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Case Report

Laparotomy management of diaphragmatic and hollow viscera rupture combined with thoracic endovascular aortic repair after a traffic accident: A case report

Tran Que Son [a,b,1,*], Tran Hieu Hoc [a,1], Le Xuan Than [c], Tran Thu Huong [d], Dong Minh Hung [e], Nguyen Chien Quyet [b], Tran Thanh Tung [b], Vu Duc Long [b]

[a] Department of Surgery, Hanoi Medical University, 1 Ton That Tung Street, Khuong Thuong Ward, Dong Da District, Hanoi, Viet Nam
[b] Emergency Center A9, Bachmai Hospital, 78 Giai Phong Street, Dong Da District, Hanoi, Viet Nam
[c] Vietnam National Heart Institute, 78 Giai Phong Street, Dong Da District, Hanoi, Viet Nam
[d] Department of Pharmacy, Bachmai Hospital, 78 Giai Phong Street, Dong Da District, Hanoi, Viet Nam
[e] Department of Thoracic and Vascular Surgery, Bachmai Hospital, 78 Giai Phong Street, Dong Da District, Hanoi, Viet Nam

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ABSTRACT

Introduction: Road traffic incidents are the most common cause of multiple organ trauma in low- and middle-income countries. Multiple blunt intra-abdominal organs that rupture in conjunction with a ruptured aorta are terrible and rare.
Case presentation: A 65-year-old man sustained critical injuries during a traffic collision between a motorcycle and truck. The Injury Severity Score was 42 points,. After open abdominal exploration, we repaired the left diaphragmatic rupture with a 13-cm-long tear of IV grade (American Association for the Surgery of Trauma), resected partial small bowel, simple suture of the transverse colon, and Hartmann procedure in the descending colon. Thoracic endovascular aortic repair (TEVAR) was performed 22 h after laparotomy. Reconstruction of the head depicting a cheekbone fracture and inferior to the left orbital bone was performed on the 14th day. The patients survived and were discharged from the hospital, at 22 days without morbidity or mortality.
Discussion: Diaphragmatic rupture provides a signal to relate head, thoracic, and abdominal blunt trauma. If the patient sustains more serious life-threatening injuries that require emergency laparotomy or craniotomy, and aortic repair may be delayed. Laparotomy is the best initial surgical method in this case. TEVAR is a feasible and gold standard procedure for the treatment of patients with the necessary indications.
Conclusion: It is essential to evaluate the level of organ damage to properly coordinate the specialists. The timing of the operation and therapeutic alternatives should be decided for each patient.

1. Introduction

Multiple organ trauma is widespread among countries with a variety of public transportation alternatives. Traumatic diaphragmatic rupture (TDR) is not a challenge to diagnose owing to its high-energy force and computed tomography (CT) imaging. This type of damage occurs in 1–7% of patients who sustain severe blunt trauma and in 10–15% of individuals with lower chest penetration [1,2]. This damage appears to be more frequently combined with head, thoracic, and abdominal trauma than to several non-ruptured diaphragmatic injuries [3,4]. As this pathology provides is usually a sign of critical trauma, a comprehensive assessment should be conducted to ensure that the lesion is not missed [1,2]. Blunt thoracic aortic injury is a critical injury related to diaphragmatic tears that has been reported in the literature [1,2,5]. Aortic arch trauma occurs in 2% of patients with blunt trauma. According to current reports, over 80–85% of patients with severe injuries die at the scene of the accident from fatal exsanguination; only 15–20% are transferred to the hospital alive [6,7]. It is critical to avoid missing lesions in multi-organ trauma and to coordinate therapy carefully with specialists.

We present a rare case of a large diaphragmatic rupture with transthoracic gastric herniation, small intestinal perforation, and aortic

* Corresponding author. 1 Ton That Tung Street, Khuong Thuong Ward, Dong Da District, Hanoi, Viet Nam.
E-mail address: tranqueson@hmu.edu.vn (T. Que Son).
[1] Tran Que Son and Tran Hieu Hoc contributed equally to this work either as first authors.

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rupture that was successfully repaired primarily to understand this clinical entity and better comprehend the management of severe multiple trauma. More studies are required to equip surgeons with evidence-based standardised procedures for dealing with this unusual pathology to ensure the best possible patient outcomes.

