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Clinical report

Damage control surgery in blunt cardiac injury

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Background: Blunt cardiac injury (BCI) is a rare, but life threatening injury. The treatment of BCI is surgical repair. However, in a BCI patient with hypothermia, acidosis, and coagulopathy, an attempt to control the bleeding completely by surgery alone may not be successful. Damage control principles should be used in this situation.
Objective: To study a BCI patient who underwent a successful operation using damage control principles.
Methods: We reviewed and analyzed the patient's chart, operative notes and follow up visit records. Review of the literature regarding the issue was also conducted.
Results: We report the case of a patient with BCI who developed hypothermia and coagulopathy during surgery. Abbreviated surgical repair was performed with a right pleuropericardial window created to avoid blood accumulation in the pericardial sac. Subsequent aggressive resuscitation was performed in the intensive care unit. We accepted ongoing bleeding through the right chest tubes while correction of hypothermia and coagulopathy was undertaken. The bleeding was gradually stopped once the patient's physiology was restored. Although the patient developed a retained right hemothorax requiring subsequent video-assisted thoracoscopic surgery on the third postoperative week, he recovered uneventfully and was discharged on postoperative day 36.
Conclusion: In patients with BCI who develop coagulopathy during surgery, terminating the operation quickly and creating a pleuropericardial window is a possible bailout solution because this can prevent postoperative cardiac tamponade without leaving the chest open. Continue bleeding from the chest tubes is acceptable provided that adequate resuscitation to correct coagulopathy is underway.

Keywords: Blunt cardiac injury, damage control, pleuropericardial window

Blunt cardiac injury (BCI) is an uncommon injury with a reported incidence of 0.02%–2% [1-3]. Two life-threatening forms of BCI requiring immediate surgical treatment are free wall rupture and cardiac tamponade [4]. Since the early 1980s, "damage control surgery" (DCS) has been widely accepted in management of severely injured patients, resulting in improved outcomes [5, 6]. However, few investigators have described DCS techniques in thoracic injuries, particularly in cardiac injuries [7-10]. We report a case in a patient with blunt cardiac rupture detected 24 hours after the injury who developed hypothermia and coagulopathy during a surgical repair. Abbreviated surgical repair was accomplished with a right pleuropericardial window created to avoid blood accumulation in the pericardial sac. This approach helped us terminate the operation and allowed subsequent aggressive resuscitation to be performed in the intensive care unit (ICU).

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Case report

A 38 year-old male patient sustained a motorcycle accident with a blunt torso trauma. He was initially treated at a private hospital, where he was found to be hypotensive with questionable abdominal signs. He underwent immediate exploratory laparotomy, which was negative for intra-abdominal injuries. Subsequently, the patient was resuscitated with intravenous fluid, blood product, and inotropic drug administration in the ICU. Nevertheless, he remained persistently hypotensive. Therefore, he was transferred to our hospital 24 hours after the accident.

At our emergency department, the patient was already intubated, but awake, alert, and cooperative. His blood pressure was 80/50 mmHg, and pulse rate 140 per minute. Although his neck veins were not distended, he had a high central venous pressure of 22 cmH_2O. Focused assessment with sonography for trauma (FAST) revealed a large amount of pericardial

fluid causing cardiac tamponade (**Figure 1**). Therefore, the patient was taken promptly to the operating room for median sternotomy. Upon opening the pericardium, a large amount of unclotted blood was encountered in the pericardial sac. The bleeding wound in the heart, a 1.5 cm laceration at the right atrium–superior vena cava junction, was controlled with a Satinsky vascular clamp and sutured with 4–0 polypropylene (**Figure 2**). However, the bleeding continued from the suture line requiring multiple additional suture repairs. After 1 hour, the patient was hypothermic (body temperature 35°C), acidotic (pH 7.2, base excess—17), and coagulopathic (international normalized ratio 3.59), with diffuse bleeding from the heart wound and raw surfaces. The heart per se was swollen with multiple petechiae. Therefore, we decided to end the operation quickly by (1) packing the right atrial wound with 5 sheets of Surgicel, (2) creating a right pleuropericardial window, (3) inserting 2 right chest tubes and 2 pericardial drains, and (4) closure of the sternotomy wound without closing pericardium (**Figure 3**). The peak airway pressure increased from 24 cmH_2O before the closure to 27 cmH_2O after the closure. The operative time was 2 hours 30 minutes and the estimated blood loss was 2,000 cc.

Figure 1. A focused assessment with sonography for trauma (FAST) performed at the emergency department demonstrated a large amount of pericardial blood (*) causing left ventricular compression.

Figure 2. The right atrium including the appendage was clamped with a Satinsky vascular clamp to control the bleeding from a 1.5 cm laceration at the right atrium–superior vena cava junction (not demonstrated here).

