

CASE REPORT

A case of multiple organ injury resuscitated by collaboration of damage control surgery and interventional radiology in hybrid emergency room

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Abstract

Background: Hybrid emergency room systems, namely hybrid ER (HER), enable us to perform computed tomography (CT), surgery, and interventional radiology (IVR) without patient transfer. HER significantly shortened the time to CT after arrival and allowed us to achieve early intervention, resulting in reduced mortality from exsanguination in patients with severe blunt trauma.

Case Presentation: We encountered a patient diagnosed with left common iliac artery occlusion and dissection caused by blunt traumatic compressive abdominal injury with transection of the small intestine, kidney, and adrenal and pelvic ring fractures. Although the patient experienced cardiopulmonary arrest (CPA) immediately after CT, we performed damage control surgery (DCS) and IVR after temporary aortic occlusion in the HER and resuscitated the patient.

Conclusion: The present case, in which rapid diagnosis and intervention were performed and the patient was successfully resuscitated, supports the efficacy of the HER system for managing severe blunt trauma.

KEY WORDS

case report, damage control surgery, hybrid emergency room, interventional radiology, open abdominal management

BACKGROUND

Compared with penetrating trauma, in which the source of bleeding is typically focal and can be relatively easily identified from the appearance, blunt trauma often accompanies multiple organ injuries that are difficult to identify from the appearance. Therefore, CT is indispensable for the accurate diagnosis of severe blunt trauma.

The hybrid ER is a novel trauma resuscitation room that includes a CT scanner and an angiography system. The hybrid ER enables an innovative trauma workflow in which whole-body CT, emergency surgery, and endovascular treatment are conducted immediately and sequentially without the need for time-consuming patient transfer. In August

2011, we developed and installed the world's first hybrid ER and performed all examinations and treatments for trauma resuscitation in a single room.¹ Introduction of a hybrid ER shortens the time required to undergo CT and receive life-saving interventions, resulting in a significant reduction in mortality from exsanguination in patients with severe blunt trauma.²

CASE PRESENTATION

A 64-year-old man presented to our emergency department with a lower abdomen crushed between iron plates weighing approximately 2 tons at work. His past medical history

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included hypertension and hyperlipidemia. His consciousness level on admission was clear, and his vital signs were as follows: blood pressure of 78/53 mm Hg, heart rate, 133 beats per minute; respiratory rate, 25 breaths/min; blood oxygen saturation, 99% (O_2 : 10 L/min); and body temperature, 36.1°C. Physical examination revealed that the pulses of the left dorsalis pedis artery were not palpable, and his left limb was cold.

Although blood circulation was barely maintained in this case, we decided to conduct whole-body enhanced CT next to the primary survey because the hybrid ER enabled safe performance of CT even in patients with hemodynamic instability as long as the airway and breathing were intact. Whole-body enhanced CT was conducted six minutes after arrival. The scan showed active intraperitoneal hemorrhage from the mesentery of the small intestine and kidney; adrenal injury with extravasation; stable pelvic ring fracture (left pubis and ischium); right transverse process fracture of the 1st, 2nd, and 5th lumbar vertebrae; and common iliac artery occlusion and dissection (Figure 1). Laboratory data showed a serum hemoglobin level of 12.1 g/dL, platelet count of $224 \times 10^3/\mu\text{L}$, prothrombin time-international normalized ratio of 1.1, and fibrinogen level of 220 mg/dL. Metabolic acidosis markedly deteriorated with a base excess of -19.1 mmol/L. His Injury Severity Score was 26, the Revised Trauma Score was 6.08, and the probability of survival according to the Trauma and Injury Severity Score method was 63.5%.

After CT, his systolic blood pressure dropped to 50 mm Hg, and crash laparotomy was performed immediately after endotracheal intubation and Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) via the right femoral artery. Because the patient experienced CPA during laparotomy, we performed chest compression, manually clamped the abdominal aorta, and intravenously injected 1 mg of epinephrine. Two minutes after the cardiac arrest, spontaneous and sustained heart rhythm restarted. We soon established REBOA in Zone I and started controlling the

bleeding and contamination for DCS. Intraperitoneal findings showed a tear in the small intestine; the sigmoid was extensively crushed at the root, and bleeding from the small mesentery continued. The retroperitoneal tissue was also severely crushed to an oozing state, and the pulses of the left common iliac artery were not palpable from the bifurcation.