These results may be useful in both education and clinical practice. This case report was prepared following Surgical Case Report Guidelines 2020 [8].

2. Case presentation

A 65-year-old man sustained critical injuries to his maxillofacial zone, chest, and abdomen during a traffic collision. He was transferred to our emergency medical center on the 14th and operated at the 20th hour after the accident between motorcycle and truck. The patient had tachycardia, with a blood pressure of 110/60 mmHg and oxygen saturation of 97% in room air. The Glasgow Coma Scale was 14, complaining of epigastric abdominal and left thoracic pain. On examination, the patient had slightly decreased breath sounds on the left, with diffuse abdominal tenderness and signs of peritonitis.

The patient suffered from hypertension 2 years back and without previous medical history.

Laboratory examinations revealed that red blood cells 4.61 T/L, white blood cells 15.2 G/L, platelet count 240 G/L, urea 5.6 mmol/L, creatinine 90 μmol/L, glucose 8.62 mmol/L, serum glutamic oxaloacetic transaminase 789.5 U/L, serum glutamic pyruvic transaminase 543.8 U/L, K 4.4 mmol/L, prothrombin 82%, international normalised ratio 1.14, activated partial thromboplastin time 0.97, and fibrinogen 3.13 g/L.

The diagnosis was performed immediately in all acute patients using a radiograph and computed tomography (CT) scan after admission due to multi-organ trauma. Although there was an elevation of the diaphragm on the patient's initial chest radiograph, there was no obvious pneumothorax to be discovered. CT imaging revealed discontinuity of the left hemidiaphragm with intrathoracic herniation of the stomach, greater omentum, and colon (Fig. 2). Contrast-enhanced CT revealed a tear in the aortic arch adjacent (Grade III-AAST) to the origin of the left subclavian and left common carotid arteries (Figs. 2A and 3). The patient had several other traumatic injuries, including multiple complicated fractures of the temporomandibular junction and the left orbital wall (Fig. 1), ascending to the mandible, left-sided rib fractures (Grade II, from 2 to 7 adjacent ribs), left haemothorax, left lower lobe pulmonary contusion (Grade II), and lateral hepatic segment trauma with grade II according to American Association for the Surgery of Trauma (AAST) classification.

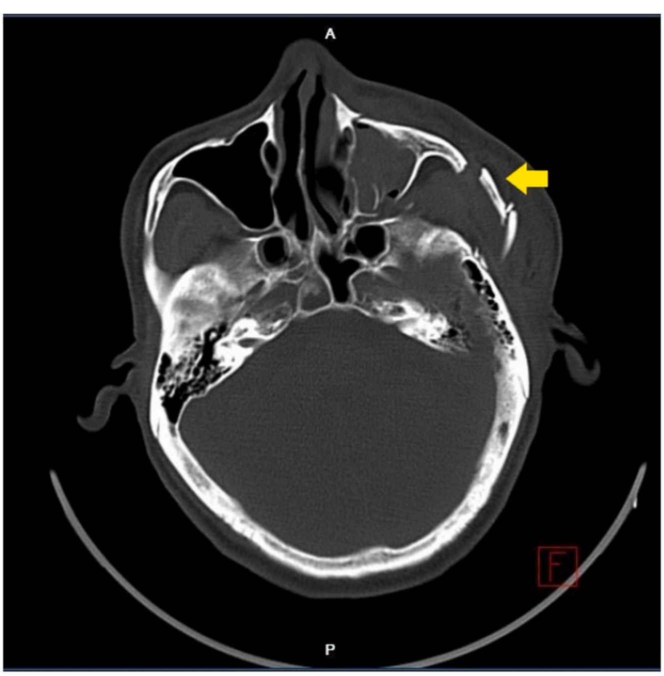

Fig. 1. A fracture of the left cheekbone is revealed by computed tomography of the brain (yellow arrow).