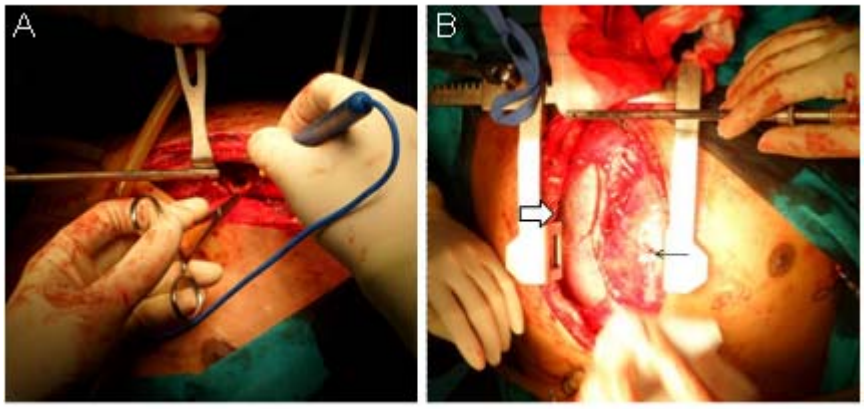

Figure 3. **A:** A right pleuropericardial window was created by opening the right mediastinal pleura using electrocautery. **B:** After creating the right pleuropericardial window, the right lung (white arrow) could be seen through the window. At this point, the heart (black arrow) was swollen with multiple petechiae.

In the ICU, the patient was aggressively resuscitated with blood product transfusion, external warming devices, and warm saline irrigation through a nasogastric tube and a Foley catheter. The patient continued to bleed via the right chest tubes at a rate of 100–200 cc/hour; nevertheless, bed side echocardiography did not show any pericardial blood collection or signs of cardiac tamponade. The bleeding ceased after correction of hypothermia and coagulopathy was accomplished at 48 hours postoperatively. The patient received 23 units of packed red blood cells, 35 units of fresh frozen plasma, 16 units of platelets, and 40 units of cryoprecipitate in the first 48 hours. He was extubated on postoperative day 6 and subsequently transferred out of the ICU. He developed a retained right hemothorax, requiring video-assisted thoracoscopic surgery (VATS) to remove the clot on the third postoperative week. Afterwards, the patient recovered uneventfully and was discharged on postoperative day 36. At three months follow up, he was able to resume his normal activity with no signs of complication. The patient graciously provided his written informed consent for publication of this case report.

Discussion

BCI is a rare injury for trauma surgeons, because most of the patients barely survive their accidents [2]. Among the patients who reach a hospital, 18%–79% had cardiac arrest [1-3, 11, 12]. The mortality rates of BCI range from 27% to 89%; the higher mortality rates were reported in a series with a higher incidence of cardiac arrest upon arrival [1-3, 11, 12]. Although the most common manifestation of BCI is cardiac tamponade; the classical Beck's Triad—muffled heart sounds, jugular venous distention, and hypotension—is rarely seen [2, 3]. The presence of unexplained hypotension after blunt torso trauma should prompt suspicion of BCI and cardiac tamponade [2, 3]. A diagnosis of BCI can be made rapidly by FAST or echocardiography, which may show pericardial fluid or collapsed heart chambers, as seen in our patient [2, 11]. Nan and colleagues found that FAST did not detect BCI in 3 out of 11 (27%) patients with blunt cardiac rupture; and these 3 patients required further diagnostic tests (i.e., echocardiography, computed tomography, and surgical exploration) to confirm the diagnosis [3]. Accordingly, negative FAST results cannot entirely exclude BCI, and further investigations may be needed in a patient suspected to have BCI.

The definitive treatment of blunt cardiac rupture is surgical repair [1-3]. The choice of incision can be either median sternotomy, which gives excellent exposure to the heart in relatively stable patients, or left anterolateral thoracotomy, which provides rapid access to the heart and left lung in unstable patients, but may give inadequate exposure to certain parts of the heart (namely, the right atrium and right ventricle) [2]. Because the right atrium and right ventricle are the two most common chambers injured in blunt cardiac rupture (66%–72%), median sternotomy seems to be an incision of choice in these patients [2, 3]. In the presented patient, a median sternotomy incision was performed, giving us a good exposure to the heart, especially the right atrium where the injury was found.