We resected the small intestine (150 cm) without anastomosis and performed a gauze packing of the retroperitoneum. To control damage and intraperitoneal contamination, we selected endovascular treatment for common iliac artery occlusion and performed temporary abdominal closure using ABTHERA™. In addition, we performed transarterial embolization (TAE) for renal and adrenal extravasation using a gelatin sponge. Finally, stent grafting was performed in the left iliac artery (Figure 2).

All examinations and therapeutic procedures were performed within 6 h of arrival: 46 min for surgery, 33 min for TAE, 3 h for stent graft, and 0 min for patient transfer (Figure 3). The intraoperative transfusions included 18 units of packed red blood cells, 20 units of fresh frozen plasma, and 20 units of platelets. A second operation involving ileocecal resection, retroperitoneal tissue repair, and conventional abdominal closure was performed the following day. The patient recovered after overcoming surgical complications and was discharged with only minor gait disturbance on day 143.

DISCUSSION

Conventional trauma management is based on the Advanced Trauma Life Support guidelines, in which only chest and pelvic radiography and focused assessment with sonography for trauma are recommended for physiological assessment in the primary survey.³ Although whole-body CT and interventional radiology are effective for severe blunt trauma, they are not recommended in hemodynamically unstable patients because they are time-consuming procedures.⁴

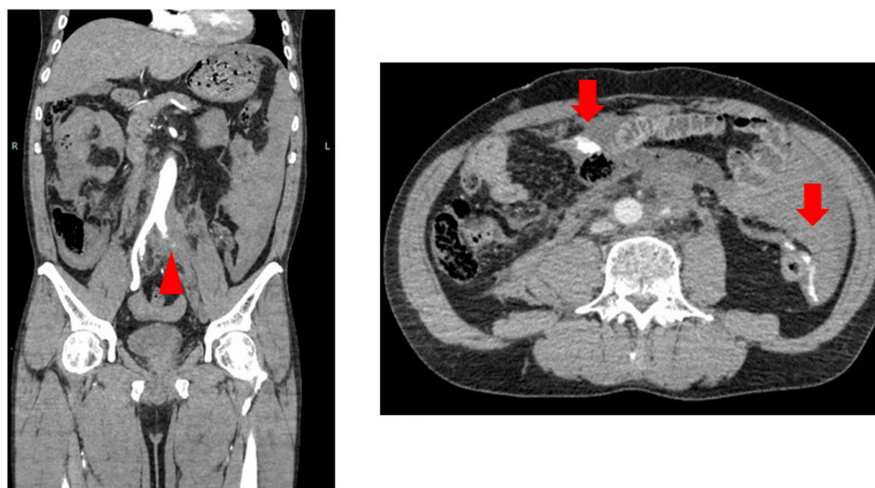


FIGURE 1 CT showed left common iliac artery occlusion (red arrowhead) and active intraperitoneal hemorrhage (red arrows).

The hybrid ER is a novel trauma resuscitation room equipped with a CT scanner and angiography system, that enables trauma surgeons to simultaneously perform both examinations and life-saving procedures. With the installation of the hybrid ER at our facility in 2011, we have dramatically changed our strategy for managing cases of severe blunt trauma. In our novel strategy, we resolved airway and breathing problems in the primary survey and judged whether the patient could tolerate a few minutes of CT scanning. In addition, we skipped chest and pelvic radiography

and FAST because CT could be performed immediately without patient transfer. As in this case, we checked the vital signs and maintained only the peripheral venous lines before the CT. Thus, we shortened the time required for CT scanning and achieved an early therapeutic intervention. This sophisticated decision-making process enables early intervention, leading to reduced exsanguination and decreased mortality in patients with severe trauma.²

Compared to conventional trauma management, the most significant advantage of HER system, in this case, was the ability to make a prompt and precise diagnosis by CT without patient transfer time. We were able to perform CT just 6 min after arrival and recognize kidney injury and common iliac artery occlusion as well as identify the presence of an intra-abdominal hemorrhage from the mesentery of the small intestine. In conventional trauma management, we only rarely detect such retroperitoneal injuries or identify the exact source of intra-abdominal bleeding by echocardiography or X-ray. Therefore, we would have performed laparotomy. After laparotomy, TAE could then be started immediately and preparations for stent graft could then be begun.

With recent innovations in interventional radiology for the treatment of severe trauma, the usefulness of TAE has been reported even in the presence of hemodynamic instability.⁵ TAE has also been reported to be effective in reducing arterial bleeding after DCS in hemodynamically unstable patients.⁶ In the present case, TAE was performed after retroperitoneal gauze packing for renal and adrenal extravasations.

