Trauma Surgery & Acute Care Open

Prosthetic graft infection after vascular trauma

Kathryn Tchorz,[1] Grace Rozycki,[2] David V Feliciano[3]

[1]Department of Surgery, Wright State University Boonshoft School of Medicine, Dayton, Ohio, USA
[2]Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA
[3]Surgery, University of Maryland School of Medicine, Baltimore, Maryland, USA

Correspondence to
Dr David V Feliciano;
davidfelicianomd@gmail.com

HISTORY

A 25-year-old man presented to the trauma center with gunshot wounds to the left shoulder and left lower quadrant.

EXAMINATION

The patient was combative and diaphoretic with a systolic blood pressure of 100 mm Hg and a heart rate of 132 beats per minute. He had a single gunshot wound to the soft tissue of the superior aspect of the left shoulder, with normal pulses at the left wrist and a normal neurological examination in the left upper extremity. His abdominal examination was significant for a gunshot entrance wound in the left lower quadrant and diffuse peritonitis. The right femoral pulse was not palpable.

MANAGEMENT

After blood was drawn for type and cross-match, a surgeon-performed ultrasound was 'negative' for a hemopericardium and a left hemopneumothorax. A massive transfusion protocol was initiated, and a cephalosporin antibiotic was administered. On the first set of arterial blood gases, the pH was 7.11 with a base deficit of −17.5. After transport to the operating room, the patient was intubated, a midline exploratory laparotomy was performed and 2 L of hemoperitoneum were evacuated. There were multiple enterotomies in the small bowel, transection of the right external and internal iliac arteries and near transection of the right spermatic cord. Intestinal clamps were rapidly placed at the sites of enterotomies. Progressive hypotension mandated manual compression of the supraceliac abdominal aorta. A vascular clamp was then applied to the right common iliac artery, and the distal end of the right internal iliac artery was clamped and ligated. As the distal end of the right external iliac artery had retracted under the inguinal ligament, the midline abdominal incision was extended obliquely across the inguinal ligament into the right groin. A vascular clamp was then applied to the distal end of the right external iliac artery. The right spermatic cord was ligated. After debridement of fractured intima from the proximal right common iliac artery and the distal end of the right external iliac artery, the distance between the ends appeared to be too long to complete an end-to-end anastomosis.

QUESTION

Your choice to complete an arterial repair in this patient would be

A. insertion of a segment of the internal iliac artery,
B. insertion of a temporary intra-arterial shunt,
C. insertion of an interposition graft,
D. ligation of both ends of the transected artery and a femorofemoral bypass.

MANAGEMENT

The surgical team chose to insert an externally supported 6-mm polytetrafluoroethylene (PTFE) interposition graft using 5–0 polypropylene sutures on the end-to-end anastomoses. Right pedal pulses were present after removal of the vascular clamps. After suture closure of the multiple enterotomies and irrigation of the abdomen and pelvis with a saline-antibiotic solution, the pelvic retroperitoneum was closed over the new graft. The midline abdominal incision and oblique extension into the right groin were closed with the subcutaneous tissue and skin being left open. The final step in the operation was a two-skin incision four-compartment 'prophylactic' fasciotomy (no measurement of compartment pressure performed) below the right knee.

The patient's postoperative course was complicated by an elevated temperature and a leukocytosis on postoperative day 7. On physical examination, the midline incision and the right oblique extension were normal. After a normal CT scan of the abdomen and pelvis and a normal ultrasound examination of the right groin, the patient was discharged with a slightly elevated white blood cell count on postoperative day 10.

One month later, the patient returned to the emergency room with pain in his right first toe which was noted to have multiple punctate hemorrhages thought to be from arterial embolism. All incisions were well-healed, but a thrill was palpable in the right groin. A blood culture was subsequently positive for methicillin-sensitive *Staphylococcus aureus* (MSSA). A vascular imaging study documented no active hemorrhage from the proximal and distal anastomoses of the graft, but there were false aneurysms at both as well as an intraluminal defect in the graft consistent with clot.

QUESTION

Your choice for the next step in management would be resection of the PTFE graft and

A. insertion of an endovascular stent graft
B. insertion of an autogenous femoral vein graft (from the left thigh),
C. ligation of the ends of the artery, unilateral axillofemoral bypass graft,
D. ligation of the ends of the artery, crossover femorofemoral bypass graft.

MANAGEMENT

Intravenous antibiotic coverage for the MSSA infection and systemic anticoagulation with

© Author(s) (or their employer(s)) 2020. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Tchorz K, Rozycki G, Feliciano DV. *Trauma Surg Acute Care Open* 2020;**5**:e000547.

Trauma Surg Acute Care Open: first published as 10.1136/tsaco-2020-000547 on 3 November 2020. Downloaded from http://tsaco.bmj.com/ on April 18, 2024 by guest. Protected by copyright.

unfractionated heparin were administered for 2 days before the patient was returned to the operating room. The right inguinal extension of the previous midline laparotomy incision was reopened. Simultaneously, another member of the surgical team harvested a segment of the 8 mm in diameter contralateral femoral vein (formerly, superficial femoral vein) from the proximal and middle left thigh distal to the entrance of the profunda femoris vein.