During the hospital stay, the patient underwent three procedures. At the 20th hour after the accident, the emergency abdominal surgery was performed. Abdominal cavity includes a lot of digestive juices. We discovered three rupture sites positioned adjacent to each other in a 20 cm long small intestinal tract (Grade III -AAST) (Fig. 4a). In addition, the right colonic (hepatic) flexure had a laceration with grade I, the sigmoid colon had laceration >50% of circumference without perforation (Grade II) (Fig. 4b). The left lobe of liver contusion with intraparenchymal haematoma was grade II (Fig. 5, Fig. 6). We also discovered a 13-cm-long rupture of the left diaphragmatic grade IV (AAST) (Fig. 5). The gastric and large omentum extends into the left pleural area through this rupture site. The Injury Severity Score (ISS) based on worst injury of six body systems such as head and neck, face, abdomen, extremity (including pelvis), chest, and external worst injury was 42 score. A high score of ISS indicates a severe injury burden with multiple-organ trauma.

We underwent a partially perforated small bowel, and repairing the left diaphragm (Fig. 6). The muscularis mucosae of the transverse colon were sutured. The sigmoid colon was resected with an ischaemic contusion, and Hartmann's method was performed. This procedure was performed by a senior hepatobiliary and digestive surgeon with more than 15-year experience, 100 small bowel resections, 50 colectomies, 100 liver resections, and 50 pancreaticoduodenectomies.

At the 42nd hour, endovascular intervention for aortic arch rupture was performed after laparotomy. Firstly, we underwent carotid–carotid artery crossover bypass surgery via a synthetic vascular graft at our hospital by a thoracic and vascular surgeon (LifeSpan® - ePTFE Vascular Graft – Promepe, LeMaitre Vascular, Inc. 63 Second Avenue. Burlington, MA 01803. The USA) (Fig. 7a). Secondly, the stent-graft was implanted via a femoral artery approach in an operating theatre equipped with a C-arm. A stent graft was placed posterior to the brachiocephalic artery through the left subclavian artery with a stent-graft from Talent (Medtronic) (Figs. 7b and 8) by an experienced interventional cardiologist.

On the 17th day, reconstruction of the head depicting a cheekbone fracture and inferior to the left orbital bone was performed using a 16-hole screw brace (DESC: MINI STRAIGHT 16 HOLE, QTY: 1 EA, MATL: Titanium F-67, LOT-GP180726; MAXI SCREW 2.4 * 8 mm, QTY: 10 EA, MATL: Titanium F-136, LOT-GF171030) and condylar neck fracture using four-hole screw brace (DESC: MAXI PLATE STRAIGHT 4 HOLE, QTY: 1 EA, MATL: Titanium F-67 and MINI SELF DRILLING SCREW 2.0 * 8 mm, QTY: 10EA, MATL: Titanium F-136, LOT: GF170929) manufactured by G SSEM in Korea.

The patient was admitted to the intensive care unit for 10 days. Antibiotics were administered to the patient as follows: meropenem Kabi 1 g (Facta Farmaceutici S. p.A Nucleo Industriale S. Atto, S. Nicolo a Torino, 64100 Teramo) × 3 vials g per 8 h/day, metronidazole Kabi 0.5 g (Fresenius Kabi Bidiphar) × 2 vials/day. For the first 3 days, complete parenteral nutrition was provided by Nutriplex peri 1000 mL (B. Braun Medical AG) × 1 bag and glucolyte 500 mL (Otsuka Pharmaceutical Co., Ltd. Tokushima Itano Factory, Japan) × 2 bottles/day; oral refeeding began on the fourth day in collaboration with intravenous nutrition. We also prevented anticoagulation using an aspirin 81 mg (Aventis Pharma Specialities, France) × 1 pilladministered daily and decreased gastric secretion with Pantoloc 40 mg (Nycomed GmbH – Germany) × 1 vial daily.

Daily blood tests revealed a decrease in the propensity for liver enzymes and no anaemia. On the fourth postoperative day, a CT scan revealed neither cerebral oedema nor intracranial haematoma, and both lungs were deflated. The patient was discharged after 21 days of treatment.