In general, the survival rate of blunt traumatic cardiac arrest is 3.1% and neurological outcomes are extremely poor.⁷ In our case, the patient experienced cardiopulmonary arrest once, but survived and had a good neurological outcome. This may be a benefit of the hybrid ER, where we were able to combine REBOA and DCS for life-threatening bleeding used as a bridge until definitive control of bleeding by surgery could be achieved. Although resuscitative thoracotomy (RT) is commonly used in patients with extreme cardiac arrest for open cardiac massage and aortic cross-clamping, REBOA is increasingly used in severe trauma settings. Although there is little evidence regarding the survival benefit of REBOA compared



FIGURE 2 After stent grafting, angiography showed the re-reflux of blood flow in the common iliac artery.

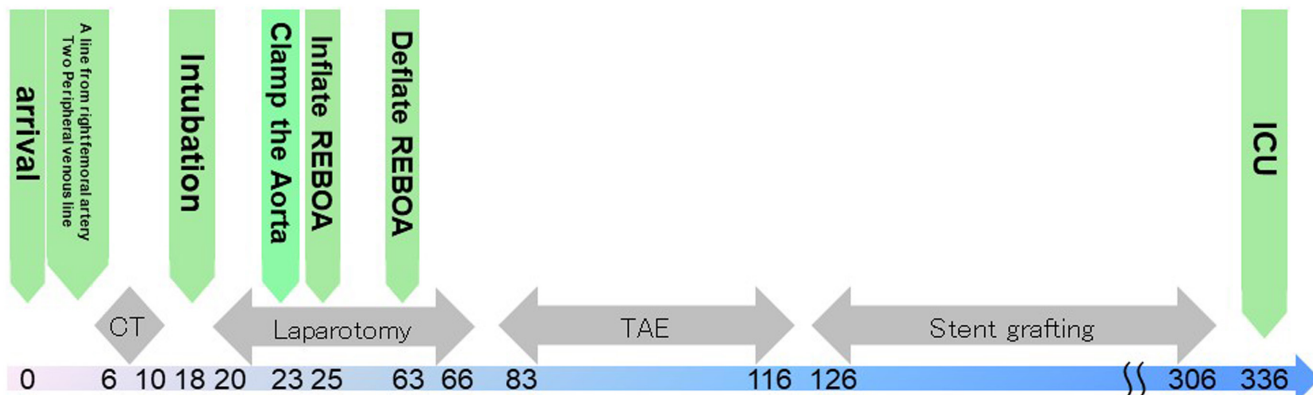


FIGURE 3 The time course of this case from arrival to ICU admission is shown.

with non-REBOA resuscitation, several studies have reported a significant survival benefit of REBOA compared with RT.⁸

Occlusion of the common iliac artery due to blunt trauma is rare, ranging from 0.4% to 7.1%, and only 8 cases have been reported.⁹ The rarity of this injury is largely because the vessels are located in the retroperitoneum and protected by the pelvic girdle.¹⁰ Although an appropriate diagnosis of common iliac artery occlusion tends to be missed or delayed because of its low incidence, atypical presentation, and frequent association with other serious injuries, we were able to diagnose it early and perform intervention without delay. In the present case, although the patient suffered from postoperative ischemia–reperfusion syndrome, resulting in compartment syndrome in the lower limb, which required surgical decompression, he was able to avoid amputation of his leg and did not have severe gait disturbance.

Endovascular treatment offers advantages such as easier access to the target lesion, reduced need for blood transfusions, and elimination of the need for systemic heparin; of the eight patients described above, five underwent endovascular stenting.¹⁰ Endovascular therapy, alone or in conjunction with open surgery, plays an important and expeditious role in the treatment of vascular injuries; however, there is no superiority between endovascular and surgical treatment for iliac artery occlusion.

CONCLUSION

We can make a precise and immediate diagnosis and achieve early intervention in a hybrid ER by combining emergency surgery and interventional radiology. This sophisticated decision-making process may improve the outcomes of patients with severe blunt trauma.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ETHICS STATEMENT

Approval of research protocol: N/A.

Informed consent: Informed consent for publication was obtained from the patient.

Registry and the registration no. of the study/trial: N/A.

Animal studies: N/A.

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How to cite this article: Omoto R, Umemura Y, Kato M, Nakahori Y, Fujimi S. A case of multiple organ injury resuscitated by collaboration of damage control surgery and interventional radiology in hybrid emergency room. *Acute Med Surg.* 2024;11:e925. <https://doi.org/10.1002/ams2.925>