Original Article

Surgical management of iatrogenic vascular injuries

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ABSTRACT

Objective: Iatrogenic vascular injury is an abnormal state that occurs in patients as a result of inadvertent or erroneous treatment by physicians or surgeons. We describe our 10 year experience with patients who underwent surgical repair of iatrogenic vascular injuries after catheterization or operation.

Methodology: Thirty one patients with iatrogenic vascular injury incurred between February 2001 and February 2011 who were surgically managed in our Department were reviewed retrospectively. The clinical presentation, localization and type of vascular injury were each analyzed.

Results: This study group consisted of 19 males and 12 females, ranging in age from 16 to 69 years with an average age of 47.8 years. Of the 31 iatrogenic vascular injuries, 19 resulted from a percutaneous procedure and 12 were sustained intraoperatively. The intraoperative iatrogenic injuries affected the inferior vena cava in three patients, left renal vein in one, external iliac artery in four, common carotid artery in three, and internal carotid artery in one. Eleven patients associated with catheterization were operated on immediately. The remaining eight were operated on an elective surgical basis (Pseudoaneurysm or arteriovenous fistula). All patients made an uneventful recovery.

Conclusion: Although experience and thorough knowledge of the vascular anatomy can prevent many potential iatrogenic vascular injuries, the risk of iatrogenic vascular injury cannot be completely eliminated. Therefore, we recommend that major operations requiring dissection in proximity to the vascular structures, and catheter based diagnostic or therapeutic procedures should be performed only in hospitals with an established vascular surgery department.

KEY WORDS: Vascular injury; Iatrogenic.

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INTRODUCTION

Iatrogenic vascular injury is an abnormal state that occurs in patients as a result of inadvertent or erroneous treatment by physicians or surgeons.[1] As the care of surgical patients becomes increasingly complex and catheter-based techniques are more frequently employed, the incidence of iatrogenic vascular injuries may be increasing.[2]

Because of the low incidence of iatrogenic vascular injuries, the literature consists mostly of case reports, and the optimal management remains unclear.[3] Especially, a paucity of literature exists concerning the management of iatrogenic operative vascular injuries.[4] We describe our 10-

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year experience with patients who underwent surgical repair of iatrogenic vascular injuries after catheterization or major surgical operation.

METHODOLOGY

Thirty one patients with iatrogenic vascular injury incurred between February 2001 and February 2011 who were surgically managed in our Department were reviewed retrospectively. Vascular injury was caused by iatrogenic catheter-related trauma or iatrogenic operative vascular trauma. All operative injuries were serious enough to warrant emergent intraoperative vascular surgery consultation for massive bleeding control and definitive reconstruction.

An iatrogenic vascular injury was defined as an injury sustained to a main blood vessel (excluding those originating directly from the heart and those distal to wrist and ankle joint) during surgical or percutaneous intervention requiring vascular repair.

The clinical presentation, localization and type of vascular injury were each analyzed. Initial control of the intraoperative vascular injuries was accomplished by manually compressing the site of the bleeding while dissecting the area surrounding the injury in order to apply definitive vascular control with vascular clamps. We have avoided applying blind clamping and special attention was paid to its application and handling so that further iatrogenic vascular injury was avoided. Before compression or vascular clamping, all patients were given intravenous heparin (5000 U). Operative injuries were repaired immediately.

The catheter-related injuries were diagnosed according to a combination of signs, symptoms, and Color Flow Duplex Imaging (CFDI) findings. CFDI identified the precise location of the vascular lesion in these patients. Criteria for surgical intervention were increased skin pressure, rapid expansion, hypotension, concomitant distal ischemia, and massive hematoma (Fig.1).

Fig.1: Catheter-induced massive pulsatile hematoma.

All patients received intravenous prophylactic antibiotics, which were continued postoperatively for 2 to 5 days, unless prolonged use was dictated by the presence of contamination or infection. Two months after hospital discharge, patients were examined by ultrasonographic investigation.

RESULTS

This study group consisted of 19 males and 12 females, ranging in age from 16 to 69 years with an average age of 47.8 years. Of the 31 iatrogenic vascular injuries, 19 resulted from a percutaneous procedure (Table-I) and 12 were sustained intraoperatively. Percutaneous procedure resulted in injuries to the femoral artery in all patients except one patient with brachial artery median vein fistula (Fig.2). All the iatrogenic vascular injuries of the abdomen and neck occurred during surgery. These injuries resulted from aggressive tumor resections performed by non-vascular surgeons and life-threatening massive bleeding was the presenting symptom. These patients had hostile or distorted anatomy with difficult dissection.

