Case Report

Polymicrobial infection presenting as non-clostridial gas gangrene in a patient with an open pelvic ring fracture accompanied by abdominal evisceration: a case report

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Background: Open pelvic fractures are rare but represent a serious clinical problem with high mortality rates. Acute mortality is often associated with hemorrhage, whereas delayed mortality is most often associated with sepsis and multiple organ failure. We report a case of Wang's classification of type II open pelvic ring fracture with hemorrhagic shock and septic shock from gas gangrene.

Case Description: A healthy 41-year-old man presented with an open pelvic ring fracture and a laceration in the lower abdomen sustained at an ironworks. His hemodynamic status was unstable. Pelvic ring stabilization with an external fixator, ligation of the median sacral and bilateral internal iliac arteries, partial resection of the ileum, appendectomy, and intra-abdominal pelvic packing were performed. Seven days after the injury, he developed a single spike fever of 39.8 ℃ with a significant pus discharge from the open wound around his groin. A computed tomography scan revealed an accumulation of gas around the sacroiliac joint, in the abdominal cavity, and the adductors and gluteus maximus muscles caused by non-clostridial gas gangrene. We performed surgical debridement three times and initiated vancomycin administration. Hyperbaric oxygen therapy was also initiated as an adjunctive therapy. The patient could walk with a cane 5 months after the injury.

Conclusions: We described a multidisciplinary case of a patient with a Wang type II open pelvic fracture who required emergent damage control and subsequently developed anaerobic sepsis. Bleeding was controlled by packing gauze into the intraperitoneal cavity and applying external fixation to the pelvic ring. However, it is important to administer prophylactic antibiotics against anaerobic bacteria and to detect subsequent infections early when packing gauze into the intraperitoneal cavity in patients with open pelvic fractures.

Keywords: Open pelvic ring fracture; gas gangrene; non-clostridial infection; case report

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Introduction

Open pelvic fractures are rare, often resulting from high-energy trauma, and are associated with high morbidity and mortality rates owing to the accompanying lethal injuries (1-3). The mortality rates of open pelvic fractures remain high (1,2) despite improvements in treatment protocols such as damage control surgery, aggressive transfusion, hemorrhage control, and arterial embolization. Bony structure instability and internal hemorrhage can be major primary treatment targets in patients with closed pelvic fractures. However, managing patients with open pelvic fractures is challenging and requires a multidisciplinary approach (2,4). The difficulty in treating open pelvic fractures includes managing severe wound infections with further sepsis and multiple organ failure after stopping concomitant external and internal hemorrhages (1,3). Uncontrolled infection can cause sepsis and contribute to mortality (4). This report presents a case of open pelvic ring fracture with hemorrhagic shock, abdominal wall and intestinal tract injuries, and septic shock from gas gangrene. We present this case in accordance with the CARE reporting checklist (available at https://acr.amegroups.com/article/view/10.21037/acr-24-128/rc).

Highlight box

Key findings

- Successful acute bleeding control, such as pelvic ring stabilization with an external fixator, ligation of the median sacral and bilateral internal iliac arteries, and intra-abdominal pelvic packing saved the patient's life. However, the patient subsequently developed a non-clostridial gas gangrene infection.
- This study highlights the critical need for prompt and comprehensive management of open pelvic fractures, particularly in cases complicated by gas gangrene.

What is known and what is new?

- Open pelvic fractures are rare but represent a serious clinical problem with high mortality rates. Acute mortality is often associated with hemorrhage, whereas delayed mortality is most often associated with sepsis and multiple organ failure.
- Patients with open pelvic ring fractures with abdominal wall rupture may develop gas gangrene infection.

What is the implication, and what should change now?

- Clinically, it underscores the importance of early infection control measures and antibiotic prophylaxis to prevent sepsis-related complications and improve patient outcomes. Policy-wise, it underscores the need for guidelines on early antibiotic prophylaxis and infection control in similar trauma cases.

Figure 1 Plane anteroposterior radiograph taken soon after the admission shows a lateral compression type III pelvic ring fracture according to the Young-Burgess classification.