Under continuing systemic anticoagulation, the right common iliac artery proximal to and the right external iliac artery distal to the infected PTFE graft were occluded with vascular clamps. The infected graft and surrounding tissues were then excised, the open wound was debrided with a curette and vigorous irrigation of the wound was performed with a saline-antibiotic solution. Appropriately sized Fogarty balloon catheters were passed into the proximal right common and distal external iliac arteries, but no clot was retrieved. The femoral vein interposition graft was then sewn in place with continuous 5–0 polypropylene sutures on both anastomoses. Appropriate flushing was performed before tying down the first knot on the distal anastomosis. As right pedal pulses were immediately palpable, the plastic surgery service scrubbed in and rotated a right sartorius muscle flap to cover the new interposition graft. The open oblique incision was irrigated again and closed in layers.

During the patient's postoperative course, a right groin seroma developed and was aspirated percutaneously. The culture of this fluid was negative for bacterial growth. The remainder of the postoperative course including completion of a 10-day course of intravenous antibiotics against MSSA was uneventful. His oblique incision in the right lower quadrant healed well, there was no edema in the left lower extremity and he was discharged with a normal white blood cell count on postoperative day 12.

DISCUSSION

Penetrating wounds to the distal external iliac artery are difficult to expose as the vessel passes under the inguinal ligament. The preferred operative approach is to make the standard midline laparotomy incision for proximal control of the external iliac artery and a longitudinal groin incision for distal control of the common femoral artery. The other option of dividing the inguinal ligament still mandates a longitudinal groin incision and has the following disadvantages: (1) once divided, the inguinal ligament cannot be reconstructed; (2) a layer of soft tissue coverage over a newly inserted vascular graft is missing and (3) there is presumably a future risk of an inguinal hernia.

The common and external iliac arteries should never be ligated.[1] As documented in the review of arterial injuries in World War II by the late Michael E. DeBakey and Fiorindo A. Simeone, the amputation rates after ligation of injuries to the common and external iliac arteries was 58.3% (7/13) and 46.7% (14/30), respectively.[2] During a 'damage control' operation in which there is a significant injury to either vessel, a temporary intra-arterial shunt should be inserted.[3 4] The shunt will preserve arterial inflow to the ipsilateral lower extremity as the patient is stabilized in the intensive care unit and a perioperative antibiotic is infused if the patient had significant gastrointestinal contamination at the original operation.

The multiple options to repair an injured common or external iliac artery include the following: lateral arteriorrhaphy; segmental resection and an end-to-end anastomosis or insertion of a saphenous vein or PTFE graft; mobilization and division of the ipsilateral internal iliac artery to serve as a replacement for the proximal external iliac artery; or transposition of one common iliac artery to the side of the contralateral common iliac artery for wounds near the aortic bifurcation.

When there is enteric or colonic contamination in addition to a significant injury to the common or external iliac artery mandating a segmental resection, the surgeon must ask the following questions:

**Is it safe to insert an interposition graft?

**If so, which graft is most appropriate?

**If it is not safe, which extra-anatomic bypass is most appropriate?

With modest enteric or colonic contamination in the upper abdomen, all trauma surgeons will insert an interposition graft into the injured artery in the pelvis. When the surgeon has touched or clamped the holes in the gastrointestinal tract before starting the arterial repair, the following should be done: (1) change gloves; (2) irrigate the abdomen and pelvis with a saline-antibiotic solution; (3) wall off the gastrointestinal injuries with another sterile drape; and (4) cover the saphenous vein or PTFE graft in the common or external iliac artery with closure of the retroperitoneum or with a vascularized pedicle of greater omentum. Depending on the length of the pedicle, the omentum can be tacked down to cover the graft anteriorly and laterally or wrapped circumferentially around the graft.[5]

An autogenous saphenous vein graft from an uninjured lower extremity is the preferred choice for an interposition graft in the common or external iliac artery. The problem is that these vessels have an 8 to 12 mm diameter in most male patients. And, a saphenous vein graft in a young patient may not dilate to this size. Until there is more experience with biological vascular grafts, the alternative to a saphenous vein is a PTFE interposition graft.[6 7]

In an adult male patient, the minimum diameter of a PTFE interposition graft for insertion into the common or external iliac artery should be 8 mm. It has been known for 40 years that PTFE grafts develop neointimal hyperplasia, particularly at the distal anastomosis, pseudointimal hyperplasia in the remainder of the graft and atheromatous changes throughout.[8 9] These changes narrow the lumen of the graft over time, so the largest appropriate PTFE graft should be inserted in all locations.

Appropriate intraoperative technique (skin always covered as graft inserted) and early removal of vascular lines and other catheters have always kept the incidence of Gram-positive (especially *Staphylococcus* species from the skin or bloodstream) or Gram-negative infections (groin skin or source often unclear in elective operations) low in both elective and trauma vascular surgery. Unfortunately, such an infection developed in this patient, and he presented with the usual symptoms and signs. Other patients with infected grafts in this location (pelvis-to-groin) have presented with a presumed incisional infection in the groin which is actually an extension of the perigraft infection. The most lethal complication of an infected graft in this location or in the abdomen alone is sudden hemorrhage from dissolution of a saphenous vein graft or rupture of a false aneurysm at a PTFE-artery suture line.

