CASE REPORTS

Major retroperitoneal vascular injury during laparoscopic surgery

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We sought to assess the outcome of large retroperitoneal vascular injury that occurred during operative laparoscopy but was not related to trocar or Veress needle injury. We conducted a retrospective review of cases operated and reviewed by our centres. Eight cases were identified. Four women were undergoing lymphadenectomy, where vascular injury is a recognized risk. Distorted anatomy was a compounding factor in three of the remaining four patients who were undergoing intraperitoneal procedures. The injuries involved the inferior vena cava ($n = 2$), the right external iliac artery ($n = 2$), the left external iliac artery ($n = 1$), the right external iliac vein ($n = 1$), the hypogastric artery ($n = 1$) and the inferior mesenteric artery ($n = 1$). Injuries were caused by unipolar electrode ($n = 1$), electrosurgical scissors ($n = 3$), sharp scissors ($n = 2$) and CO_2 laser ($n = 2$). The vessel injury was repaired at laparotomy in four women. The other four cases were managed laparoscopically. Transfusion attributable to the vascular injury occurred in two cases. The outcome in all cases was good, except for one in which the patient died. These cases demonstrate that all energy sources used without proper understanding and caution can cause significant vascular injury. The adequacy and safety of laparoscopic control of major vessel bleeding should be investigated further and consultation with a vascular surgeon should be considered in all cases.
Key words: laparoscopy/management/prevention/vascular injury

Introduction

Injury to retroperitoneal large blood vessels is a rare but potentially catastrophic complication of laparoscopy (Katz *et al.*, 1979; Peterson *et al.*, 1982; Kurzel and Edinger, 1983; Baadsgaard *et al.*, 1989). In a literature review, Baadsgaard *et al.* (1989) found 15 cases of major vascular injury during gynaecological laparoscopy. All occurred during insertion of the Veress needle or the trocar and required management by laparotomy (Baadsgaard *et al.*, 1989). As the number and complexity of laparoscopic procedures increases, the risk of complications is unavoidably increased. In the past, major vascular injuries have always been associated with operative procedures that were extremely unlikely to result in this complication. Unfortunately, this has not changed. Operative laparoscopists with little experience, unfamiliar with energy sources and confronted with a distorted anatomy are still responsible for the majority of these complications. However, this may change as more procedures for abdomino-pelvic pathology are being performed laparoscopically.

We present eight cases of large retroperitoneal vascular injuries that occurred during operative laparoscopy but were not caused by trocars or Veress needles. Four cases were associated with lymphadenectomy, where vascular injury is a known risk, and four cases were associated with intraperitoneal procedures for benign disease, where the likelihood of these complications is significantly lower.

Case reports

Over a 5 year period, eight cases of large vessel injury came to our attention (Table I). Five cases were operated by the authors at two different centres (nos. 4–8; University of Arizona, Tucson, AZ, USA and Center for Special Pelvic Surgery, Atlanta, GA, USA). The remainder were submitted to the authors as medico-legal consults or personal communications (nos. 1–3).

Four women were undergoing lymph node dissection, three were being treated for endometriosis or adhesions and normal anatomy was distorted, and one was having salpingostomy to remove an ampullary ectopic pregnancy (Table I). Injuries were to the inferior vena cava ($n = 2$), the right or left external iliac artery ($n = 3$), the right hypogastric artery ($n = 1$), the right external iliac vein ($n = 1$) and the inferior mesenteric artery ($n = 1$). The vascular laceration was caused by unipolar electrosurgery in four cases and by carbon dioxide (CO_2) laser in two cases. In the remaining two cases injury to the artery or vein occurred during sharp dissection.

The vessel injury was repaired by the conventional open technique in four women. The remaining four cases were managed laparoscopically, three by applying metal clips on the vessel wall and one with bipolar electro-desiccation ($n = 6$).

Table I. Patient information and summary of results

Patient no.	Age (years)	Indication	Operation	Injury	Mechanism	Laparoscopic repair	Outcome
1	28	Right ampullary tubal pregnancy	Right salpingostomy	Right external iliac artery	Unipolar electrode	No	Good
2	42	Chronic pelvic pain	Omental adhesiolysis	Left external iliac artery	Unipolar scissors	No	Death
3	16	Chronic pelvic pain	Adhesiolysis	Right external iliac artery	CO_2 laser	No	Good
4	28	Endometriosis, adhesions	Vaporization of pelvic wall endometriosis	Hypogastric artery	CO_2 laser	Yes, bipolar desiccation	Good
5	60	Second look for ovarian cancer	Pelvic node dissection	Inferior vena cava	Electrosurgical scissors	No	Good
6	58	Adnexal mass	Right para-aortic node dissection	Inferior vena cava	Sharp scissors	Yes, surgical clips	Good
7	33	Cervical cancer	Node dissection	Inferior mesenteric artery	Sharp scissors	Yes, surgical clips	Good
8	56	Second look for ovarian cancer	Biopsy of obturator and external iliac nodes	Right external iliac vein	Electrosurgical scissors	Yes, surgical clips	Good