Case presentation

A healthy 41-year-old man was trapped beneath a 2-ton steel frame while working on ironwork. He was rescued, but his intestinal tract prolapsed from the lower abdominal area on the right side, with pelvic instability. Upon arrival, his Glasgow Coma Scale score was E4 V5 M6; however, his hemodynamic status was unstable, with a blood pressure of 88/57 mmHg and a pulse rate of 107 beats per minute. The initial hemoglobin concentration was 135 g/L but decreased to 49 g/L after massive infusion. Physical examination revealed instability of the pelvic ring and constant bleeding from a wound in the lower abdomen. The right intestinal tract and testes were exposed; however, there were no injuries to the rectum or bladder. No signs or symptoms of neurological injury or blood flow disorders were observed in the lower extremities. Endotracheal intubation and fluid resuscitation with massive transfusion were performed in the emergency department. Radiography revealed a lateral compression type III pelvic ring fracture according to the Young-Burgess classification (*Figure 1*), and computed tomography (CT) images showed an abdominal wall rupture extending from the ventral side to the retroperitoneum (*Figure 2*). Contrast CT showed extravasations around the internal iliac artery (*Figure 2C*). The laceration tear in the right lower abdomen was in Zone II according to the classification system of open pelvic fracture described by

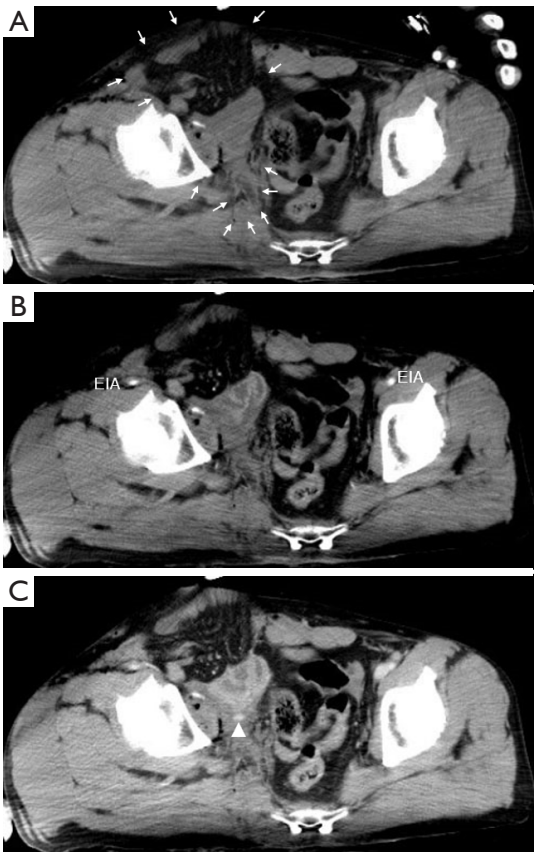

Figure 2 CT axial image of the hip joint level. (A) Plane CT view. The area surrounded by the white arrows is the intestinal tract that has prolapsed from the peritoneum. (B) Contrast enhancement CT in the early phase. (C) Contrast enhancement CT in the delayed phase shows extravasation from the internal iliac artery (arrowhead). EIA, external iliac artery; CT, computed tomography.

Faringer (5) or an inguinal type (type II) open pelvic ring fracture according to Wang's classification (1). This patient was classified as grade IV according to the World Society of Emergency Surgery (WSES) classification (6).

Two hours after admission, a laparotomy was performed through a midline abdominal incision extending to the lacerated part of the abdominal wall, in an effort to stabilize the patient's hemodynamically unstable condition according to the WSES management guidelines (6). Because of abdominal wall rupture, the retroperitoneum could be approached from the abdominal cavity. After ligation of the median sacral and bilateral internal iliac arteries, partial resection of the ileum was performed for mesenteric injury and an appendectomy for serious cecal injury. The pelvic ring was stabilized using an external fixator; however, bleeding around the sacrum could not be controlled. Therefore, pelvic packing was performed, with the placement of surgical laparotomy pads into the retroperitoneal space communicating with the peritoneum due to peritoneal rupture (*Figure 3A*,*3B*). After gauze packing, hemodynamics was controlled. Administration of sulbactam/ampicillin antibiotics was initiated after surgery (2 g every 8 h for 6 days). During the first surgery, there was no rectal damage, and the wound was distant from the perineum, corresponding to Wang classification type II; therefore, no colostomy was performed.