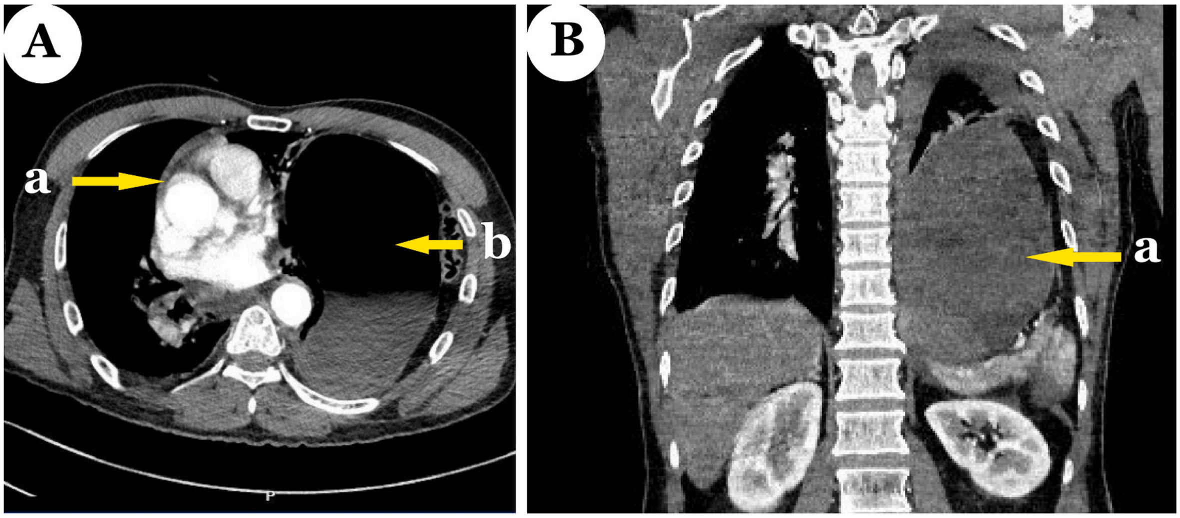

Fig. 2. Intra-abdominal organs are herniated into the pleural cavity via the left diaphragmatic tear (A-b, B-a) and aortic rupture (A-a) with an axial (A) and coronal (B) computed tomography (CT) scan image.

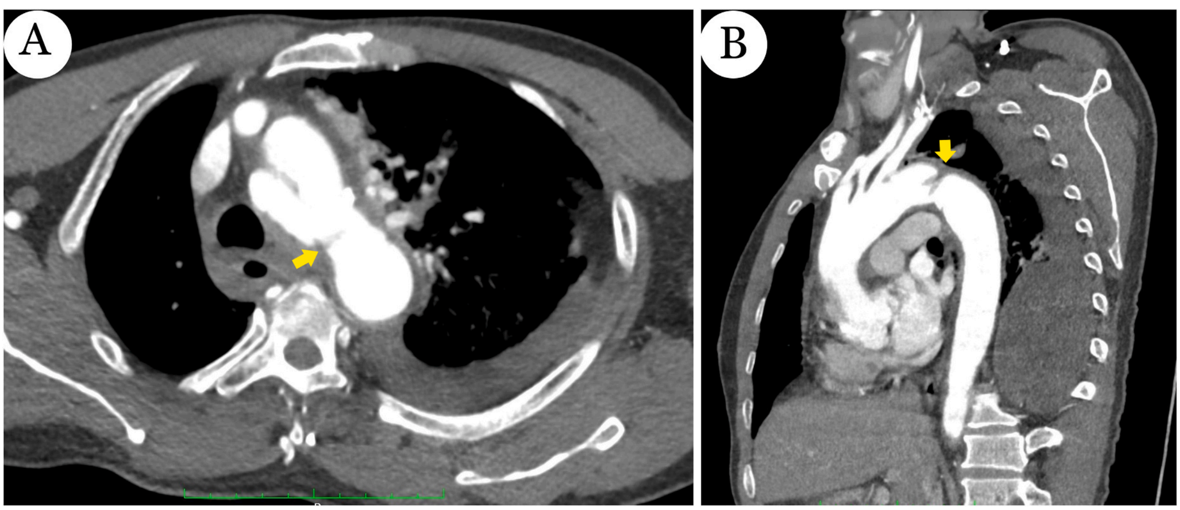

Fig. 3. Thoracic aortic rupture with an axial (A) and coronal (B) computed tomography (CT) scan image.