Case 1

A 28 year old patient underwent operative laparoscopy for a right ampullary unruptured ectopic pregnancy. The tube containing the ectopic pregnancy was lying over the external iliac artery. A unipolar needle electrode was used to create the salpingostomy. The tube was not elevated off the underlying artery during the salpingostomy. The incision penetrated the opposite side of the tube and the underlying artery. Severe bleeding and an expanding retroperitoneal haematoma were noticed which, despite the application of direct pressure, worsened. Immediate laparotomy was performed and a 4 cm laceration over the right external iliac artery was repaired by vascular surgeons using a fine suture. Her post-operative course was uneventful.

Case 2

A 42 year old patient, gravida 1, para 1, with a history of total abdominal hysterectomy and bilateral salpingo-oophorectomy presented for a diagnostic and operative laparoscopy for chronic pelvic pain. During the separation of omental adhesions from the left pelvic sidewall using unipolar scissors, a small amount of bleeding was noticed. While attempting to coagulate the bleeding using unipolar electrocautery, the surgeon perforated the external iliac artery. Profuse haemorrhaging followed, which the surgeon unsuccessfully attempted to control using unipolar electrocautery. Laparotomy was then performed and the lacerated vessel was repaired. The patient lost a significant amount of blood and required transfusion. She arrested on the operating table and was resuscitated, but died the following day. In reviewing the video, it was noted that the anatomy was distorted by the adhesions, and the surgical site was not clear.

Case 3

A 16 year old patient, gravida 0, with a history of pelvic inflammatory disease and appendectomy presented for a diagnostic and operative laparoscopy for chronic pelvic pain.

During lysis of adhesions between the caecum and lateral sidewall using the CO_2 laser, the right external iliac artery was traumatized, which caused significant active bleeding. A laparotomy was performed by the operating surgeon, and the laceration was identified on the right external iliac artery which was repaired using interrupted 5-0 polyglactin suture. After haemostasis was assured, the abdomen was closed. However, a pedal pulse examination revealed no palpable pulse from the right femoral artery. A vascular consult was obtained and the patient was re-explored. A hole was identified in the anterior wall of the right external iliac artery between the sutures placed earlier. The perforation was repaired with fine sutures and circulation apparently resumed. The following day, she underwent another exploration and extensive resection and grafting because of complications and thrombosis. This patient was discharged without further complications and had a full-term pregnancy 3 years later. The videotape shows that during lysis of the pelvic wall adhesions, the operator was apparently unaware of the anatomy of the pelvic wall vessels, and the CO_2 laser was used without a backstop.

Case 4

A 28 year old female with a history of pelvic endometriosis and adhesions underwent diagnostic and operative laparoscopy. During excision of peritoneal endometriosis involving the right pelvic sidewall near the origin of the uterine artery, the lower portion of the hypogastric artery was perforated with the CO_2 laser. The lacerated blood vessel was immediately grasped with three 5 mm atraumatic grasping forceps to decrease pulse pressure. The adjacent pelvic ureter was identified after the accumulated blood was removed from the peritoneal cavity. A Kleppinger bipolar forceps was used to desiccate the artery. The injury site was observed under low pneumoperitoneal pressure for 5 min. After haemostasis was ensured and the integrity of the ureter was confirmed, the procedure was completed. Transfusion was not required and there were no other complications. The patient was discharged home without

any post-operative complications after a 2 day hospital stay and experienced no sequelae during a follow-up of >5 years.

Case 5

A 60 year old patient (gravida 6, para 6) with a history of ovarian carcinoma underwent a second-look laparoscopy. After a thorough inspection of the intraperitoneal cavity and multiple biopsies with no disease discovered on frozen section, a lymphadenectomy was performed. During removal of the lymph node bundle overlying the vena cava, a venotomy was created using scissors for sharp dissection. Bleeding was minimal, despite an obvious visible hole in the vena cava. An immediate laparotomy was then performed and the anterior wall injury was successfully repaired with 5-0 Prolene.

