Trauma Case Reports 11 (2017) 13–17

Contents lists available at ScienceDirect

Trauma Case Reports

journal homepage: www.elsevier.com/locate/tcr

Case report

Importance of the capability for complete resuscitative treatment combining surgery and interventional radiology for potentially lethal multiple injuries: A case report

Hiroyuki Otsuka*, Toshiki Sato, Keiji Sakurai, Hiromichi Aoki, Takeshi Yamagiwa, Shinichi Iizuka, Sadaki Inokuchi

Department of Emergency and Critical Care Medicine, Tokai University School of Medicine, Japan

ARTICLE INFO

Keywords:
Resuscitative treatments
Life-threatening injury
Interventional radiology
Damage control strategy

ABSTRACT

Background: Recently, trauma management has been complicated owing to the introduction of damage-control strategies and interventional radiology. Here, we discuss important aspects regarding survival of patients with severe trauma.

Case presentation: A 74-year-old Japanese woman experienced a traffic accident on a highway. On arrival, paramedics were unable to measure her blood pressure, and her condition deteriorated. The patient was immediately transferred to our hospital in a physician-staffed emergency helicopter, during which she was administered emergency blood transfusions. On admission, her systolic blood pressure was 44 mmHg, and focused assessment with sonography for trauma yielded positive findings at the anterior mediastinum, right thoracic cavity, and intra-abdominal cavity. Plain radiography revealed a partial unstable-type pelvic fracture. Immediately, cardiac tamponade caused by the massive anterior mediastinal hematoma with internal thoracic vessel injuries was diagnosed through a median sternotomy, while a diaphragmatic rupture and hemorrhage from the intra-abdominal cavity were diagnosed through right anterior-lateral thoracotomy. Furthermore, massive bowel and mesenteric vessel injuries were diagnosed through laparotomy; all of these injuries were treated sequentially as a simplified process. The patient then underwent transcatheter arterial embolization for the retroperitoneal hematoma and the pelvic fracture. Reestablishing intestinal continuity was performed after intensive care. All procedures were seamlessly performed by trained emergency physicians, and the postoperative course was uneventful, with the patient recovering completely after rehabilitation.

Conclusions: The capability to perform complete resuscitative treatments that seamlessly combine surgery and interventional radiology in the appropriate order is important for the survival of patients with multiple traumatic injuries.

Background

It is important to accurately decide on and then perform without delay a life-saving management strategy for patients with severe traumatic injury [1]. Recent trauma management protocols have been complicated owing to the introduction of damage control (DC) strategies and interventional radiology (IVR) [2–7].

* Corresponding author at: Department of Emergency and Critical Care Medicine, Tokai University Hospital, 143 Shimo Kasuya, Isehara City, Kanagawa Prefecture, Japan.
E-mail address: hirootsu@is.icc.u-tokai.ac.jp (H. Otsuka).

http://dx.doi.org/10.1016/j.tcr.2017.10.007
Accepted 24 October 2017
Available online 01 November 2017

