CQ16 Is it useful to use postmortem images to determine organ damage due to cardiopulmonary resuscitation?

Grade of recommendations: C1

Postmortem images are useful in cases of cardiopulmonary arrest without trauma. There are differences in the frequency of organ damage that occurs when cardiopulmonary resuscitation is performed manually and when it is performed using an automatic chest compression device (LUCUS®, AutoPulse®). Do not mistakenly interpret organ damage caused by cardiopulmonary resuscitation as an antemortem injury.

Explanation----------

Background

In cardiopulmonary resuscitation for out-of-hospital cardiopulmonary arrest, there is a method where the victim is placed in a supine position and the precordial chest is subjected to manual pressure. In recent years, various automatic chest compression devices have been developed and their usefulness has been reported, while complications have also been reported.

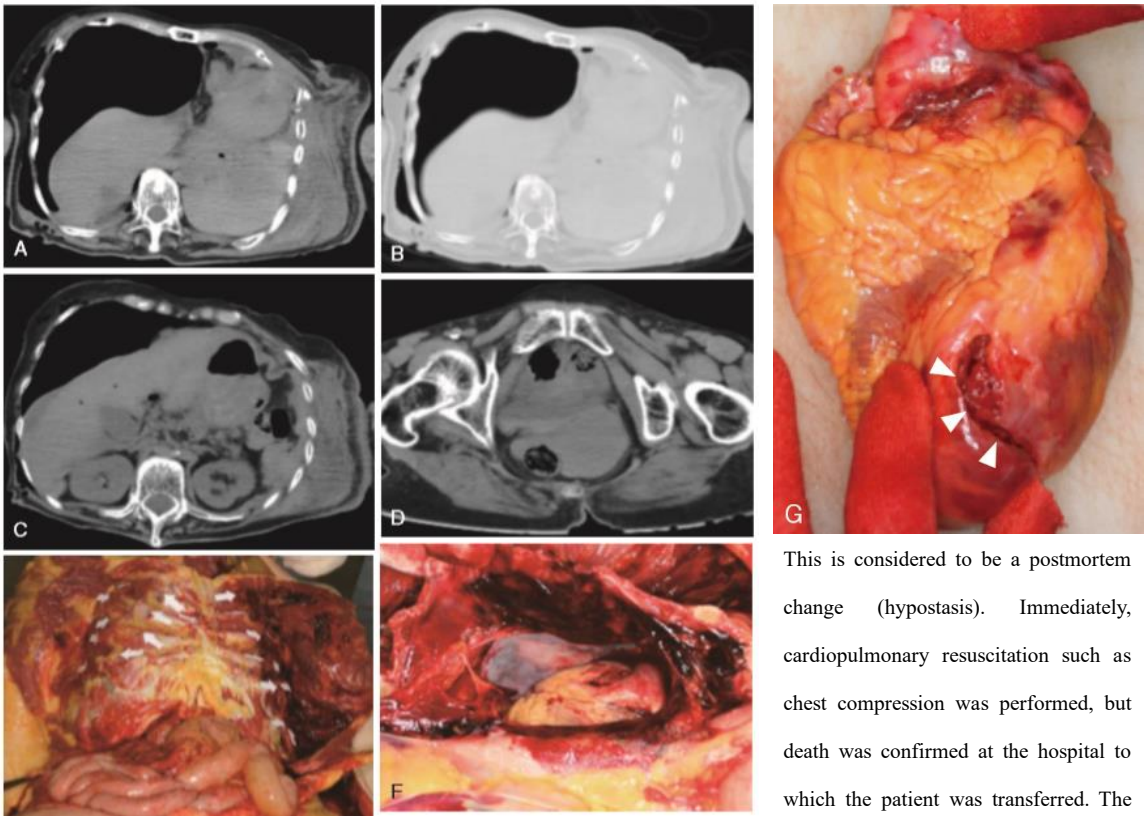
Image findings

Cardiopulmonary resuscitation for cardiopulmonary arrest includes chest compression and positive pressure ventilation. There are many reports of organ damage that become apparent after resuscitation [1, 2]. In addition to rib/sternal fracture (CQ15), thoracic pericardial hematoma [2-4], myocardial injury [2], coronary artery injury (embolism) [2], aortic dissection [2], inferior vena cava injury [2], mediastinal hemorrhage [2], pneumothorax/pneumomediastinum [2, 5], pleural fluid retention/hemothorax [2, 4], lung injury [2], and abdominal liver injury [2, 3, 6] have been reported. As the cardiopulmonary resuscitation becomes longer, more intravascular gas is observed [7], and intravascular gas is observed not only in the blood vessels and hepatic veins [8], but also in the skull [9,10] (CQ7). Many studies are still ongoing to investigate whether intravascular gas in non-trauma death flows into blood vessels during cardiopulmonary resuscitation or occurs after death due to causes other than putrefaction.

Regarding the severity of organ damage, no significant differences were observed between manual cardiopulmonary resuscitation and those performed using an automatic chest compression device [3]. However, when an automatic chest compression device was used, liver damage [3, 11-13] was frequently observed, and intraperitoneal hemorrhage, retroperitoneal hemorrhage, and intraperitoneal free gas were statistically significantly increasing in incidence when compared to manual precordial compression [14]. Of the automatic chest compression devices, LUCUS® does not cause more serious

organ damage than manual precordial compression. AutoPulse® has been reported to cause serious organ damage [11]. Although postmortem angiographic CT make it easier to identify the site of injury [15], it has not been concluded that it is possible to determine whether it is an antemortem injury or postmortem injury.