In the short time it took to perform an emergency laparotomy, the patient lost a significant amount of blood after removal of pneumoperitoneum pressure. She required a transfusion of four units of packed red blood cells and post-operatively developed a deep vein thrombosis of the lower vena cava and right common iliac vein. She was discharged home on post-operative day 10.

Case 6

A 58 year old patient underwent an operative laparoscopy for an adnexal mass. Laparoscopically assisted vaginal hysterectomy and bilateral salpingo-oophorectomy were performed, and frozen section confirmed an ovarian carcinoma. Surgical staging was performed laparoscopically for this apparent stage I ovarian cancer. During removal of the lymph node package over the lower inferior vena cava, a small hole was created on the surface of the vena cava. It was believed to be the site of entrance of a perforating vein. Bleeding was persistent despite pressure with a gauze pad for 5 min. Haemostasis was ultimately achieved by grasping the venotomy site with atraumatic forceps and applying two surgical clips through a suprapubic midline port. Haemostasis was confirmed under low pneumoperitoneum pressure. The post-operative course was uneventful. The patient did not require transfusion and did not develop a deep vein thrombosis. She was discharged home on post-operative day 2.

Case 7

A 33 year old patient with a stage IB squamous cell cancer of the cervix was undergoing a pelvic and para-aortic lymphadenectomy before laparoscopic radical hysterectomy. During the left para-aortic lymphadenectomy, the inferior mesenteric artery was cut but not completely transected. The artery was successfully occluded laparoscopically using surgical clips. Transfusion was necessary because of combined blood loss from the radical hysterectomy and the injured inferior mesenteric artery. Intra-operatively, there did not appear to be compromised blood flow to the rectosigmoid colon. There were no post-operative complications, either immediate or long term, and the patient is now >2 years out from her surgery.

Case 8

A 56 year old female with a history of ovarian carcinoma underwent a second-look laparoscopy. After discovering no

evidence of persistent intraperitoneal disease, a pelvic lymphadenectomy was attempted. She had had a previous pelvic lymphadenectomy and lymph nodes contained metastatic ovarian carcinoma. The peritoneum was densely adherent to the underlying external iliac vessels and, in opening of the retroperitoneal space, the external iliac vein was opened as well. Bleeding was minimal, despite a 5–6 mm venotomy. The vein was dissected free from the peritoneum and repaired with three endoscopically placed clips. The patency of the vein was maintained. No transfusions were required as blood loss was minimal. No deep vein thrombosis developed and the patient was discharged on post-operative day 1.

Discussion

Laparoscopic injury to large retroperitoneal vessels has been attributed to 'operator inexperience, as well as faulty technique and inadequate knowledge of the anatomy' (Kurzel and Edinger, 1983). Unfortunately, this is still true. The incidence of this potentially catastrophic complication is now increased with the introduction of advanced procedures, such as lymph node dissection and treatment of severe pelvic endometriosis. A certain degree of risk for vascular injury must be considered inevitable, even for the most experienced laparoscopic surgeon, during these procedures. Laparoscopic surgical dissection requires modalities such as sharp dissection, monopolar electricity and lasers, which are powerful enough to cause significant vascular injury. The surgeon must be familiar with the physics of surgical instruments and their potential injuries. When using the CO_2 laser, a backstop is required, either an instrument such as a suction–irrigation probe or a layer of water created with hydrodissection (Nezhat *et al.*, 1995). As the surgeon views the field in two dimensions and the control of these instruments is different from that of the traditional scalpel, skill and experience are essential for safe laparoscopic operations. Tissue manipulation is also different at laparoscopy. This lack of dimension and reduced palpation can easily lead to disorientation and dissection in the wrong surgical plane, which can in turn result in significant complications. Several of the complications detailed above can be attributed to this special laparoscopic environment.

The potential catastrophic nature of major blood vessel injury cannot be over-emphasized. In almost all cases, laparotomy should be performed immediately, and local pressure applied (with hands, packs or vascular clamps) until a vascular surgeon is available to correct the vascular damage (Nordestgaard *et al.*, 1995). To manage this type of injury laparoscopically, the surgeon should atraumatically grasp the vessel to temporarily control the bleeding and obtain an unobstructed view. After any free blood is suctioned, the vessel must be clearly isolated before management is attempted. The only case in the present series which resulted in the patient's death (no. 2) should serve as a warning. In this case, control of active bleeding was critically delayed.