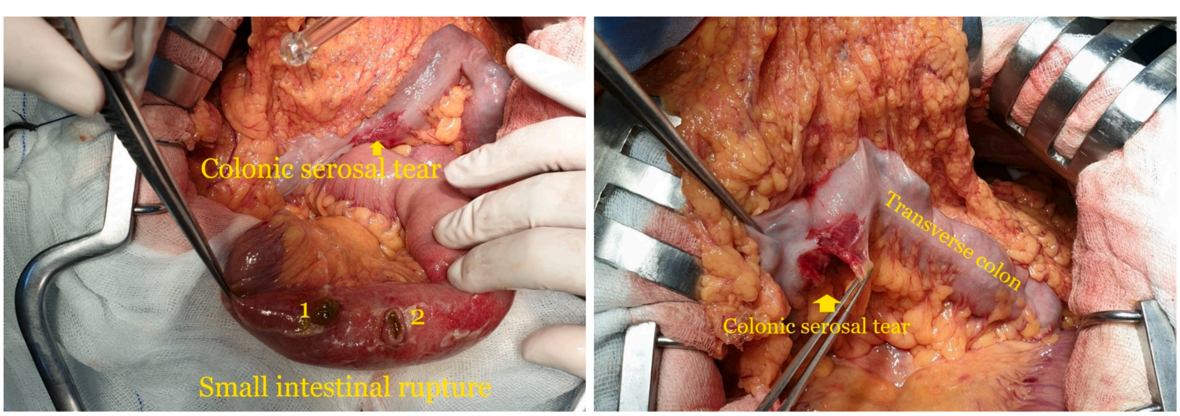

Fig. 4. During surgery, abnormalities are discovered. A (1,2), small bowel rupture in three locations along the same 15-cm-long small bowel loop at the free border. B, transverse colonic mucosa tear.

3. Discussion

Motor vehicle incidents are the most common causes of multiple organ trauma [1]. Vietnam is a low- and middle-income nation with a population of 96.462 million individuals, ranking 15th worldwide and third in Southeast Asia, with the majority of injury-related deaths

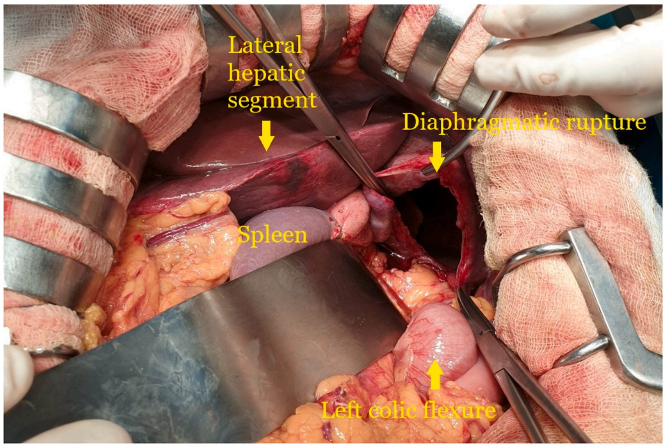

Fig. 5. Left diaphragmatic rupture with a 13-cm-long tear of IV grade (American Association for the Surgery of Trauma).

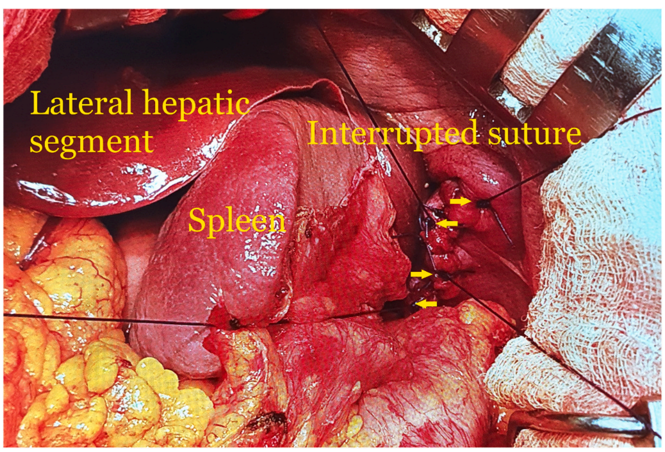

Fig. 6. Reconstruction diaphragmatic rupture with two-layer repair consisting of an inner layer of interlocking horizontal mattress sutures followed by reinforcement with a running non-absorbable suture.