On day 3, after removing the surgical laparotomy pads, the peritoneal cavity was lavaged with 10 L of saline and continuously irrigated (200 mL/h). A tube containing saline for perfusion through the upper abdomen and two open drains were inserted for drainage: one from the inside of the right proximal femur through the abdominal cavity to the mid-abdomen and the other from the sacral fracture site through the abdominal cavity to the inguinal open wound of the right (*Figure 3C*). On day 4, CT revealed an abscess at the groin wound, leading to suture release and drainage. On day 7, we received a report from the laboratory department that *Bacteroides fragilis* and *Staphylococcus epidermidis* were detected in the gauze removed from the intraperitoneal cavity on day 3. Antimicrobial susceptibility patterns of *Staphylococcus epidermidis* showed sensitivity to gentamicin, erythromycin, clindamycin, minocycline, levofloxacin, vancomycin, teicoplanin, trimethoprim-sulfamethoxazole, fosfomycin, and rifampicin. The bacteria were resistant to piperacillin, cefazolin, cefotiam, flomoxef, imipenem, and sulbactam/ampicillin. Minimum inhibitory concentration values were >2 for piperacillin, <8 for cefazolin, <8 for cefotiam, <4 for flomoxef, 8 for imipenem, and <8 for sulbactam/ampicillin. In contrast, broad-spectrum antibiotics are effective against *Bacteroides*, and because antimicrobial susceptibility testing for anaerobes is technically difficult, we did not perform the test.

On day 8, the patient developed a single spike fever of 39.8 ℃ with a large amount of pus discharge from the open groin wound. CT revealed gas accumulation around the fracture site of the sacrum, gluteus maximus muscle, and pectineus muscle on the right side (*Figure 4*). Blood count revealed mild elevation of white blood cells 8,930/μL with neutrophilia 86.3%, C-reactive protein (CRP) value was 42.36 mg/dL (local lab norm is 0–0.4 mg/dL). Anaerobic gas gangrene was strongly suspected, and surgical debridement was performed. Necrotic tissues of the right adductor and gluteus maximus muscles were resected