Laparoscopic management of a large retroperitoneal vascular injury should only be attempted by a highly experienced surgeon and only when there is no possibility of compromising short- or long-term results. Laparoscopic techniques used to

control bleeding from injury to large retroperitoneal blood vessels have not been fully elucidated. Arteries and veins that can be sacrificed without untoward consequences may be occluded using standard laparoscopic techniques such as clips or bipolar electricity. When large veins are injured, the surgeon should first decide whether total occlusion or repair to maintain patency is the appropriate management. Then the surgeon must decide whether repair should be accomplished endoscopically or via laparotomy. We have successfully used clips to repair two large venous injuries which otherwise would have required laparotomy. While this technique is undoubtedly a deviation from the norm, the fact remains that repair was successfully accomplished by all measures. Those surgeons who believe traditional vascular suturing techniques are necessary may consider temporary placement of clips to prevent blood loss during laparotomy.

If bipolar electro-desiccation is used to occlude large blood vessels, it is imperative that the surgeon understands the physics of this technique. The aim is to encircle, compress and fuse the vessel with the lowest degree of heating and the least volume of fusion. This results in the vessel wall collagen and elastic fibres fusing to obliterate the lumen of the vessel. We accomplish this using 20–25 W of high frequency electro-desiccation applied sequentially with repeated partial desiccation. We determine when desiccation is complete by visual inspection, and evaluate for bleeding under low pneumoperitoneal pressure. Using low levels of heat preserves the connective tissue's inherent fibrillar structure and limits thermal spread to surrounding tissues. Preventing overheating is important to avoid destruction of the tissue fibrillar structure, forming a less defined and stable coagulum, characterized by carbonization and loss of substance.

Theoretically, CO_2 embolism is a major concern when venotomy occurs. We have seen blood flow from our venous injuries, making this unlikely. However, the Venturi effect of sucking gas into the vein is always a possibility. This complication is most likely to occur if the Veress needle is inserted directly into the blood vessel. When surgery is undertaken in the retroperitoneal spaces, the surgeon and anaesthetist must be experienced in the recognition and management of CO_2 embolism. Gas embolism initially presents as cardiac arrhythmias and hypotension, and the classic 'mill wheel' murmur can be heard (Lantz and Smith, 1994). Management includes placing the patient in the left lateral decubitus position and advancing an i.v. catheter to the level of the superior vena cava or the right atrium to facilitate aspiration of the gas from the heart. Mechanical hyperventilation may enhance the elimination of CO_2.

While the focus of this series is on vascular injuries, any retroperitoneal structure is subject to inadvertent injury. Therefore, solid knowledge of the anatomy, the recognition of anatomically normal variation or distortion resulting from a disease process or previous surgery and the appropriate use of the energy source, whether mechanical or electrical, is mandatory.

This series shows that injury to the retroperitoneal vessels can occur during both intraperitoneal and retroperitoneal surgery. Whether a clear surgical error or a recognized risk of a

procedure, these complications can occur via blunt and sharp dissection, monopolar electrosurgery or laser-cutting devices. Safe application of these energy sources is imperative. Prompt recognition and appropriate action are necessary to lower or prevent the potential morbidity and mortality associated with these complications. In particular, surgeons performing laparoscopic lymphadenectomies should be prepared for this occurrence. Patients undergoing procedures where anatomy is likely to be distorted or vascular injury is a recognized risk should be informed of the potential consequences of this complication.

References

Baadsgaard, S.E., Bille, S. and Egeblad, K. (1989) Major vascular injury during gynecologic laparoscopy. *Acta Obstet. Gynecol. Scand.*, **68**, 283–285.

Katz, M., Beck, P. and Tancer, M.L. (1979) Major vessel injury during laparoscopy: two cases. *Am. J. Obstet. Gynecol.*, **15**, 544–545.

Kurzel, R.B. and Edinger, D.D. (1983) Injury to the great vessels: a hazard of transabdominal endoscopy. *South. Med. J.*, **76**, 656–657.

Lantz, P.E. and Smith, J.D. (1994) Fatal carbon dioxide embolism complication attempted laparoscopic cholecystectomy — case report and literature review. *J. Forens. Sci.*, **39**, 1468–1480.

Nezhat, C.R., Nezhat, F.R., Luciano, A.A. *et al.* (eds) (1995) *Operative Gynecologic Laparoscopy: Principles and Techniques*. McGraw-Hill, New York, NY, USA, pp. 89–92.

Nordestgaard, A.G., Bodily, K.C., Osborne, R.W. Jr *et al.* (1995) Major vascular injuries during laparoscopic procedures. *Am. J. Surg.*, **169**, 543–545.

Peterson, H.B., Greenspan, J.R. and Ory, H.W. (1982) Death following puncture of the aorta during laparoscopic sterilization. *Obstet. Gynecol.*, **59**, 133–134.