A special clinical scenario is when the patient has 'significant' enteric or colonic contamination of the abdomen and pelvis and need for segmental resection of an injured common or external iliac artery. This is clearly a high risk situation for the development of a postoperative graft infection. While unpleasant, the surgeon should consider a 'prophylactic' operation to avoid the potentially lethal postoperative complication described above. The first step would be ligation of the proximal and distal ends of the injured artery with a double continuous row of 4–0 or 5–0 polypropylene sutures. Then, the stumps are covered with

Trauma Surg Acute Care Open: first published as 10.1136/tsaco-2020-000547 on 3 November 2020. Downloaded from http://tsaco.bmj.com/ on April 18, 2024 by guest. Protected by copyright.

uninjured retroperitoneum or the previously mentioned viable pedicle of greater omentum. To restore arterial inflow to the ipsilateral lower extremity, an extra-anatomic bypass such as a crossover femorofemoral bypass avoiding the most inferior aspect of the midline incision or a unilateral axillofemoral bypass using an 8 mm. Externally supported PTFE graft is performed at the first or second operation after trauma. Patency at 1 and 2 years will be 5% to 20% higher for the femorofemoral bypass graft.[10]

Should an infection occur in an interposition graft in the common or external iliac artery, a reoperation is performed to remove the graft and surrounding soft tissue as in the patient described. In situ graft replacement is preferred using the contralateral femoral vein. This is based on the numerous reports by Patrick Clagett and James Valentine from the University of Texas Southwestern at the time.[11 12] These reports describe the operative technique and outcomes of patients with infected grafts in the infrarenal abdominal aorta treated with resection and replacement with the femoral vein—the so called 'neo-aortoiliac system'. One of the main concerns about this procedure has been the potential morbidity of removing the main venous drainage of a lower extremity.

In one of their postoperative studies of 61 patients with harvest of the femoral vein from 86 limbs, mild leg edema was present in 31% and varicose veins developed in 2 patients at a mean of 3 years postoperatively.[13]

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Commissioned; internally peer reviewed.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

REFERENCES

1. Feliciano DV, Asensio JA. Abdominal vessels. In: Feliciano DV, Mattox KL, Moore EE, *Trauma*. Ninth Edition. New York: McGraw-Hill Education, 2021:747–70.
2. DeBakey ME, Simeone FA. Battle injuries of the arteries in World War II. An analysis of 2,471 cases. *Ann Surg* 1946;123:534–79.
3. Feliciano DV, Subramanian A. Temporary vascular shunts. *Eur J Trauma Emerg Surg* 2013;39:553–60.
4. Ball CG, Feliciano DV. Damage control techniques for common and external iliac artery injuries: have temporary intravascular shunts replaced the need for ligation? *J Trauma* 2010;68:1117–20.
5. Yokoyama H, Maida K, Takahashi S, Tanaka S. Purulently infected abdominal aortic aneurysm: in situ reconstruction with transmesocolic omental transposition technique. *Cardiovasc Surg* 1994;2:78–80.
6. Jaspan VN, Hines GL. The current status of tissue-engineered vascular grafts. *Cardiol Rev* 2015;23:236–9.
7. Feliciano DV, Mattox KL, Graham JM, Bitondo CG. Five-Year experience with PTFE grafts in vascular wounds. *J Trauma* 1985;25:71–82.
8. Echave V, Koornick AR, Haimov M, Jacobson JH. Intimal hyperplasia as a complication of the use of the polytetrafluoroethylene graft for femoral-popliteal bypass. *Surgery* 1979;86:791–8.
9. Selman SH, Rhodes RS, Anderson JM, DePalma RG, Clowes AW. Atheromatous changes in expanded polytetrafluoroethylene grafts. *Surgery* 1980;87:630–7.
10. Hardouin S, Cheng TW, Farber A, Kalish JA, Jones DW, Malas MB, Rybin D, Oriel BS, Plauche LM, Siracuse JJ. Axillary-bifemoral and axillary-unifemoral artery grafts have similar perioperative outcomes and patency. *J Vasc Surg* 2020;71:862–8.
11. Clagett GP, Valentine RJ, Hagino RT. Autogenous aortoiliac/femoral reconstruction from superficial femoral-popliteal veins: feasibility and durability. *J Vasc Surg* 1997;25:255–70.
12. Valentine RJ, Clagett GP. Aortic graft infections: replacement with autogenous vein. *Cardiovasc Surg* 2001;9:419–25.
13. Wells JK, Hagino RT, Bargmann KM, Jackson MR, Valentine RJ, Kakish HB, Clagett GP. Venous morbidity after superficial femoral-popliteal vein harvest. *J Vasc Surg* 1999;29:282–91.

Trauma Surg Acute Care Open: first published as 10.1136/tsaco-2020-000547 on 3 November 2020. Downloaded from http://tsaco.bmj.com/ on April 18, 2024 by guest. Protected by copyright.