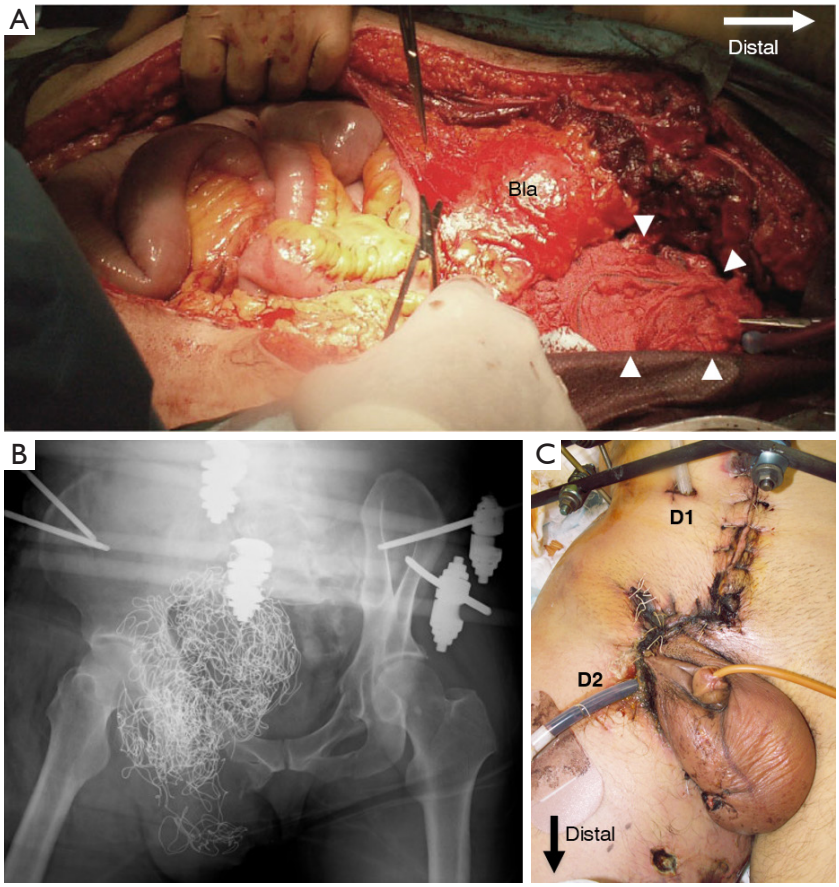

Figure 3 Surgery on the day of injury. (A) Intraoperative photographs at the surgery on day 1. Pelvic packing with surgical laparotomy pads into retroperitoneal space communicating with the peritoneum due to peritoneal rupture (arrowheads). (B) Postoperative anteroposterior radiograph of the pelvis. (C) Photographs of the right groin wound on day 4. Drainage tube 1 (D1) was inserted from the inside of the right proximal femur through the abdominal cavity to the mid-abdomen, and drainage tube 2 (D2) was inserted from the sacral fracture site through the abdominal cavity to the inguinal open wound on the right for drainage. Bla, bladder.

(*Figure 5*). In addition, the necrotic portion of the right testicle was removed. An iodoform gauze was placed in the cavity, and the muscle was removed without wound closure. *Enterobacter cloacae*, *Enterococcus* sp., *Bacteroides fragilis*, and *Bacteroides* sp. were detected in the pus discharge, soft tissue specimens, and the tip of the abdominal lavage drain. On day 10, however, a large amount of exudate from the open right groin wound was still observed, prompting further surgical debridement. On day 11, a blood examination showed white blood cells 9,320/μL with neutrophilia 86.9% and a CRP value of 26.92 mg/dL. CT images revealed gas in the iliopsoas muscle on the right and gluteus muscle on the left, along with abscess formation in the right pubic muscle. Therefore, an additional surgical debridement was performed.

On day 9, hyperbaric oxygen therapy (HBOT) was initiated as adjunctive therapy. The HBOT consisted of a monoplace chamber (BARAMED, Koike Medical, Japan) with 100% oxygen in a pressure chamber of 2.0 atmospheres absolute (pressure of 202.65 kPa) once daily for 6 days. The total time in 100% oxygen was 85 min, with three phases: 15 min of pressurization, 60 min of preservation, and 10 min of depressurization. A progressive reduction in white blood cell, CRP, and procalcitonin values (10,000 mm^3, <20 U/L, and 0.10 ng/mL, respectively) was observed. Clinical improvement was observed 3 days after the initiation of HBOT.

Antibiotics were adjusted to vancomycin (1 g every 12 h for 15 days) and meropenem (1 g every 8 h for 30 days) immediately after surgical debridement for gas gangrene.

