



## Case report

## Liver laceration related to cardiopulmonary resuscitation



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## ABSTRACT

Cardiopulmonary resuscitation (CPR) is recognized as a medical procedure performed to maintain vital functions of a person whose cardiac and respiratory functions have stopped. Chest compression is the most essential component of CPR and it is performed on the lower half of the sternum. During CPR, many complications may occur because of chest compressions, especially chest injuries including sternum and rib fractures. Rarely tracheal injury, rupture of the stomach, or liver or spleen injury may also occur as complications.

In this study, we present two cases of liver injury caused by resuscitation. With this article, we want to emphasize the importance of making correct chest compressions.

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## 1. Introduction

Cardiopulmonary resuscitation (CPR) is recognized as a medical procedure performed due to maintain vital functions of a person whose cardiac and respiratory functions have stopped. Chest compression is the most essential component of CPR and it is performed on the lower half of the sternum. During CPR, many complications may occur because of chest compressions, especially chest injuries including sternum and rib fractures. Rarer complications include tracheal injury, gastric rupture or injury to solid organs (liver and spleen).<sup>1,2</sup>

In this study, two cases of liver injury caused by resuscitation have been presented and the subject has been discussed in the light of actual literature.

## 1.1. Case 1

A 26 year old female patient with complaints of chest pain, palpitations, and sudden collapse, was brought to the Emergency Department by the 112 emergency resuscitation team. During the

examination, due to the diagnosis of an arrest, CPR was started. After 60 min of not responding to CPR, the patient was recognized as exitus and the suspicious death was reported. In the autopsy performed due to the suspicious death, no findings related to the trauma was detected. However, in the examination of the thorax a 6 × 8 cm big soft tissue bleed was observed on the right side of the inner surface of the ribs. It was found that the left 1st–4th ribs and the right 2nd–5th ribs, were broken on the midclavicular line. This was thought to happen during the process of resuscitation. Having opened the abdomen, 700 cc of blood was aspirated. In the inner abdominal examination, a 7 cm long blunt laceration was detected 0.5 cm deep to the surface of right lobe of the liver. In addition, a 3 × 4 cm big subcapsular hematoma was observed on the diaphragm side of the laceration (Fig. 1). Moreover, blood leakage was found in the liver, in the area close to the gallbladder, where veins enter and exit from liver. Having analyzed findings from the scene examination, internal and external findings from the autopsy and judicial investigation files, it was suggested that the reason for death was sudden heart disease (acute arrhythmia).

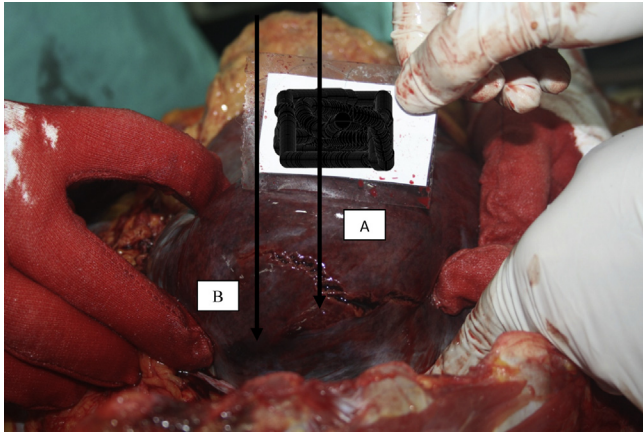
## 1.2. Case 2

A 65 year old male truck driver who collapsed due to cardiac arrest was resuscitated at the scene by the 112 emergency resuscitation team. Since he did not respond to resuscitation, he was

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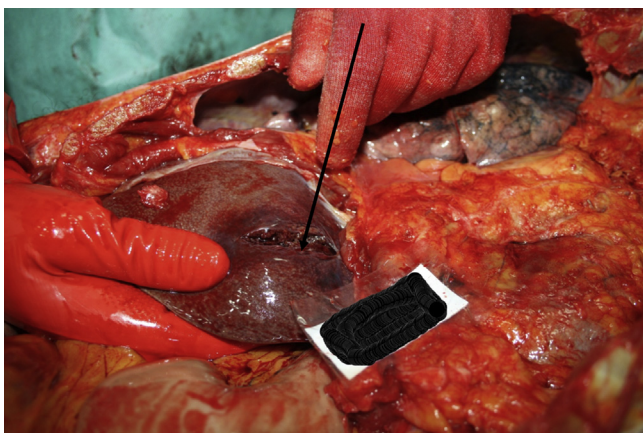