Figure Severe collateral damage from cardiopulmonary resuscitation



This is considered to be a postmortem change (hypostasis). Immediately, cardiopulmonary resuscitation such as chest compression was performed, but death was confirmed at the hospital to which the patient was transferred. The posmortem CT shows multiple rib fractures, right pneumothorax, left mediastinal deviation, left hemothorax (coagulation), massive bleeding in the subcutaneous muscles of the left chest and back, and right subcutaneous emphysema(A-C). Liquid retention (D) was also observed in the abdominal cavity, and intra-abdominal organ damage was suspected. With the autopsy, a wide range of fractures are observed in the chest, but no bleeding is observed in the fractures of the right thorax, and bleeding is observed in the muscle covering the left thorax that communicates with the chest cavity (E). A rupture was observed on the front surface of the left lobe of the liver (under the xiphoid process), and 430 ml of blood fluid was accumulated in the abdominal cavity. The pericardium was greatly dehisced, the heart averted to the left pleural cavity (F), and a 340 ml of blood containing clot was accumulated in the left pleural cavity. A large rupture was observed on the anterior wall of the heart to the apex (G). Histopathological examination revealed a heart rupture after myocardial infarction.

It is considered that the severe collateral damage caused by cardiopulmonary resuscitation modified the pathology at the time of death.

Literature search formula and literature selection (2019/6/28)

PubMed

#	Search formula	Number of documents
1	Search (((((("postmortem CT") OR "postmortem MRI") OR "postmortem imaging") OR "post-mortem CT") OR "post-mortem MRI") OR "postmortem imaging"	827
	Search (#1) AND CPR	16

Ichushi (Medical Journal)

#	Search formula	Number of documents
1	(死後 mri/AL) and (PT=原著論文,会議録除く)	15
2	(死後 ct/AL) and (PT=原著論文,会議録除く)	191
3	((心肺蘇生法/TH or 心肺蘇生術/AL)) and (PT=原著論文,解説,総説,図説,Q ＆A,講義,会議録除く)	6,281
4	#1 and #3	0
5	#2 and #3	16

From other than search formula

[1], [2], [15]

References

[1] Meron G et al: Cardiopulmonary resuscitation-associated major liver injury. Resuscitation 2007; 75: 445-453 (Level 4b)

[2] Miller AC et al: A systematic review and pooled analysis of CPR-associated cardiovascular and thoracic injuries. Resuscitation 2014 85: 724-731 (Level 4b)

[3] Ondruschka B et al: Chest compression-associated injuries in cardiac arrest patients treated with manual chest compressions versus automated chest compression devices (LUCAS II): a forensic autopsy-based comparison. Forensic Sci Med Pathol 2018; 14: 515-525 (Level 4b)

[4] Watanabe S et al: Classification of hemopericardium on postmortem CT. Leg Med 2015; 17: 376-380 (Level 4b)

[5] Kashiwagi Y et al: Computed tomography findings of complications resulting from cardiopulmonary resuscitation. Resuscitation 2015; 88: 86-91 (Level 4b)

[6] Pinto DC et al: Manual and automated cardiopulmonary resuscitation (CPR): a comparison of associated injury patterns. J Forensic Sci 2013; 58: 904-909 (Level 4b)

[7] Halbertsma FJ et al: Prevalence of systemic air-embolism after prolonged cardiopulmonary resuscitation in newborns: a pilot study. Resuscitation 2015; 93: 96-101 (Level 4b)

[8] Offiah CE et al: Post-mortem CT and MRI: appropriate post-mortem imaging appearances and changes related to cardiopulmonary resuscitation. Br J Radiol 2016; 89: 20150851 (Level 4b)

[9] Shiotani S et al: Nontraumatic postmortem computed tomographic demonstration of cerebral gas embolism following cardiopulmonary resuscitation. Jpn J Radiol 2010; 28: 1-7 (Level 5)

[10] Takahashi N et al: Examination of postmortem and cardiopulmonary resuscitation findings in 360 cases of postmortem CT (autopsy imaging). Jpn J Clin Radiol 2008; 53: 1840-1845 (Level 4b) (Japanese)

[11] Koster RW et al: Safety of mechanical chest compression devices AutoPulse and LUCAS in cardiac arrest: a randomized clinical trial for non-inferiority. Eur Heart J 2017; 38: 3006-3013 (Level 4b)

[12] Olds K et al Injuries associated with resuscitation: an overview. J Forensic Leg Med 2015; 33: 39-43 (Level 4b)

[13] Smekal D et al: CPR-related injuries after manual or mechanical chest compressions with the LUCAS TM device: a multicentre study of victims after unsuccessful resuscitation. Resuscitation 2014; 85: 1708-1712 (Level 4b)

[14] Koga Y et al: Effects of mechanical chest compression device with a load-distributing band on post resuscitation injuries identified by post-mortem computed tomography. Resuscitation 2015; 96: 226-231 (Level 4b)

[15] Zerlauth JB et al: Surgical interventions with fatal outcome: utility of multi-phase postmortem CT angiography. Forensic Sci Int 2013; 225: 32-41 (Level 4b)