The intraoperative iatrogenic injuries were affected the inferior vena cava in three patients, left renal vein in 1, external iliac artery in 4, common carotid artery in 3, and internal carotid artery in 1. The injuries involving the inferior vena cava occurred during resection of a gynecologic tumor in two patients and during resection of a kidney tumor in one patient. Caval injuries were repaired

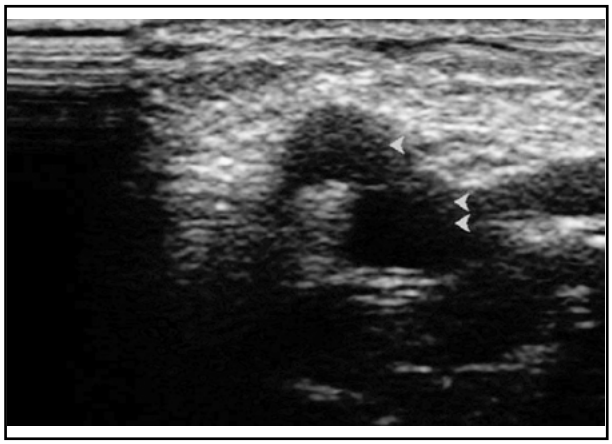

Fig.2: Arteriovenous fistula between radial artery and median vein.

Table-I: Types of catheter-related iatrogenic vascular injuries.

Type of injury	*No. of patients*
Coronary angioplasty-stent	12
Coronary angiography	4
Peripheral angiography	2
Inra-aortic ballon	1
Total	19

with lateral venorrhaphy. In one patient, a partial laceration of the left renal vein occurred during nephrectomy and it was also repaired by lateral venorrhaphy.

Iliac artery injuries occurred during pelvic tumor resection in three patients, and gynecologic operation in one patient. These injuries were repaired by lateral repair in two patients, end-to-end anastomosis in one patient, and PTFE interposition graft in one patient.

Four patients underwent primary vascular repair due to iatrogenic carotid artery injury common carotid artery in three patients and internal carotid artery in one patient). These four patients had been operated on due to glomus tumor or malignancies of the neck.

The commonest causal factor for catheter induced injuries was coronary angiography with angioplasty/stenting (n=12). In eleven patients associated with catheterization, ultrasonograpic examination confirmed massive hematoma and active bleeding from the superficial femoral artery (six patients) and common femoral artery (five patients). They were operated on immediately, the hematoma was excavated, and the defect at the anterior aspect of the femoral artery was repaired with direct suture. The remaining eight cases associated with catheterization were operated on an elective surgical basis (six patients with femoral artery pseudoaneurysm, one patient with femoral arteriovenous fistula, and one patient with brachial artery median vein fistula). In six patients with pseudoaneurysm, pseudoaneurysm was located in the superficial femoral artery and traditional surgical repair was performed. Hematoma was evacuated and arterial defect was repaired with patch angioplasty. In the remaining two patients with arteriovenous fistula, fistulectomy was performed. Following the repair of catheter-induced vascular injuries, all limbs were salvaged.

Postoperative complications included one groin wound infection. Infection was controlled by antibiotic treatment and debridement. All patients made an uneventful recovery and were discharged home without incidences. Patency was evaluated by duplex ultrasonography in 23 patients (catheter-related injury in 19 patients and carotid injury in four patients) during the 2 month postoperatively. All repaired vessels were found patent. In the remaining eight patients with intraabdominal vascular injury, no venograms or other imaging studies were performed. However, there were no vascular injury-related complications, such as edema of the lower limbs. Peripheral pulses were patent in all.

DISCUSSION

Nowadays, incidence of iatrogenic vascular injuries has risen. This can perhaps be attributed to the rapid progress in medical care, including the introduction of many diagnostic and therapeutic procedures used in management of cardiovascular disease.[1] Additionally, Patients referred to major tertiary care centers often have advanced cancers that are deemed inoperable elsewhere. It is possible that these patients are predisposed to more serious iatrogenic vascular injuries because of the aggressiveness of surgical management.[4] Therefore, it can be expected that iatrogenic major vascular injuries will continue to increase, and may become more frequent. In this series, we excluded simple iatrogenic vascular injuries and therefore underestimated the true incidence of iatrogenic vascular injuries, because minor vascular injuries were probably repaired by the other department surgeons or treated with non-surgical procedures (compression therapy or sonographically guided thrombin injection) by cardiologists or radiologists.