**Fig. 1.** Case 1; 7 cm long blunt laceration was detected 0.5 cm deep on the surface of right lobe of the liver (A) and 3 × 4 cm big subcapsular hematoma was observed on the diaphragm side of the laceration (B).

recognized as exitus. In the autopsy performed fractures were found on the midclavicular lines of the left and right 4th, 5th, and 6th ribs. Ecchymoses was observed around the fractures. These injuries were thought to be related to the resuscitation. Moreover, it was found that the heart had been dilated and a stent had been inserted 1 cm from the output of the left coronary artery and it had been blocked distally. The area 2 cm from the output of the right coronary artery was blocked with atheromatous plaques while the distal part at the output of the right coronary artery was found to be completely blocked. Having opened the abdomen, an intraperitoneal hemorrhage was found and 1 L of blood was aspirated from the abdomen. Furthermore, a 3.5 cm laceration with surrounding ecchymosis, which matched to the projection of the xiphoid process, was found in the liver (Fig. 2). The reason for death was thought to be the sudden heart disease (heart attack). The laceration on the upper part of the left lobe of the liver might happen during the resuscitation process (injuries caused by xiphoid process).

## 2. Discussion

Chest compression is the most vital component of CPR. Its importance for resuscitation and number increases every day. The European Resuscitation Council (ERC) and The American Heart Association, are recognized as important institutions, and



**Fig. 2.** Case 2; A 3.5 cm long laceration with an ecchymotic around, which matched to the projection of the xiphoid process, was found in the liver.

recommend chest compressions of 4–5 cm at a rate of 100–120 beats/min.<sup>3</sup> Chest compression is a traumatic procedure and any complication more serious than soft tissue trauma (rib-sternum fractures, internal organ injuries, etc.) is undesirable.<sup>4,5</sup> Chest compression application can vary depending on condition of the applicator and the location and this condition can alter the degree of complication.

Chest wall injury is the most common complication related to CPR. That is why rib and sternum fractures are frequently observed cases.<sup>1</sup> Despite the fact that fractured ribs usually do not cause additional injuries, multiple rib fractures or segmental fractures may become a main reason of injury to other organs.<sup>4</sup> In the cases we present, multiple rib fractures have been found and they caused injury to solid organs.

Intra-abdominal injuries are rare resuscitation complications. However, many organs may be affected. Liver and spleen laceration, gastric dilatation and gastric perforation are encountered. Moreover, intestinal trauma, intraperitoneal bleeding, and retroperitoneal hematomas have been recorded as complications. In the literature, liver damage is seen at an incidence of ~0.6–3% and is the most frequent intra-abdominal complication related to CPR.<sup>6–14</sup>

Liver laceration was recorded in two of our cases and is observed more often on the left lobe. The most important factor in this is the close anatomical relationship between the left lobe of the liver and the sword-shaped lower end of the sternum. A similar laceration was seen in our cases. Two other important factors that can increase the risk of liver laceration are hepatic ischemia and liver distension due to venous obstruction.<sup>6–14</sup> The reason for liver laceration in our case was thought to be similar. Moreover, treatments with antiplatelet, antithrombotic, and thrombolytic agents in patients with myocardial infarction may cause lacerations.<sup>7,8,14</sup>

Proper use of CPR techniques may reduce rib fractures and thus, may also decrease injuries of adjacent organs. Umach and Underdorfer<sup>15</sup> noticed that localization of hands during the chest compression application and the strength of compressions may be the reason of organ injuries related to CPR. Meron et al emphasized the importance of the resuscitation team and their qualifications and pointed out that despite their training, most complications mentioned occur after CPR is applied by the qualified team and that even if the resuscitation team does chest compressions slightly, it may still cause organ injuries.<sup>12</sup> The case of liver laceration related to the automatic external defibrillator presented by Camden and Carutti<sup>13</sup> is essential to showing that organ injuries do not only depend on the resuscitation team's performance.

