CASE REPORT

Delayed torrential haemorrhage after firearm injury

Pankaj Kumar,¹ Maneesh Singhal,¹ Sushma Sagar,¹ Amit Gupta²

¹Department of Surgical Disciplines, JPN Apex Trauma Center, All India Institute of Medical Sciences, New Delhi, India

²Trauma Surgery, JPN Apex Trauma Centre, All India Institute of Medical Sciences, New Delhi, India

Correspondence to

Dr Maneesh Singhal,
drmaneesh@gmail.com

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SUMMARY

A 30-year-old man was referred to us after 48 days of gunshot injury to left groin, with torrential bleeding from a pseudoaneurysm of the left external iliac artery. He was successfully managed with a team of specialists involving trauma surgeon, vascular and plastic surgeon, general surgeons and intervention radiologist with the help of critical care specialists. He required judicious debridement, a transverse rectus abdominis musculocutaneous flap, stenting of the external iliac artery, repair of the external iliac vein and ligation of the bilateral internal iliac artery. He had prolonged intensive care unit stay with open abdomen requiring specialised care. Errors in regular assessment of patient by clinical and radiological examination along with failure in early adequate debridement were responsible for trauma suffered by him. Though it is a rare injury, these devastating complications can occur after any gunshot injury and proper management guidelines must be established.

pseudoaneurysm of external iliac artery, repair of the external iliac vein and ligation of the bilateral internal iliac artery. There are several published reports of pseudoaneurysms occurring in various arteries after infection/trauma/gunshot and were managed in different ways, but there is no published article with similar presentation and outcomes. Owing to the rarity of this injury and challenges faced during its treatment, the literature is reviewed, and various principles are suggested to improve the management.

CASE PRESENTATION

A 30-year-old man with alleged H/O Gunshot injury in left iliac fossa 48 days back, presented to our emergency department with chief symptoms of bleeding from the entry site for the last 3 days. He was referred to us from a private hospital with packs in left perivesical space. He had history of

BACKGROUND

Gunshot injury can cause significant damage to the adjacent tissues. Delayed haemorrhage after complete debridement, haemostasis and proper cover of vessel by muscular flap is rare. Underestimating the damage potential of gunshot injuries can lead to a devastating situation. We are reporting a case of gunshot injury with delayed, torrential, life-threatening haemorrhage after transverse rectus abdominis musculocutaneous (TRAM) flap, from the erosion of iliac vessel, requiring stenting of the

Figure 1 Bullet at D12 vertebrae (arrow).

Figure 2 CT angiography, showing a pseudoaneurysm of left external iliac artery (arrow).

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gunshot injury (close shot) by Rifle (0.30 calibre bullet) at left iliac fossa and left lower chest 48 days back. He was admitted and evaluated in a private hospital. The bullet, which has entered through left chest, entered in the abdomen and then injured D12 vertebra. He had undergone exploratory laparotomy and resection anastomosis of small bowel, diaphragmatic repair and spinal instrumentation for D12 vertebral fracture (figure 1). The bullet with entry wound in left iliac fossa travelled caudally and was retrieved from upper left thigh (just below left inguinal ligament) by a separate incision. He was discharged on day 31. On day 39 he noted slight bleeding from the left iliac fossa entry wound which subsided without intervention on the same day. He had an episode of massive bleeding from left iliac fossa entry wound on day 46 for which local wound exploration and packing was carried out in the same hospital. He was then referred to us after stabilisation. At the time of arrival at our institute (day 48), he had packs around the left perivesical area with foul smelling discharge from the wound. There was no more bleeding. He was assessed as per ATLS protocol. His vitals were stable and the primary concern was the cause of bleeding from the wound site and its management. A diagnosis of bleeding from iliac vessel was made and to ascertain its cause, CT angiography was planned. Doppler sonography was not possible due to the presence of the sponge pack at left iliac fossa.

INVESTIGATIONS

CT angiography, detected a pseudoaneurysm of the left external iliac artery (figure 2). No other vascular abnormality was seen.

DIFFERENTIAL DIAGNOSIS

A differential diagnosis of pseudoaneurysm of iliac vessel, arteriovenous (AV) fistula, delayed erosion of vessels and muscular bleed was kept in mind.