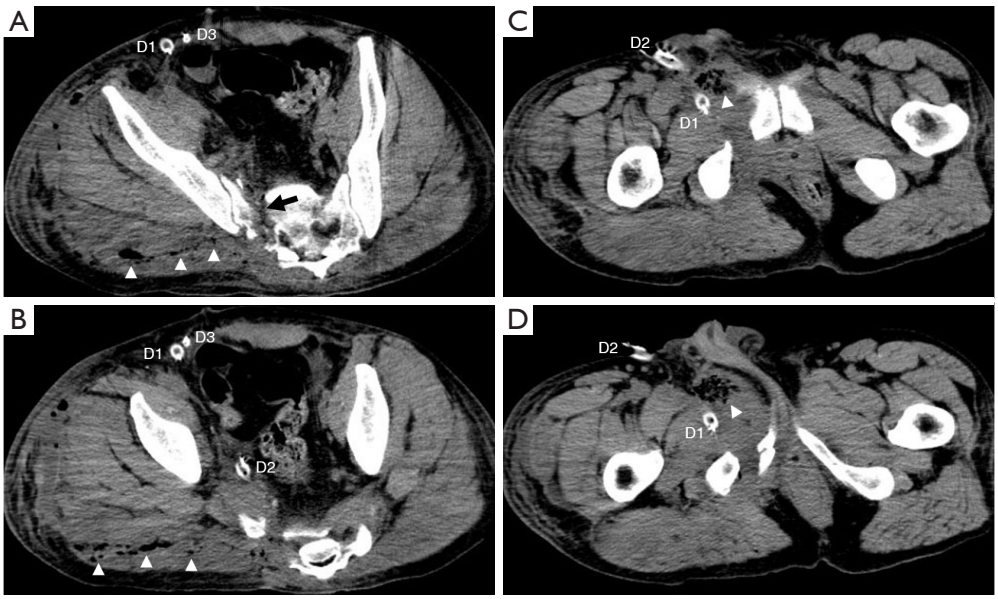

Figure 4 Transaxial image of plain computed tomography scans on day 8. At the level of sacrum (A), proximal of hip joint (B), proximal of lessor trochanter (C), and lessor trochanter (D). The tube for injecting irrigation fluid (drainage tube 3, D3) is inserted into the abdominal cavity through the upper abdomen. Drainage tube 1 (D1) was inserted from the inside of the right proximal femur through the abdominal cavity to the mid-abdomen, and drainage tube 2 (D2) was inserted from the sacral fracture site through the abdominal cavity to the inguinal open wound on the right for drainage. (A,B) Accumulation of gas (arrowheads) in the gluteus maximus muscle. The fractured lesion of the sacrum communicates with the abdominal cavity (black arrow). (C,D) Accumulation of gas (arrowheads) in the pectineus muscle.

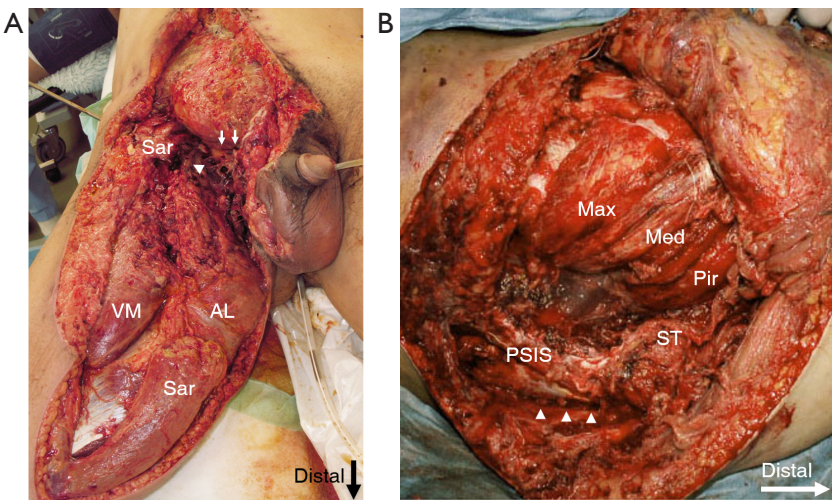

Figure 5 Intraoperative photograph on day 8. (A) The proximal femur on the right after debridement surgery. The arrowhead indicates the femoral artery on the right, and the arrows indicate superior ramus of pubis. (B) The gluteus maximus muscle on the right after debridement surgery. The arrowheads indicate the fracture line of sacrum. Sar, sartorius muscle; VM, vastus medialis muscle; AL, adductor longs muscle; Max, gluteus maximus muscle; Med, gluteus medius muscle; Pir, piriformis muscle; PSIS, posterior superior iliac spine; ST, ruptured sacrotuberous ligament.