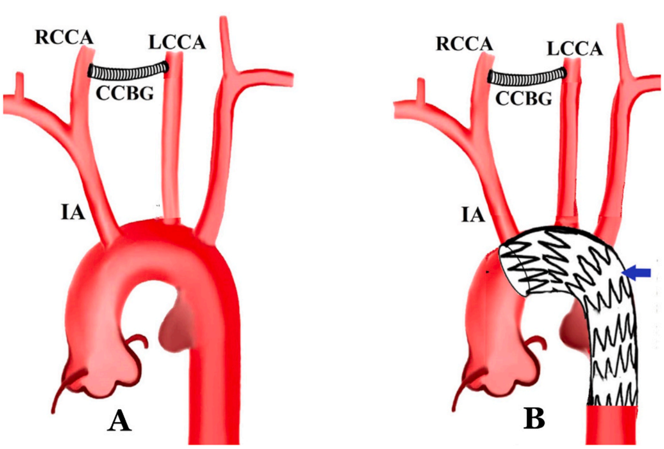

Fig. 7. (A) Illustrative sketch showing carotid-carotid bypass (right to left carotid artery) graft following stage I hybrid aortic repair. (B) Line sketch to illustrate the complete aortic stent graft. CCBG, carotid-carotid bypass graft; IA, innominate artery; LCCA, left common carotid artery; LSCA, left subclavian artery; RCCA, right common carotid artery.

occurring in traffic crashes. Road traffic injuries are rapidly becoming a significant public health challenge [9]. These injuries have increased in frequency during the last 25 years as a result of rapid economic growth and motorisation [10].

Multiple injuries with severe combined lesions have been reported in the literature [1,11,12]. If the lesion is missed or surgery is delayed, diaphragm rupture, small intestine rupture, or aortic arch injury can lead to death. It is necessary to coordinate treatment with a variety of specialisations to completely repair these lesions [4,5]. Thus, all patients were initially treated according to the Advanced Trauma Life Support®: a primary survey (life-threatening injuries) and a secondary survey (possibly life-threatening injuries) [2]. A (airway), B (breathing), C (circulation), D (disability), and E (environment and exposure) were managed during the initial survey. For haemodynamically stable patients, the suspected lesions were imaged using a radiograph, abdominal ultrasound, and CT. Of the large number of traumas, which were identified in this patient, the most critical was aortic arch rupture (2% of patients with blunt trauma), followed by evidence of a left diaphragmatic hernia, in which the stomach and colon migrate to the thorax (Fig. 2), and left lateral hepatic contusion (Fig. 5). CT revealed no evidence of small bowel rupture, such as free air in the abdominal cavity. However, based on the clinical symptoms, we suspected a hollow viscera rupture (fever, abdominal distension, and tenderness all over the abdomen). According to our clinical experience, a patient with blunt abdominal trauma will have pain far away from the injured area, peritoneal tenderness, abdominal wall stiffness, and abdominal fluid, all indicating a hollow visceral rupture.

The TDR is a challenging condition for detection. This damage occurs in less than 0.5% of trauma cases with elevated intra-abdominal pressure (67%) and abdominal trauma (33%). Patients with missed diaphragmatic injuries were detected to have a mortality rate of 10% and a morbidity rate of 30% [1,13]. A high-energy force is necessary for TDR in patients with closed abdominal trauma. The widely accepted theory is that it is produced by a dramatic increase in intra-abdominal pressure. The right diaphragm is built stronger than the left and is partially covered by the liver, which can disperse pressure across a broader surface area [2]. The rate of left-sided TDR following physical trauma has been reported to range from 68% to 87% [1,2,11]. This injury appears to be more commonly associated with head, chest, and abdominal trauma than with several non-ruptured diaphragmatic injuries. Patients with blunt injuries were more likely to sustain injuries to the thoracic aorta (2.9% vs. 0.5%, $p < 0.001$), lungs (48.7% vs. 28.1%, $p < 0.001$), bladder (5.9% vs.7%, $p < 0.001$), and spleen (44.8% vs. 29.1%, $p < 0.001$) [14]. Blunt traumatic diaphragmatic rupture was found to be related to rib fracture ($n = 28$, 73.7%), extremity injury ($n = 16$, 42.1%), liver injury ($n = 14$, 36.8%), splenic injury ($n = 10$, 26.3%), digestive tract injury ($n = 10$, 26.3%), and pelvic fracture in another study ($n = 2$). When it comes to penetrating TDR without a hernia, the “offside sign” is a useful initial examination. The overall mortality was 12.5% with an average ISS of 41.8 points, and blunt injuries had a mortality rate of 21.2% [5]. Predictors of mortality include age, ISS, preoperative shock, and haemodynamic status [15]. As diaphragmatic rupture provides a signal for serious trauma, the doctor should conduct a comprehensive assessment to ensure that the lesion is not missed [1,2].