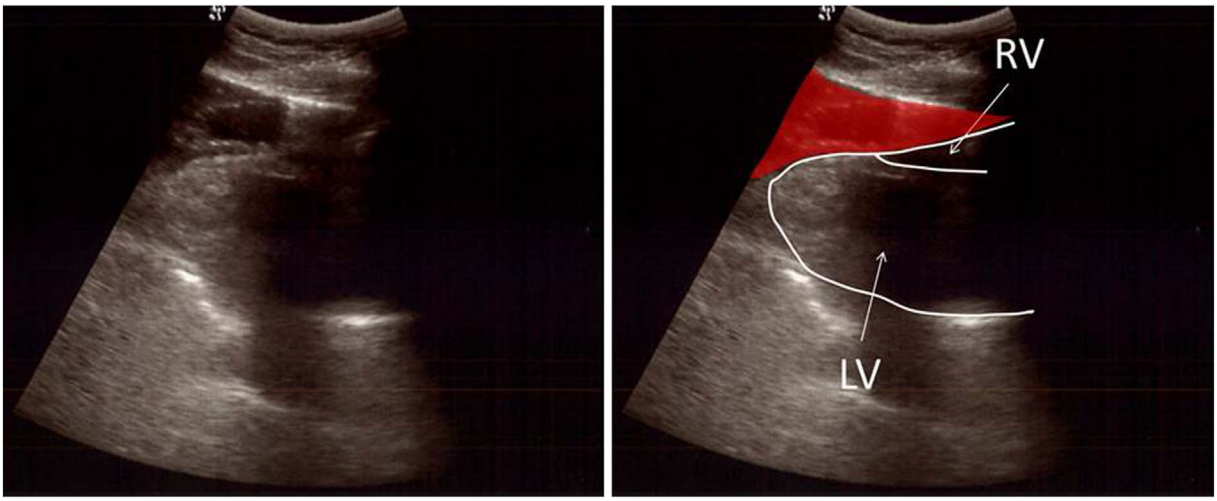

Fig. 1. FAST (focused assessment with sonography for trauma). The right ventricle was crushed slightly by the anterior mediastinal hematoma (red area). RV: right ventricle, LV: left ventricle. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

This case presentation describes the current important factors instrumental in saving the lives of patients with severe trauma.

Case presentation

A 74-year-old Japanese woman experienced a severe traffic accident on a highway. The paramedics could not measure her systolic blood pressure (sBP), and her condition subsequently deteriorated. Consequently, the paramedics urgently requested a trained emergency physician (TEP)-staffed helicopter. Upon arrival at the scene, the TEP performed a focused assessment with sonography for trauma (FAST) and administered emergency transfusions. The FAST indicated trauma in the anterior mediastinum (Fig. 1) and intra-abdominal cavity. After emergency surgery was arranged via radio communication, the patient was immediately transported to our hospital. During transportation, her sBP improved to approximately 100 mmHg.

On admission, her Glasgow coma scale score was E2V2M4, her respiratory rate was 30 breaths per minute, her pulse was 104 beats per minute, and her sBP dropped again to 44 mmHg. Her chief complaint was consciousness disturbance. Hence, a physical examination could not be completed. Laboratory evaluation revealed that her base excess was − 13.4 mmol/L and her D-dimer and serum lactate levels were elevated, at 96.6 μg/mL and 89 mg/dL, respectively. FAST additionally indicated trauma of the right thoracic cavity. Plain radiographs showed a massive hemothorax on the right side and a partial unstable-type pelvic fracture (Tile classification, type B). At this point, the diagnosis comprised the following: cardiac tamponade caused by massive anterior mediastinal hematoma (AMH), hemothorax on the right side, intra-abdominal hemorrhage, and pelvic fracture. Thoracostomy of the right thoracic cavity and median sternotomy were performed about 10 min later in the operating room (OR) of the emergency department (ED), where the massive AMH with internal thoracic vessel injuries was diagnosed and removed, and hemostasis of the internal thoracic vessels was also performed. Simultaneously, a sheath was inserted into the femoral artery to perform resuscitative endovascular balloon occlusion of the aorta (REBOA) for the abdominal and retroperitoneal hemorrhage. Consequently, the patient's sBP was momentarily elevated to 90 mmHg without REBOA; however, shortly thereafter, her sBP dropped to 60 mmHg. Hence, a right anterior-lateral thoracotomy was performed, during which a diaphragmatic rupture (Fig. 2) and hemorrhage into the intra-abdominal cavity were diagnosed. Additionally, immediate laparotomy was performed, where massive injuries to the bowels and mesenteric vessels (Fig. 3) and retroperitoneal hematoma were detected. Subsequently, hemostasis of the mesenteric vessels and bowel resection were performed; thereafter, the patient's sBP remained elevated up to 120 mmHg. After repairing the diaphragmatic rupture and brief closure of the thoracic and abdominal cavities, angiography (Fig. 4) and transcatheter arterial embolization (TAE) were used to treat the retroperitoneal hematoma and pelvic fracture in the angiography suite of the ED. Following TAE, the patient underwent computed tomography and was admitted to the intensive care unit.

The following final diagnoses were made: fractures of the left 6–10th ribs and sternum, hemothorax on the right side, hemopneumothorax on the left side, bilateral lung contusions, cardiac tamponade caused by AMH, left internal thoracic vessel injuries, right-sided diaphragmatic rupture, massive small bowel and mesenteric vessel injuries, retroperitoneal hematoma, partial unstable-type pelvic fracture (Tile classification, type B), fracture of the 5th cervical vertebral body, and fracture of the left 5th transverse process of the lumbar vertebra. Her revised trauma score was 3.4786, while the injury severity score was 57 and probability of survival was 0.0158.