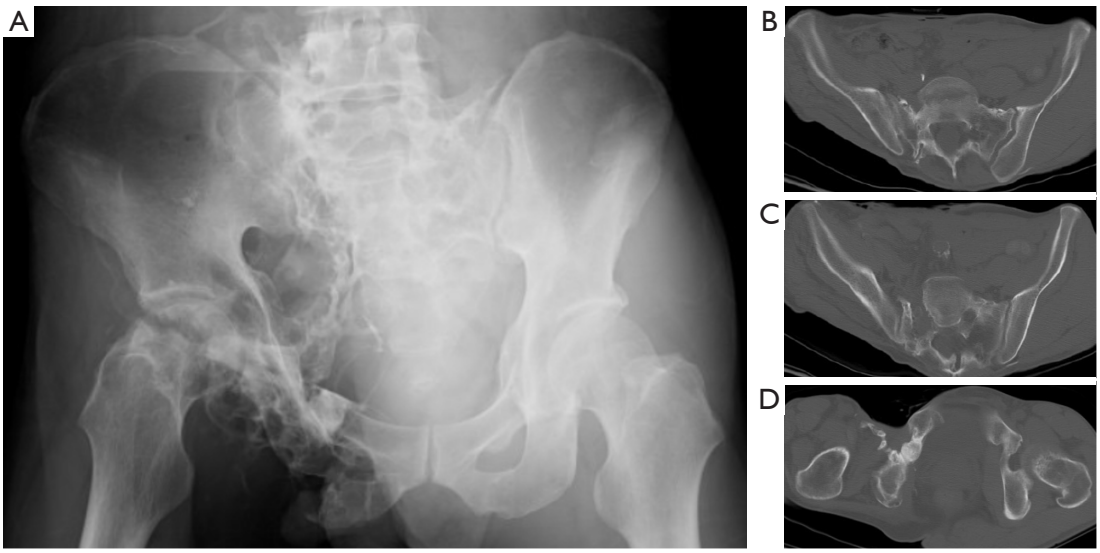

Figure 6 Radiological images 2 years after injury. (A) Plane anteroposterior radiograph. Computed tomography axial images at the proximal sacrum level (B), mid-sacral level (C), and pubic level (D). These images show complete bone fusion.

Vancomycin was administered intravenously for 2 weeks, and swelling of the right thigh and buttocks and pain were significantly reduced. Oral levofloxacin (500 mg/day for 2 weeks) was then prescribed. On day 25, oral nutrition was initiated after a temporary single-hole stoma was created in the transverse colon to prevent wound contamination from defecation. The infection of the open wound was controlled by day 36, and the stoma was closed on day 151.

Bone union was achieved on postoperative day 93, and the external fixator was removed (*Figure 6*). He was able to walk with a cane 5 months after the injury, using a short-leg orthosis, and could walk very satisfactorily without a cane 8 months after the injury.

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for the publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

Discussion

Successful acute bleeding control, including pelvic ring stabilization with an external fixator, ligation of the median sacral and bilateral internal iliac arteries, and intra-abdominal pelvic packing, saved the patient's life according to the WSES management guidelines. However, the patient subsequently developed a non-clostridial gas gangrene infection.

The high mortality rate of open pelvic fractures is caused by hemorrhage due to vascular injury around the pelvis in the early stages and infection in the later stages. Wang *et al.* classified open pelvic fractures into four types: perineal (type I), inguinal (type II), sacroiliac (type III), and composite (type IV) (1). Type II, as in our case, has a high probability of macrovascular and vascular plexus injury, requiring vascular repair and tamponade. They also reported that types I and IV have a high risk of middle- and late-stage infections, together with contamination of the rectum and anal canal, which can aggravate the degree of soft tissue contamination. In our case, ligation of both the internal iliac arteries and veins and gauze packing in the abdominal cavity were initially required. Hemodynamics were controlled after surgery; however, gas gangrene became apparent despite no stool contamination. In cases like ours, the infection might have been caused by intraperitoneal infection, direct transmission from the inguinal wound, or hematogenous infection. As mentioned above, the patient's open pelvic fracture was Wang type II, and there was no stool contamination. Additionally, no bacteria were consistently detected in the arterial blood specimens from the time of admission to discharge. Therefore, we considered the possibility of direct transmission from the wound or hematogenous infection to be unlikely. We strongly suspected intraperitoneal infection, as anaerobic

bacteria were identified in the peritoneal cavity.