Due to the significant morbidity and fatality rates associated with TDR, patients with this injury require rapid surgical treatment [2,5,15,16]. Most studies demonstrate that laparotomy is the best initial surgical method [2,15,16]. For defects greater than 2 cm, some authors recommend a two-layer repair consisting of an inner layer of interlocking horizontal mattress sutures followed by reinforcement with a running non-absorbable suture. Greater defects (AAST grades 4–5) may require the use of an artificial mesh to avoid diaphragm tension [16]. We agree with the Eastern Association for the Surgery of Trauma (EAST) that more research is required to provide clinicians with evidence-based standardised approaches for managing this infrequent disorder [1,16]. According to Furak et al., many methods can be used for chronic TDR,

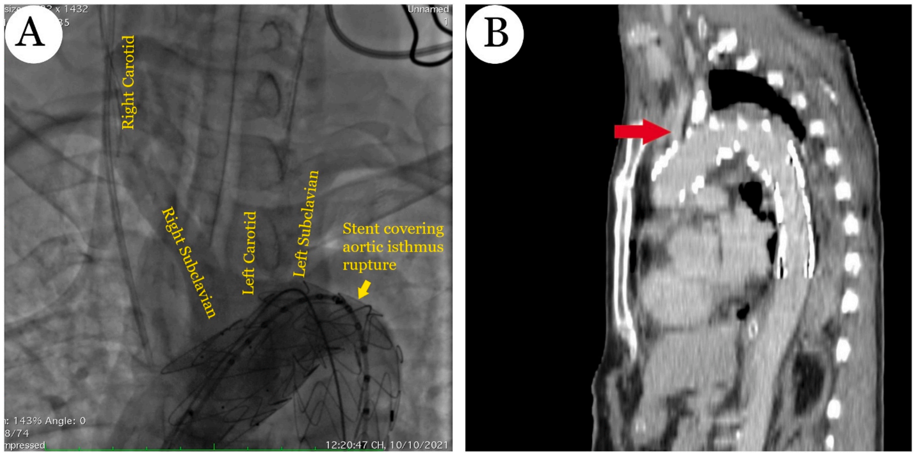

Fig. 8. Stent covering aortic ruture on C-arm imaging (A) and computed tomography of the fourth day (B).

including transthoracic, transabdominal, thoracoabdominal, and minimally invasive thoracoscopy. The choice depends on the clinician's experience [17].

The approach to hollow visceral rupture varies according to the location and extent of intestinal injury. We chose to respect the small intestine because it was perforated in numerous locations, but not too wide apart. We used a unified approach for all gastrointestinal anastomoses, consisting of two layers: the inner layer was sutured with monofil 4.0, and the outside layer was applied simple interrupted sutures. Colonic trauma results in a more severe sigmoid sphincter tear and anaemia but without perforation at grade II (AAST). As a result, we had to remove the left colon to create a colostomy and reduce the risk of peritonitis. This is a sensible choice in situations involving multiple traumas.