Reestablishing intestinal continuity was performed about 24 h after admission. All procedures listed here were performed seamlessly by TEPs in our hospital. Other injuries were treated conservatively without surgery. The postoperative course was uneventful, and the patient recovered completely after rehabilitation and was discharged 2 months later.

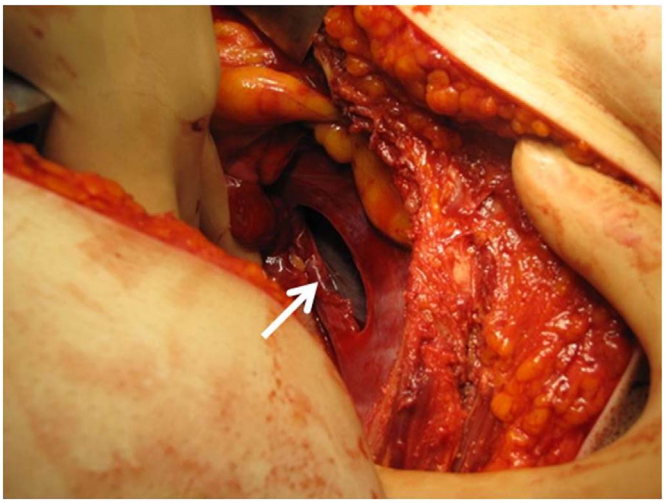

Fig. 2. Right-sided diaphragmatic rupture (arrow).

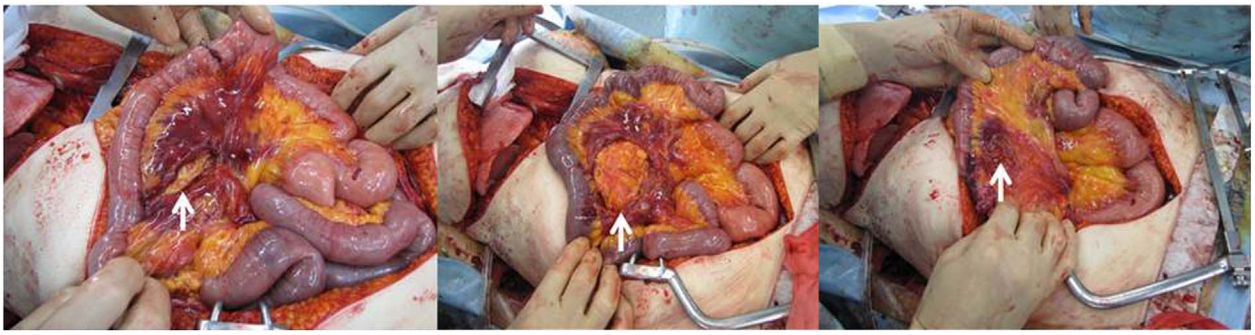

Fig. 3. Injuries to the three parts of the massive bowel and mesenteric vessel (arrow).

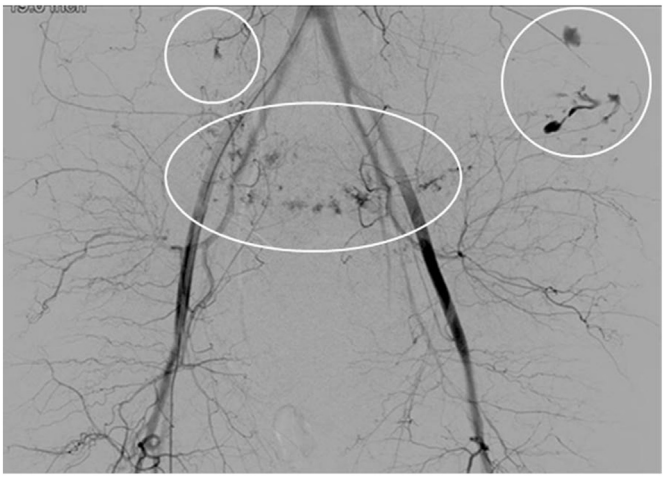

Fig. 4. Angiography findings.
Multiple contrast medium extravasations (circle) from the lumbar artery and branches of the internal iliac arteries can be seen.

