englund [12]	2006
	AutoPulse	Case report	Wind [10]	2009
	LUCAS	Case report	De Rooij [8]	2009
	LUCAS	3 %	Smekal [11]	2009
	AutoPulse	Case report	Von Bary [18]	2009
	AutoPulse	Case report	Camden [19]	2011
Spleen injury	AutoPulse	Case report	Wind [10]	2009
Gastric perforation	Cardiopump	Case report	Liu [20]	1996
	LUCAS	Case report	Sajith [14]	2008
	LUCAS	Case report	Platenkamp	2013

It is debatable whether MCCDs lead to more serious injuries compared with manual compressions, because CPR may cause injury in any case. Smekal et al. compared lesions found at autopsy in patients who were resuscitated either manually or mechanically [11]. It should be noted that the mechanically resuscitated patients received manual compressions before the initiation of the device. Furthermore, a study on autopsy concerns the deceased patients and not the survivors. In this study, no differences in the incidence of injury between manual and mechanical groups were described, except for skin lesions, which were more common in mechanical CPR. Pathologists of the University Hospital of Lund suggest an increase in the number and severity of injuries with mechanical CPR. Unfortunately, they do not mention statistics [12].

In the described patient, the combination of difficult ventilation causing gastric air insufflations and the vigorous LUCAS device compressions most probably led to blowout injury of the stomach. In a review of all case reports of described gastric ruptures after CPR, Spoormans et al. discovered 67 case reports of gastric perforation after cardiopulmonary resuscitation (CPR) [13]. Common risk factors for this complication were bystander-provided basic life support (BLS), use of mask ventilation and difficult airway management. These factors are all associated with gastric distention due to air aspiration. This combined with the force provided by chest compressions may lead to perforation of the stomach. Thus far, Sajith et al. have described the only case of gastric perforation after CPR using the LUCAS device [14].

The risk of complications from CPR never outweighs the benefit of return of spontaneous circulation. Knowing the risks is important for treatment issues after ROSC, because both manual and mechanical CPR may lead to injuries. In unstable patients after CPR, physicians should be aware of rare complications such as abdominal injury of liver, spleen and stomach or injury to the great vessels.

Conclusion

Mechanical chest compression devices are increasingly used during CPR. They provide uninterrupted and reliable chest compressions and may lead to a better outcome compared with manual chest compressions. The most reported complications of this therapy are skin or skeletal injury, but more serious injuries and life-threatening complications are described. We report a case in which a serious complication of a mechanical chest compression device led to clinical deterioration and eventually death, after an initially successful resuscitation. Physicians should be aware of these possible severe complications of mechanical chest compression devices if patients remain clinically unstable after CPR.

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References

1. Olasveengen TM, Wik L, Steen PA. Quality of cardiopulmonary resuscitation before and during transport in out-of-hospital cardiac arrest. Resuscitation. 2008;76:185–90.
2. Larsen AI, Hjornevik A, Bonarjee V, Barvik S, Melberg T, Nilsen DW. Coronary blood flow and perfusion pressure during coronary angiography in patients with ongoing mechanical chest compression: a report on 6 cases. Resuscitation. 2010;81:493–7.
3. Steen S, Liao Q, Pierre L, Paskevicius A, Sjoberg T. Evaluation of LUCAS, a new device for automatic mechanical compression and active decompression resuscitation. Resuscitation. 2002;55:285–99.
4. Rubertsson S, Karlsten R. Increased cortical cerebral blood flow with LUCAS; a new device for mechanical chest compressions compared to standard external compressions during experimental cardiopulmonary resuscitation. Resuscitation. 2005;65:357–63.
5. Axelsson C, Nestin J, Svensson L, Axelsson AB, Herlitz J. Clinical consequences of the introduction of mechanical chest compression in the EMS system for treatment of out-of-hospital cardiac arrest-a pilot study. Resuscitation. 2006;71:47–55.
6. Perkins GD, Brace S, Gates S. Mechanical chest-compression devices: current and future roles. Curr Opin Crit Care. 2010;16:203–10.
7. Buschmann CT, Tsokos M. Frequent and rare complications of resuscitation attempts. Intensive Care Med. 2009;35:397–404.
8. de Rooij PP, Wiendels DR, Snellen JP. Fatal complication secondary to mechanical chest compression device. Resuscitation. 2009;80:1214–5.
9. Hutchings AC, Darcy KJ, Cumberbatch GL. Tension pneumothorax secondary to automatic mechanical compression decompression device. Emerg Med J. 2009;26:145–6.
10. Wind J, Bekkers SC, van Hooren LJ, van Heurn LW. Extensive injury after use of a mechanical cardiopulmonary resuscitation device. Am J Emerg Med. 2009;27:1017–2.
11. Smekal D, Johansson J, Huzevka T, Rubertsson S. No difference in autopsy detected injuries in cardiac arrest patients treated with manual chest compressions compared with mechanical compressions with the LUCAS device–a pilot study. Resuscitation. 2009;80:1104–7.
12. Englund E, Kongstad PC. Active compression-decompression CPR necessitates follow-up post mortem. Resuscitation. 2006;68:161–2.
13. Spoormans I, Van HK, Balliu L, Jorens PG. Gastric perforation after cardiopulmonary resuscitation: review of the literature. Resuscitation. 2010;81:272–80.
14. Sajith A, O'Donohue B, Roth RM, Khan RA. CT scan findings in oesophagogastric perforation after out of hospital cardiopulmonary resuscitation. Emerg Med J. 2008;25:115–6.
15. Luiz T, Ellinger K, Denz C. Active compression-decompression cardiopulmonary resuscitation does not improve survival in patients

with prehospital cardiac arrest in a physician-manned emergency medical system. J Cardiothorac Vasc Anesth. 1996;10:178–86.
16. Rabl W, Baubin M, Broinger G, Scheithauer R. Serious complications from active compression-decompression cardiopulmonary resuscitation. Int J Legal Med. 1996;109:84–9.
17. Baubin M, Sumann G, Rabl W, Eibl G, Wenzel V, Mair P. Increased frequency of thorax injuries with ACD-CPR. Resuscitation. 1999;41:33–8.
18. von Bary C, Hohenester S, Gaa J, Laugwitz KL. Liver laceration associated with the use of a chest compression device. Resuscitation. 2009;80:839.
19. Camden JR, Carucci LR. Liver injury diagnosed on computed tomography after use of an automated cardiopulmonary resuscitation device. Emerg Radiol. 2011;18:429–31.
20. Liu N, Boyle K, Bertrand C, Bonnet F. Stomach rupture during CPR. Ann Emerg Med. 1996;27:105–6.