TREATMENT

After CT angiography, a diagnosis of pseudoaneurysm of the left external iliac artery, caused by erosion of vessel by necrotic tissue was made. It was decided to put a stent in the vessel, then to go forward for pack removal and debridement. Stenting (covered self-expanding vascular stent) of the left external iliac artery was carried out by our interventional radiologist followed by removal of packs in the operative room (OR). A cavity of around 5×5×6 cm was seen just left and lateral to midline, below umbilicus, with pus, slough and necrotic left rectus, external oblique, internal oblique, transverse abdominis and left iliopsoas muscle. Left ureter was visible within the wound with dusky wall. All necrotic muscle debrided, slough removed and wound washed. The internal iliac vessel was palpable in the bed. We planned to cover the vessel with muscle flap. Inferior epigastric artery-based opposite side (right) TRAM flap was used to cover the vessel and take care of the infection and dead space (figure 3). Complete haemostasis was achieved. Left ureter was stented with double J stent. He was then shifted to the ward in satisfactory condition. He was doing well till postoperative day 3. Suddenly he had a torrential haemorrhage from left iliac fossa. The patient went into shock within minutes. Digital compression was applied and he was shifted to OR. On exploration, there was a tear in left external iliac vein and about 1 cm of left internal iliac artery was sloughed out. There was pus collection between skin and external oblique muscle. The TRAM flap, which we had applied over the vessel, was healthy but slough was still present in the cavity, which we had debrided earlier. This slough and infection was probably the cause of erosion of

Figure 3 Inferior epigastric artery based right rectus abdominis muscle flap (arrow) raised and was used to cover the left iliac vessels. Abdomen left open in presence of gross contamination.

already damaged vessels, leading to torrential haemorrhage. Left external iliac vein was repaired with 5-0 prolene (lateral venorrhaphy) and left internal iliac artery was ligated. It was decided not to close the abdomen in the presence of gross contamination, pus and absence of covering tissues (skin and muscle). It was not possible to use negative pressure wound therapy (NPWT) due to risk of rebleed from the vessel and infection. The patient was shifted to intensive care unit (ICU) with temporary cover of abdomen with non-absorbable mesh. Within an hour of shifting, the dressing was soaked and significant bleeding was observed after dressing removal. He was explored again and bleeding from retrovesical area was noted. Individual vessels were ligated but bleeding could not be stopped. In suspicion of bleeding from collaterals from opposite internal iliac artery, right internal iliac was ligated. After ligation haemostasis was achieved. This prevented ligation of ipsilateral iliac vessel and thus prevented his left lower limb ischaemia. He was transfused seven units of packed red blood cell and fresh frozen plasma each. He had an ICU stay of 16 days. Multidrug resistant *Pseudomonas aeruginosa* was cultured from the wound (figure 4), though blood culture was sterile. He was treated with tigecycline and colistin for 10 days. Regular washing of abdominal wound with normal saline was carried out through zipper made in polypropylene mesh. The mesh was removed on day 9, after flimsy adhesions appeared between the bowel loops. Finally, on day 19, once the granulation tissue had appeared and infection had subsided, split thickness skin graft was applied over the abdominal wound. He was discharged after 28 days of stay with us.

OUTCOME AND FOLLOW-UP

He was re-admitted after 3 months for removal of the D J stent. His abdominal wound was healthy (figure 5). He is paraplegic as a consequence of the spinal injury and has started mobilisation on wheel chair. Follow-up Doppler scan of iliac and femoral vessels were normal. Definitive closure of the abdomen has been planned for after about 1 year.

DISCUSSION

Gunshot can cause significant injuries to tissues. It is mostly recognised immediately but can manifest after many days. It causes both direct thermal injury and lateral compression injury. It is absolutely necessary to explore the abdomen if peritoneal breach is present. In the absence of peritoneal breach exploratory laparotomy can be avoided but careful and judicious debridement of any suspicious area is warranted. It must be kept

Figure 4 Flimsy layer of adhesion has appeared over the wound and the polypropylene mesh was removed. Slough (arrow) is present and the culture revealed multidrug resistant *Pseudomonas aeruginosa*.

in mind that delayed manifestation of bowel/vascular injury may be seen.¹ Treating the injury rather than a mechanism of gunshot is more important. Temporary cavity formation after high velocity gunshot injury leading to damage upto 30 times the diameter of the bullet has been shown by many studies but this may not be true as shown by Richard *et al*. As suggested by them serial judicious debridement should be carried out rather than extensive debridement at first stage, as tissues appearing near dead may recover later.² But a keen examination of nearby tissues is absolutely necessary to rule out other injuries. Delayed manifestation including bowel perforation has been reported even after extraperitoneal injury. So, repeated clinical examinations supplemented with radiological examination will help in early detection of further damage. Probably lack of adequate debridement, inability to suspect a delayed manifestation and failure of regular radiological examination lead to this complication.