Intra-abdominal infections after partial small-bowel resection are rare due to specialized fibroblast stromal and mesothelial cells within the omentum regulating the recruitment of peritoneal leukocytes and controlling their activation in a unique manner (7). However, we performed intraperitoneal gauze packing. Nicol *et al.* (8) reported that abdominal packing during damage control surgery increases postoperative infections, with intra-abdominal abscess rates as high as 20–49%. We speculated that the infection originated intraperitoneally after partial resection of the ileum and appendectomy. The anaerobic bacteria then spread to the gluteus maximus and pectineus muscles via continuous irrigation through the drain tube. A recent report suggested that extensive peritoneal lavage during emergency laparotomy, even when large amounts of contamination have occurred, does not reduce postoperative infection and may predispose patients to an increased incidence of abscess formation (9). Lu *et al.* (10) reported that soft tissue infections are very common in the early stages following admission for open pelvic fractures. They found that most patients with open pelvic fractures (28/30) developed culture-confirmed bacterial infections, with *Escherichia coli* (n=14) being the most common causative pathogen, followed by *Acinetobacter baumanii* (n=9), *Pseudomonas aeruginosa* (n=8), and *Enterococcus faecium* (n=4).

Gas was observed around the gluteus maximus muscle on both sides on CT imaging away from the injury site. Lai *et al.* (11) reported that internal iliac artery embolization after pelvic fractures was more likely to result in surgical site infections, with significant bilateral gluteus maximum necrosis after trans-arterial embolization (11). We believe that ligation of the internal iliac artery for intra-abdominal bleeding may have reduced blood flow in the gluteus muscles, triggering gas gangrene due to intramuscular hypoxia. The peritoneum of the posterior abdominal wall was not repaired after the retroperitoneal artery ligation. The infected abdominal cavity was connected to the gluteal muscle via an incised peritoneum.

The mortality rate of non-clostridial gas gangrene infections is 25% (12). Although this is lower than the mortality rate of clostridial gas gangrene infection, which is 80% (13), treatment remains challenging. Antibiotics such as piperacillin-tazobactam, imipenem, meropenem (14), and HBOT are effective for the treatment of non-clostridial infections. HBOT can maximize endogenous and pharmacological antibacterial activity via neutrophils and by directly inhibiting anaerobes and augmenting the action of antibiotics such as aminoglycosides, which are impaired under hypoxic conditions and accelerate angiogenesis and fibroblast function to improve wound healing (15).

In this case, anaerobic bacteria were detected in the specimen collected on day 3 after the injury, but the results were reported on day 7. We speculate that the delay in starting antibiotics against anaerobic bacteria worsened the symptoms. We believe that prophylactic antibiotics should have been administered to target anaerobic bacteria before the first surgery, in addition to following the WSES management guidelines.

Conclusions

We described here a multidisciplinary case of a patient with a Wang type II open pelvic fracture who required emergent damage control and subsequently developed anaerobic sepsis. Bleeding was controlled by packing gauze into the intraperitoneal cavity and applying external fixation to the pelvic ring. However, it is crucial to administer prophylactic antibiotics against anaerobic bacteria and to detect subsequent infections early when packing gauze into the intraperitoneal cavity in patients with open pelvic fractures.

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Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at https://acr.amegroups.com/article/view/10.21037/acr-24-128/rc

Peer Review File: Available at https://acr.amegroups.com/article/view/10.21037/acr-24-128/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://acr.amegroups.com/article/view/10.21037/acr-24-128/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research

committee and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for the publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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