However, no matter the reason, CPR is a procedure applied in order to bring patients back to life and increase their chance of surviving, which can also result in complications leading to patients' death. It should not be forgotten that CPR done correctly can still cause organ injuries or fatal complications and at the same time, it should be known that compressions violent enough to break the rib or sternum can harm many organs and reduce the chance of survival. That is why it is the physicians' responsibility to have good knowledge of the resuscitation process, to be well qualified, and to be careful not to cause organ injuries while performing the resuscitation.

## Conflicts of interest

The authors declare that there are no potential conflicts of interest.

## Acknowledgments

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## References

1. Black CJ, Busuttill A, Robertson C. Chest wall injuries following cardiopulmonary resuscitation. *Resuscitation*. 2004;63:339–343.
2. Machii M, Inaba H, Nakae H, Suzuki I, Tanaka H. Cardiac rupture by penetration of fractured sternum: a rare complication of cardiopulmonary resuscitation. *Resuscitation*. 2000;43:151–153.
3. Kim MJ, Park YS, Kim SW, et al. Chest injury following cardiopulmonary resuscitation: a prospective computed tomography evaluation. *Resuscitation*. 2013;84:361–364.
4. Boz B, Erdur B, Acar K, Ergin A, Turkcuier I, Ergin N. Frequency of skeletal chest injuries associated with cardiopulmonary resuscitation: forensic autopsy. *Ulus Travma Acil Cerrahi Derg*. 2008;14:216–220 [Article in Turkish].
5. Jude JR, Kouwenhoven WB, Knickerbocker GG. Cardiac arrest. Report of application of external cardiac massage on 118 patients. *J Am Med Assoc*. 1961;178:1063–1070.
6. Krischer JP, Fine EG, Davis JH, Nagel EL. Complications of cardiac resuscitation. *Chest*. 1987;92:287–291.
7. Kaplon-Cieslicka A, Kosior DA, Grabowski M, Rdzanek A, Huczek Z, Opolski G. Coronary artery dissection, traumatic liver and spleen injury after cardiopulmonary resuscitation - a case report and review of the literature. *Arch Med Sci*. 2013;9:1158–1161.
8. Rosen J, Tucheck JM, Hartmann JR. Liver laceration in the hemodynamically unstable post-cardiac massage patient: early recognition and management—case report. *J Trauma*. 1999;47:408–409.
9. Adams HA, Schmitz CS, Block G, Schlichting C. Intra-abdominal bleeding after myocardial infarction with cardiopulmonary resuscitation and thrombolytic therapy. *Anaesthesist*. 1995;44:585–589 [Article in German].
10. Pezzi A, Pasetti G, Lombardi F, Fiorentini C, Iapichino G. Liver rupture after cardiopulmonary resuscitation (CPR) and thrombolysis. *Intensive Care Med*. 1999;25:1032.
11. Druwe PM, Cools FJ, De Raedt HJ, Bossaert LL. Liver rupture after cardiopulmonary resuscitation in a patient receiving thrombolytic therapy. *Resuscitation*. 1996;32:213–216.
12. Meron G, Kurkciyan I, Sterz F, et al. Cardiopulmonary resuscitation-associated major liver injury. *Resuscitation*. 2007;75:445–453.
13. Camden JR, Carucci LR. Liver injury diagnosed on computed tomography after use of an automated cardiopulmonary resuscitation device. *Emerg Radiol*. 2011;18:429–431.
14. Ziegenfuss MD, Mullany DV. Traumatic liver injury complicating cardiopulmonary resuscitation. The value of a major intensive care facility: a report of two cases. *Crit Care Resusc*. 2004;6:102–104.
15. Umach P, Unterdorfer H. Massive organ injuries resulting from resuscitation measures. *Beitr Gerichtl Med*. 1980;38:29–32 [Article in German]. [Abstract].