Figure 5 Abdominal wound after 3 months.

Injury to the iliac vessels is suspected after penetrating injury around this area, if haematoma or haemorrhage is seen. Immediate damage control strategy includes manual compression and aggressive resuscitation.^{3,4} In stable patients, CT angiography is quite useful in diagnosing site of bleeding/pathology and helpful in deciding the management. In unstable patients, Doppler studies are of great help. Careful exploration of injury site is carried out to achieve haemostasis. Retro peritoneum is opened in the midline over the aortic bifurcation to take vascular control over the common iliac artery by vascular loops. The vessel is controlled distally by looping the external iliac artery and vein just proximal to the inguinal ligament. Even then there could be back bleeding from the internal iliac artery that can be controlled by either ligating or looping it. In a patient with systolic blood pressure less than 90 mm Hg, ligation of external or common iliac artery has high amputation rate (40–50%), so it is important to maintain the continuity of external iliac artery.⁵ In the presence of extensive contamination (faecal/purulent), it is appropriate to divide the artery above the level of injury and to do the anastomosis either away from the contamination or to bury the anastomosis under the uninjured retroperitoneum, as repair could blowout in the presence of infection. In a stable patient, to prevent ischaemia of the ipsilateral lower extremity after ligation of iliac artery, an extra-anatomic femorofemoral cross-over bypass should be carried out. In an unstable patient, ipsilateral below-knee fasciotomy should be carried out. After adequate resuscitation for 4–6 h, femorofemoral graft should be considered. Ligation of both internal iliac arteries has no serious consequences especially in young patients because of collaterals. Injuries to the iliac vein are mostly treated by lateral venorrhaphy with continuous 4-0 or 5-0 polypropylene sutures. The use of elastic compression bandage and limb elevation is necessary, if iliac vein is ligated. Low-molecular-weight heparin should be started after coagulopathy has resolved and then the patient was discharged on warfarin.⁵ Gunshot wounds are usually infected, so culture from wound should be taken and patient should be started on broad-spectrum antibiotics. In the presence of extremely virulent organisms like *Pseudomonas*, prolonged duration of systemic antibiotics is recommended. Wound closure not recommended in the presence of gross contamination as in this case. There are many studies regarding management of open abdomen. Silicon sheet, absorbable and non-absorbable mesh, bagota bag, tensor fascia lata free flap, vacuum pack temporary abdominal wound closure and many other methods are used for temporary closure of open abdomen with variable results.⁶ No method can be claimed superior to another. Cases must be individualised. We have used a polypropylene mesh with excellent result. The mesh was removed once flimsy adhesions appeared between bowel loops, preventing herniation. Later split thickness skin graft was applied once granulation appeared. This method had several advantages over others in this particular case. It facilitated us in closure of the abdomen with abdominal sepsis, tissue loss and bowel oedema. Daily examination and washing to control infection was possible and abdominal compartment syndrome was avoided. Vacuum pack temporary abdominal wound closure is an equally effective adjunct for abdominal wound closure.⁷ Although it is an option for these types of wounds, it is still not recommended in patients with active bleeding and purulent discharge, though many studies have shown effectiveness of NPWT in infected wounds and application over vascular grafts.⁸ Muscle flap is an effective option to cover infected or exposed vessels. It can decrease chances of vascular erosion and infection. Flap transposition can be carried out immediately after debridement or

can be delayed for few days, if length of vessel exposed is not long. A muscle flap improves the healing process by providing oxygenated blood and thus enhances the ability of macrophages to control infection. Better transportation of antibiotics is an additional benefit. Flap can fill the dead space created after debridement and increases the chances of early wound cover.^{9–11} We have used right-side TRAM flap in this case with effective result. We had covered the exposed vessel with TRAM flap after debridement but there was bleeding from same site again. The cause of bleeding was erosion of iliac vessels by infected tissues, which persisted even after debridement. This infection was probably as a result of inadequate debridement at the time of first operation, superimposed by nosocomial infection due to the presence of sponge pack in the wound for 3 days.