Damage control, introduced in the early 1980s, has been widely accepted as a principle to treat

exsanguinating abdominal trauma patients who show signs of physiological exhaustion (i.e., hypothermia, acidosis, and coagulopathy) because it is associated with decreased mortality rates [5, 6]. This approach comprises (1) abbreviated surgery to rapidly control hemorrhage and contamination, (2) restoration of patient's physiology in the ICU, and (3) subsequent definitive surgery [6]. Recently, the use of DCS has been expanded from abdominal injuries to thoracic injuries; however, none of the studies using DCS principles in thoracic injuries demonstrated significant improvement in survival [7, 8, 10]. The techniques described in DCS for thoracic injuries include cardiac stapling [13], pulmonary tractotomy [7], packing [10], and temporary chest wall closure [8-10]. Temporary chest wall closure methods described in the literature are (1) skin closure only, (2) en masse closure of chest wall (to decrease the bleeding from the chest wall), and (3) silastic sheet or "Bogota bag" closure (to avoid thoracic compartment syndrome) [7-10]. Vargo and Battistella reported the use of temporary chest wall closure in 11 trauma patients who underwent emergency thoracotomy; two had thoracic compartment syndrome as a reason to use this method, one developed cardiac compressive shock and the other had airway hypertension upon rib approximation [8]. Packing of the thoracic cavity, unlike abdominal packing, cannot be liberally employed without causing adverse effects on cardiopulmonary physiology because of increased intrathoracic pressure [6]. However, when packing is used with temporary chest closure, the airway pressure may not be increased significantly [10].

In the present patient, we encountered diffused bleeding from the raw surfaces and the right atrial wound in a cold, acidotic, coagulopathic patient. We did not use excessive packing to the heart beside some sheets of Surgicel because we were concerned about cardiac compression. An attempt to obtain complete hemostasis surgically in this situation may have resulted in prolonged operation, further bleeding, worsening physiology, and exsanguinations. Instead, we left the pericardium open, created a right pleuropericardial window, and closed the sternotomy to allow the blood drainage to the right pleural cavity and out of the patient via the right chest tubes. We believe that this approach provided several advantages in this particular patient including (1) helping us terminate the operation quickly; (2) avoiding blood accumulation in the pericardial sac and cardiac tamponade, giving us time to resuscitate and correct coagulopathy in the ICU, and (3) avoiding a reoperation. With this approach, we could avoid thoracic compartment syndrome and cardiac tamponade after the operation. Although the patient developed a retained right hemothorax requiring subsequent VATS, we consider this a minor complication.

In conclusion, we believe that terminating the operation quickly and creating a pleuropericardial window may be a bailout solution for coagulopathic patients with cardiac injury. This approach can prevent postoperative cardiac tamponade without leaving the chest open. Continued bleeding from the chest tubes placed in the corresponding pleural cavity is acceptable, so long as adequate resuscitation, and correction of hypothermia and coagulopathy are underway.

The authors have no conflict of interest to report.

References

1. Martin TD, Flynn TC, Rowlands BJ, Ward RE, Fischer RP. Blunt cardiac rupture. J Trauma. 1984; 24: 287-90.
2. Perchinsky MJ, Long WB, Hill JG. Blunt cardiac rupture. The Emanuel Trauma Center experience. Arch Surg 1995; 130:852-6.
3. Nan YY, Lu MS, Liu KS, Huang YK, Tsai FC, Chu JJ, et al. Blunt traumatic cardiac rupture: therapeutic options and outcomes. Injury. 2009; 40:938-45.
4. Schultz JM, Trunkey DD. Blunt cardiac injury. Crit Care Clin. 2004; 20:57-70.
5. Stone HH, Strom PR, Mullins RJ. Management of the major coagulopathy with onset during laparotomy. Ann Surg. 1983; 197:532-5.
6. Rotondo MF, Schwab CW, McGonigal MD, Phillips GR 3rd, Fruchterman TM, Kauder DR, et al. Damage control: an approach for improved survival in exsanguinating penetrating abdominal injury. J Trauma. 1993; 35:375-82.
7. Wall MJ Jr, Villavicencio RT, Miller CC, Aucar JA, Granchi TA, Liscum KR, et al. Pulmonary tractotomy as an abbreviated thoracotomy technique. J Trauma. 1998; 45:1015-23.
8. Vargo DJ, Battistella FD. Abbreviated thoracotomy and temporary chest closure: an application of damage control after thoracic trauma. Arch Surg. 2001; 136: 21-4.
9. Rotondo MF, Bard MR. Damage control surgery for thoracic injuries. Injury. 2004; 35:649-54.

10. Lang JL, Gonzalez RP, Aldy KN, Carroll EA, Eastman AL, White CQ, et al. Does temporary chest wall closure with or without chest packing improve survival for trauma patients in shock after emergent thoracotomy? J Trauma. 2011; 70:705-9.
11. Kato K, Kushimoto S, Mashiko K, Henmi H, Yamamoto Y, Otsuka T. Blunt traumatic rupture of the heart: an experience in Tokyo. J Trauma. 1994; 36: 859-63.
12. Alanezi K, Milencoff GS, Baillie FG, Lamy A, Urschel JD. Outcome of major cardiac injuries at a Canadian trauma center. BMC Surg. 2002; 2:4.
13. Macho JR, Markison RE, Schecter WP. Cardiac stapling in the management of penetrating injuries of the heart: rapid control of hemorrhage and decreased risk of personal contamination. J Trauma. 1993; 34: 711-5.