Vascular surgeons are occasionally involved in the management of patients with vascular injuries sustained during elective operations. Although serious iatrogenic injuries are relatively rare, they are associated with potential catastrophic complications and carry substantial risk for death.[4] Expert repair of these intraoperative injuries by a vascular surgeon is recommended, to minimize the risks of complications.[5]

In major abdominal venous injuries, a common mistake in attempting to gain vascular control before obtaining vascular surgical assistance is the forceful use of clamps around the vein, resulting in additional injuries. Direct digital pressure or sponge compression with sponge sticks proximal and distal to the injury site is a more effective and safe means of obtaining rapid vascular control.[4]

Injuries involving low-pressure and high-flow venous systems in difficult anatomic locations are

especially treacherous. Prompt identification and optimal surgical repair of such injuries during the procedure are critical for determining outcome. After bleeding is controlled, venous reconstruction should be attempted.[5] Venous repair must be meticulous because reduction in the caliber can result in occlusion. Adequate debridement of the vein margins and a tension-free repair can produce effective patency.[6]

Iatrogenic injuries of carotid arteries are seldom complications and most often happened during oncologic operations of the neck, when the carotid artery is involved by the tumor mass.[7] Cervical carotid lacerations may be managed best with endovascular repair or open surgical repair. An advantage of open surgical exploration is that this approach allows inspection of the carotid laceration and associated injuries.[3] Injuries to the external carotid artery are usually managed by ligation. But internal and common carotid artery injuries should be repaired[8], as was done in our four patients.

Complications of catheterization are uncommon, but when unrecognized or untreated they may have sequelae that are limb-threatening or even life-threatening. Early clinical identification and vascular surgery consultation are of the greatest importance.[9] Catheter-related iatrogenic injuries occur more often in elderly hypertensive patients with calcified arteries, in anti-coagulated patients, and when improper techniques are used.[10] They can be reduced, if the common femoral artery is punctured accurately. Catheterization of the atherosclerotic and hypoplastic arteries should be avoided.[1]

Reliable diagnosis of pseudoaneurysm and arteriovenous fistula can be confirmed non-invasively using CFDI, as was done in this series. Although angiography is a valuable method for the diagnosis of pseudoaneurysm, it may not show the difference among aneurysm, pseudoaneurysm, and hematoma.[11] Therefore, we have preferred CFDI instead of angiography.

The pathogenic mechanism of an arteriovenous fistula secondary to vessel puncture remains uncertain.[12] The brachial artery and the median cubital vein are anatomically very near each other and can thus easily communicate even with a simple puncture[13], as seen our one case.

Incidence of pseudoaneurysms is increased when more complex coronary and peripheral interventions are performed, especially with the use of potent antithrombotic and antiplatelet medication.[14] Furthermore, uneventful hospital discharge after a catheterization procedure does not exclude the possibility of a late onset arterial complication (pseudoaneurysms or arteriovenous fistulas).[9]

The femoral pseudoaneurysm is often located in the superficial femoral artery or the deep femoral artery because of a too short period of manual compression or a low puncture site. The common femoral artery is rarely involved because it is enclosed, together with the common femoral vein, within the femoral sheath and hemorrhage is partially limited by tamponade. Moreover, bony support is provided by the femoral head and the superior pubic ramus during arterial compression.[15] Also, at the level of the superficial and profunda femoris arteries, there is no bony support facilitating compression.[16] Also, pseudoaneurysms were located in the superficial femoral artery in this series.

Untreated femoral pseudoaneurysms can result in expansion, leakage, rupture, embolization, or compression of adjacent structures.[10] Therefore, several therapeutic strategies have been developed to treat these complications. They include ultrasound-guided compression repair, minimally invasive percutaneous treatment (thrombin injection, coil embolization and covered stents), and surgical repair.[17]

Color flow duplex-guided compression obliteration has become the first-line treatment of pseudoaneurysms at many institutions. It has been shown to be a safe and cost-effective method for achieving pseudoaneurysm thrombosis. However, it has considerable drawbacks including long procedure time, discomfort to patients, a relatively high recurrence rate in patients receiving anticoagulant therapy, and less successful in patients with large femoral artery pseudoaneurysm. Contraindications for compression therapy include limb ischemia, local ischemic skin necrosis, compromised runoff vessels, suspicion of infection or groin abscess, and inaccessible site.[10]

In many institutions, sonographically guided thrombin injection has replaced compression repair. The principle of thrombin injection into the pseudoaneurysm chamber is based on the fact that thrombin is important in the conversion of fibrinogen to fibrin.[14] This procedure is less painful, quicker and more successful than ultrasonography-guided compression repair.[17] Additionally, thrombin injection may be given in pseudoaneurysms located above the inguinal ligament, which are contraindicated for compression because of theoretic risk of intraperitoneal or extraperitoneal rupture.[10] The most feared complications are development

of deep venous thrombosis, pulmonary embolism, or arterial thrombosis and distal embolization.[14] Distal embolization is associated with short and wide pseudoaneurysm necks. Other complications include infection and allergic reactions to bovine thrombin with severity ranging from generalized urticaria to anaphylaxis.[17]