Conclusions

Our patient with severe traumatic injury, who was transferred to our hospital via a TEP-staffed helicopter, recovered completely after undergoing resuscitative thoracotomy and laparotomy, TAE, semi-elective reoperation after critical care, and early-phase rehabilitation. All procedures were performed seamlessly by TEPs, who, in our hospital, are physicians specializing in emergency

medicine and general surgery and are also trained in IVR and vascular surgery.

The majority of severe traumas comprise multiple injuries, and it is therefore important to make a judgment on the necessity of resuscitative treatments and also to determine the appropriate order in which to perform them, so as to save the patient's life [8–10]. It is therefore necessary to initiate accurate treatment without unnecessary delay in cases of severe trauma. However, it is also difficult to achieve all surgeries and IVR procedures seamlessly and in the appropriate order.

In reevaluating our case, the most important aspect was that the causes of shock were both hemorrhagic and obstructive in nature, and it was necessary to treat both. After blunt trauma, the obstructive shock caused by AMH was called “extrapericardial cardiac tamponade,” consistent with previous studies [11–13]. It was necessary to immediately drain it and initiate hemostasis to treat its cause simultaneously. In this case, a transfer was requested prior to initiation of other procedures in the field because the patient's BP was slightly elevated from the emergency transfusions. Owing to ordering the preparation of emergency surgery using radio communication, upon the TEP's arrival, the mediastinal hematoma was removed and internal thoracic vessels ligated under median sternotomy. It is known that positive airway pressure leads to cardiac arrest at the time of obstructive shock [14]; hence, this procedure was performed after resecting the hematoma. Resuscitative surgeries for the other causes of hemorrhagic shock were immediately performed sequentially in the following order: right thoracic cavity, intra-abdominal cavity, and retroperitoneum with pelvic fracture prior to performing computed tomography (owing to the fact that the serious shock state had persisted). Simultaneously, a sheath was inserted into the femoral artery to perform REBOA [15,16] for the abdominal and retroperitoneal hemorrhage; however, REBOA was not conducted because the patient's BP stabilized gradually after the resuscitative surgeries. It was also difficult to judge the necessity of performing a right anterior-lateral thoracotomy; however, the procedure was scheduled because many of the blunt traumatic diaphragmatic injuries were accompanied with aortic trauma, lung trauma, splenic trauma, and urinary bladder trauma [17].

IVR is a novel methodology for current trauma management [5–7] that may be useful, as in the present case, for resuscitative procedures, such as resuscitative IVR [6]. IVR is especially effective for injuries in which hemostasis is difficult to attain, even with surgery (such as TAE) for branches of the internal iliac arteries owing to pelvic fracture and rupture of the intercostal and lumbar arteries [5–7]. In this case, it was feasible to select and perform IVR instead of surgery for massive retroperitoneal hematoma bleeding from the lumbar arteries and some branches of the internal iliac arteries.

Management strategies for severe trauma have recently changed. Previously, complete hemostasis with repair of all injuries was the gold standard; however, current trends in the resuscitation strategy for patients with traumatic multiple injuries are the DC strategies [2–4]. The main aim of DC strategies is to treat patients with life-threatening injuries, and it is important to perform not only resuscitative surgery but also permissive hypotension and massive transfusion strategies as DC strategies. DC strategies also include intensive care for recovering from acidosis or coagulopathy after resuscitative surgery and any planned reoperations. Furthermore, DC orthopedics [18] and early rehabilitation [19] are also included in the concept of DC strategies. In this case, the patient's life was saved by administering all treatment in accordance with the DC strategies.

Owing to the incredible progress made in medical equipment, CT and procedures such as IVR have made rapid progress, and as such, they should be used positively. In contrast, if a condition exists, resuscitative surgery for diagnosis and treatment prior to adequate examination is necessary. In the current strategy for severe multiple traumas during the resuscitative phase, discretion is necessary to ensure prompt and seamless resuscitative treatment, which may consist of only surgery, only IVR, or a combination of both. This patient could probably also have been treated using the best practice in which resuscitative thoracotomy, laparotomy, and TAE prior to adequate examination under DC strategies were performed immediately and seamlessly by TEPs in the OR and angiography suites of the ED.

Currently, the capability to perform complete resuscitative treatment by combining surgery and IVR seamlessly in the appropriate order is required to treat patients with multiple potentially lethal traumatic injuries.