If the patient sustains more serious life-threatening injuries that require an emergency laparotomy or craniotomy, the aortic repair may be delayed in accordance with the EAST 2000 criteria [17]. Thoracic aortic rupture is most frequently caused by an abrupt deceleration secondary to a car accident, fall, or another catastrophe. The natural history of this condition is sudden haemorrhage, hypovolemic shock, and death in 85% of patients. The remaining minority of patients develop a self-limiting haematoma and pseudoaneurysm with a high risk of sudden rupture. The most common location of rupture is at theaortic isthmus, the region between the fixed arch and the mobile thoracic aorta, but the pathogenesis is still controversial [7]. We evaluated the diameter of the aorta between the left subclavian artery (LSA) and the left common carotid artery (LCCA), between the LSA and the rupture site, and 2 cm below the rupture site using various CT reconstructions. Additionally, we determined the distance between the LSA and LCCA, as well as the distance between the LCCA and tear point. These parameters will help interventional cardiologists choose the appropriate size and placement of the stent.

Due to the ruptured thoracic aorta occurring near the origin of the LSA, the proximal stent fixation position risks occluding the origin of the artery. As a result, before the vascular operation, we needed to bridge the artery between the two external carotid arteries. We investigated this carotid artery bypass three times (before and after stent grafts, 4 days after surgery), and all three times revealed a good anastomosis and no cerebral ischaemia on brain CT scan.

Endovascular repair is growing rapidly as a feasible alternative to surgery and may someday become the gold standard for the definitive treatment of patients with the necessary indications [18]. In haemodynamically unstable patients, covering the LSA without previous revascularisation is essential to allow quick operation. In cases of left arm ischaemia or vertebrobasilar insufficiency, LSA revascularisation may be offered as a second operational time. For haemodynamically stable patients, LSA revascularisation before stent-graft repair may be recommended. Intraoperative angiography can be accomplished via the left cervical route [19].

The unresolved issue in treating thoracic aorta lesions is the possibility of spinal cord ischaemia, which is estimated to be up to 21% with open surgery and 0–12% with endovascular surgery [7,12]. Because rupture occurs more frequently at the aortic isthmus, the distance from the LSA enables proximal stent-graft fixation. M. Ben Hammamia et al. chose to purposefully cover the LSA in 32 patients because the landing zone was 20 mm without LSA revascularizationwith no upper arm ischaemia, or neurological complaints [12].

Our surgical teams worked collaboratively to treat this patient successfully; however, our report has certain limitations. First, rupture of the aorta was Grade III-AAST with haemodynamically stable. Therefore, we had time to perform intra-abdominal surgery and vascular bypass before stenting. This sequence of steps may not be appropriate if the aortic damage is more severe or haemodynamically unstable. Second, diaphragm rupture occurred near the apex of the diaphragm. As indicated, the suture used to repair the diaphragm was beneficial. However, this clinical example does not guide how to repair the diaphragm if it is ruptured at the root. Third, the patient sustained only a lateral arch fracture and lacked a moveable costal array. Consequently, it is sufficient to drain the pleura without additional methods.

In the future, it will be necessary to evaluate the effectiveness of large-scale aortic stent-graft placement with medium-and long-term durations. Simultaneously, evidence is needed on the effectiveness of techniques for treating diaphragmatic rupture at different rupture sites.

4. Conclusion

In summary, a clinical examination and systematic CT should be performed from the head to the end of the pelvis to avoid injury. It is essential to evaluate the level of organ damage to coordinate the specialists effectively.

Consent

The surgeron informs us of this disorder, which requires urgent surgery. We aimed to understand and approve emergency surgery. We understand and accept the risks associated with the procedure, including morbidity and mortality. We confirmed our informed consent by signing it.

Informed consent

Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Sources of funding

None.

Ethical approval

Consent of the patient and the patient's wife. The director of the emergency center agreed to publish this clinical case.

Research registration

N/A.

Guarantor

Tran Que Son, MD. PhD.

Author contribution

Tran Que Son, MD. PhD: study concept, data collection, data analysis, writing the paper, main surgeon. Tran Hieu Hoc, Asscoc, MD. PhD: study concept, data collection, data analysis, writing the paper. Le Xuan Than: study concept, data collection, data analysis, writing the paper, main surgeon. Tran Thu Huong: study concept, data collection, data analysis, writing the paper, edit English language. Dong Minh Hung: data collection. Nguyen Chien Quyet: data collection. Vu Duc Long: supervisor. Tran Thanh Tung: supervisor.

Provenance and peer review

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Declaration of competing interest

The authors declare that they have no competing interests.

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