Delayed bleeding after penetrating injuries may be caused by pseudoaneurysm, AV malformation and missed subclinical vascular injuries. These lesions are associated with unpredictable complications and carry high morbidity and mortality rates. Though angiography is the gold standard, other modalities like Doppler ultrasound, CT angiography and MR angiography can provide almost similar results with benefit of being non-invasive. Treatment strategy is based on the clinical picture, type of pathology, location of lesion and associated risk. Pseudoaneurysm is a false aneurysm. In this condition, blood leaks from the vessel wall but is contained by either adventitia or perivascular tissues. The cause in this case was either subclinical vessel wall injury by firearm or by erosion of vessels by infection. Evaluation of surrounding structures and patient comorbidities are equally important for management. If possible the first option is minimal invasive techniques like radiological procedures such as ultrasound-guided percutaneous thrombin injection and endovascular management (embolisation, stent-graft placement).^{12–13} Morbidity and mortality has significantly decreased by the use of non-invasive treatments. In this case ultrasound-guided procedures were not possible due to inaccessibility and so a covered vascular stent graft was used. Operative intervention is needed in cases of failure of non-operative interventions and in unstable patients.

After reviewing the literature and challenges faced, we would like to suggest that the possibility of delayed haemorrhage must be considered in patients with gunshot injury near vessels. CT angiography is recommended for the detection of pseudoaneurysm/AV fistulas and assessment of nearby structures in stable patients. Regular Doppler study is suggested for early identification of venous thrombosis and other arteriovenous pathology. In acutely bleeding patients direct compression with finger or sponges is an initial approach before shifting the patients to OR for active intervention. Back bleeding from an opposite internal iliac artery must be suspected in patients with pelvic bleeding continuing even after ligation of ipsilateral internal iliac artery. The bilateral internal iliac arteries can be safely ligated in young patients with trauma without much detrimental effects. The expert intervention radiologist is an integral part of managing these patients. Every attempt should be made to control haemorrhage by an endovascular approach in stable patients but undue delay is not recommended in unstable patients. A surgeon with experience in managing vascular trauma is an absolute requirement. B/L internal iliac artery ligation and packing is recommended in inexperienced hand. Every attempt should be made to remove the packs as early as possible to avoid infections. Stabilisation of patients with fluids and blood products should be continued and help of experienced surgeon should be sought urgently. Complete and judicious debridement to remove all dead and necrotic materials must be carried out

and all nearby structures must be examined carefully to diagnose occult injuries. Adjacent vessels must be examined carefully for any pathology and adequate cover should be given to prevent its future erosion. In the presence of contamination, the artery should be divided above the level of injury and a bypass should be attempted only after the patient is stabilised. Ipsilateral four-compartment below-knee fasciotomy should be considered if vessels are ligated in unstable patients. The goal should be the maintenance of continuity of the external iliac artery, as its ligation leads to a 40–50% amputation rate especially in patients with hypotension. Muscle flap is a very effective option to cover exposed vessels, especially in the presence of infection. It can decrease chances of vascular erosion, fill the dead space, reduce the infection and increase the chance of early wound closure.

The contralateral TRAM flap was used in our case as ipsilateral rectus abdominis was destroyed by the injury. TRAM flap is a good option to cover the wounds in groin area although gracilis, sartorius, free tensor fascia lata or anterolateral thigh flaps can be used. Regular Doppler examination of iliac and femoral vessels should be carried out to demonstrate patency and to intervene early. Open abdomen with severe contamination and lack of covering tissue can be best managed with split thickness skin graft once granulation has appeared. This approach has several benefits including adequate drainage of purulent material, decreased chances of abdominal compartment syndrome, possibility of daily abdominal examination while the only drawbacks are prolonged hospital stay and incisional hernia.

Learning points

- ▶ A dedicated team consisting of trauma surgeon, plastic surgeon and intervention radiologist was able to save a life of a patient with a rare and challenging injury.
- ▶ An early adequate debridement and suspicion of delayed vascular injury with regular assessment of patient with clinical and radiological examination could have prevented the trauma suffered by him.
- ▶ It is wiser to transfer such patients to a specialised centre, well trained to manage these injuries, as early as possible.

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