Surgical repair has been the traditional treatment, especially for those pseudoaneurysms that are actively bleeding, are infected, or when serious underlying arterial thrombotic complications have occurred.[10] Except for patients whose ischemic changes are overlooked for a prolonged time, the results of surgical repair are generally good[18], as seen in this series. However, some patients may suffer from unfortunate complications after any procedure, even with careful management. Therefore, it is important for every practitioner to keep in mind this possibility and to inform his or her patient of all the facts regarding the planned procedure.[18]

CONCLUSION

Although experience and thorough knowledge of the vascular anatomy can prevent many potential iatrogenic vascular injuries associated with surgical intervention or catheterization (diagnostic or therapeutic), the risk of iatrogenic vascular injury cannot be completely eliminated. In this study, all patients with surgery-induced iatrogenic vascular injuries had hostile or distorted anatomy with difficult dissection. This indicates that difficult dissection thus contributes to surgery-induced vascular injuries. Additionally, intraoperative collaboration with a cardiovascular surgeon can reduce the incidence of major iatrogenic vascular injury. Therefore, we recommend that major operations requiring aggressive resection in proximity to the vascular structures, and catheter based diagnostic or therapeutic procedures should be performed only in hospitals with an established vascular surgery department.

REFERENCES

1. Al Zahrani HA, Saleh TR. Iatrogenic vascular injuries in western Saudi Arabia. Cardiovasc Surg 1995;3:39-41.
2. Giswold ME, Landry GJ, Taylor LM, Moneta GL. Iatrogenic arterial injury is an increasing important cause of arterial trauma. Am J Surg 2004;187:590-593.
3. Jonker FHW, Indes JE, Moll FL, Muhs BE. Management of iatrogenic injuries of the supra-aortic arteries. J Cardiothorac Vasc Anest 2010;24:322-329.
4. Oderich GS, Panneton JM, Hofer J, Bower TC, Cherry KJ, Sullivan T, et al. Iatrogenic operative injuries of abdominal and pelvic veins: A potentially lethal complication. J Vasc Surg 2004;39:931-936.
5. Oktar GL. Iatrogenic major venous injuries incurred during cancer surgery. Surg Today 2007;37:366-369.
6. Bergan JJ, Dean RH, Yao JS. Vascular injuries in pelvic cancer surgery. Am J Obstet Gynecol 1976;15:562-566.
7. Dorobisz AT, Rybak Z, Skora J, Pupka A, Patrzalek D, Stepinski P, et al. Iatrogenic injuries of the carotid arteries. VASA 2005;34:192-194.
8. Asfar S, Al-Ali J, Ben-Nakhi M. Repair of common carotid artery injury with an external carotid artery flap. Med Princ Pract 2004;13:292-294.
9. Filis K, Arhontovasilis F, Theodorou D, Albanopoulos K, Lagoudianakis E, Manouras A, et al. Management of early and late detected vascular complications following femoral arterial puncture for cardiac catheterization. Hellenic J Cardiol 2007;48:134-142.
10. Heis HA, Bani-Hani KE, Elheis MA, Yaghan RJ, Bani-Hani BK. Postcatheterization femoral artery pseudoaneurysms: Therapeutic options. A case-controlled study. Intern J Surg 2008;6:214-219.
11. Demirbas O, Batyraliev T, Eksi Z, Pershukov I. Femoral pseudoaneurysm due to diagnostic or interventional angiographic procedures. Angiology 2005;556:556.
12. Chapron CM, Pierre F, Lacroix S, Querleu D, Lansac J, Dubuisson JB. Major vascular injuries during gynecologic laparoscopy. J Am Coll Surg 1997;185:461-465.
13. Barros MB, Lozana FS, Queral L. Vascular injuries during gynecological laparoscopy-the vascular surgeon's advice. Sao Paolo Med J 2005;123:38-41.
14. Webber GW, Jang J, Gustavson S, Olin JW. Contemporary management of postcatheterization pseudoaneurysms. Circulation 2007;115:2666-2674.
15. Imsand D, Hayoz D. Current treatment options of femoral pseudoaneurysms. VASA 2007;36:91-95.
16. Rapoport S, Sniderman KW. Pseudoaneurysm: A complication of faulty technique in femoral arterial puncture. Radiology 1985;154:529-530.
17. Stone PA, AbuRahma AF, Flaherty SK, Bates MC. Femoral pseudoaneurysms. Vasc Endovasc Surg 2006;40:109-115.
18. Hatakeyama T, Shigematsu H, Muto T. Results of surgical treatment for vascular injuries. Surg Today 2000;30:235-240.