References

[1] A. Hirshberg, K.L. Mattox, Top Knife: The Art & Craft in Trauma Surgery, TFM Publishing, Shrewsbury, UK, 2005.
[2] M.F. Rotondo, C.W. Schwab, M.D. McGonigal, G.R. Phillips 3rd, T.M. Fruchterman, D.R. Kauder, et al., ‘Damage control’: an approach for improved survival in exsanguinating penetrating abdominal injury, J. Trauma 35 (1993) 375–382 (discussion 382-3).
[3] E.E. Moore, J.M. Burch, R.J. Franciose, P.J. Offner, W.L. Biffl, Staged physiologic restoration and damage control surgery, World J. Surg. 22 (1998) 1184–1190 (discussion 1190-1).
[4] M.B. Shapiro, D.H. Jenkins, C.W. Schwab, M.F. Rotondo, Damage control: collective review, J. Trauma 49 (2000) 969–978.
[5] S.J.A. Sclafani, Diagnostic and interventional radiology, in: K.L. Mattox, E.E. Moore, D.V. Feliciano (Eds.), Trauma, 7th ed., McGraw-Hill, New York, 2013, pp. 251–300.
[6] E.K. Hoffer, J.J. Borsa, R.D. Bloch, A.B. Fontaine, Endovascular techniques in the damage control setting, Radiographics 19 (1999) 1340–1348.
[7] S. Chakraverty, I. Zealley, D. Kessel, Damage control radiology in the severely-injured patient: what the anaesthetist needs to know, Br. J. Anaesth. 113 (2014) 250–257.
[8] K.L. Mattox, Introduction, background, and future projections of damage control surgery, Surg. Clin. North Am. 77 (1997) 753–759.
[9] F.A. Moore, E.E. Moore, Initial management of life threating trauma. Within: section 7 trauma and thermal injury, ACS Surgery: Principles and Practice, Web MS Scientific American Medicine, Hamilton, Ontario, 2005.
[10] M. Rhodes, Chapter 10: adult trauma resuscitation, in: A.B. Peizman, M. Rhodes, C.W. Schwab, et al. (Eds.), The Trauma Manual: Trauma and Acute Care Surgery, 3rd ed., Lippincott Williams & Wilkins, Philadelphia, 2008, pp. 71–80.
[11] M.C. Gary, F. Ronald, F. Francisco, Extrapericardial cardiac tamponade by a mediastinal hematoma, Chest 95 (1989) 922–924.
[12] H.L. Yong, B.K. Jong, B.P. Chan, Y.C. Si, Extrapericardial cardiac tamponade by a retrosternal hematoma after blunt chest trauma, Eur. J. Cardiothorac. Surg. 41 (2012) 958.
[13] H.K. Kyung, B.C. Jong, H.K. Min, Internal thoracic vein injury presenting as extra pericardial tamponade after blunt trauma, J. Thorac. Cardiovasc. Surg. 145 (2013) 1130.
[14] A.M. Ho, C.A. Graham, C.S. Ng, J.H. Yeung, P.W. Dion, L.A. Critchley, et al., Timing of tracheal intubation in traumatic cardiac tamponade: a word of caution,

Resuscitation 80 (2009) 272–274.
[15] B.K. Gupta, S.C. Khaneja, L. Flores, L. Eastlick, W. Longmore, G.W. Shaftan, The role of intra-aortic balloon occlusion in penetrating abdominal trauma, J. Trauma 29 (1986) 861–865.
[16] R.B. Low, W. Longmore, R. Rubinsein, L. Flores, S. Wolvek, Preliminary report on the use of the percluder occluding aortic balloon in human beings, Ann. Emerg. Med. 15 (1986) 1466–1469.
[17] A.F. Kelly, T.G. Nicole, R.B. Ronald, E.R. Susan, M.W. Jennifer, A.S. Martin, Traumatic diaphragmatic injury in the America College of Surgeons National Trauma Data Bank: a new examination of a rare diagnosis, Am. J. Surg. 209 (2015) 864–869.
[18] H.C. Pape, P. Giannoudis, C. Krettek, The timing of fracture treatment in polytraumapatients: relevance of damage control orthopedic surgery, Am. J. Surg. 183 (2002) 622–629.
[19] D.E. Clark, J.D. Lowman, R.L. Griffin, H.M. Matthews, D.A. Reiff, Effectiveness of an early mobilization protocol in a trauma and burns intensive care unit: a retrospective cohort study, Phys. Ther. 93 (2013) 186–196.