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Surgical Approaches to Iatrogenic Vascular Injuries in Adults

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ABSTRACT

Surgical procedures can result in unforeseen vascular injuries. In cases of severe vascular injuries, the involvement of an experienced vascular surgeon in the operation can be life-saving. The aim of this study is to elucidate the surgical approaches and outcomes in vascular injuries that occurred during elective operations of various branches within our institution.

Between October 2014 and June 2018, 18 patients required surgery due to unexpected severe vascular injuries. Gender, age, injury site, elective operation, intervention to vascular injury, hemodynamic status, type of anesthesia, mean operation time, and post-operative status of the patients were retrospectively obtained from hospital database. Diagnostic tests and imaging methods were recorded, and the utilization of blood products used during the operation has been investigated. The intensive care unit and service follow-ups of the patients as well as their post-discharge controls were collected from hospital records.

Among the patients undergoing vascular intervention, 60% (n=11) experienced arterial injuries, while 40% (n=7) had venous injuries. When examining the type of intervention, all patients, except for one, underwent intervention by placing a side or cross-clamp on the vascular structure. Primary repair was performed in 11 patients, end-to-end repair in 2 patients, PTFE graft placement in 1 patient, saphenous vein interposition in 3 patients, and ligation in 1 patient. Two patients (11%) died during the surgery.

As a result, the surgeon should accurately and quickly evaluate findings such as unexplained hypotension, tachycardia, loss of pulse or heat loss during the operation, and should suspect vascular injury. It is possible to reduce mortality and morbidity rates when iatrogenic vascular injuries are diagnosed early.

Keywords: Complication, Per-operative, vascular grafting, iatrogenic vascular injury, endovascular

Introduction

Endo-vascular diagnosis and treatment methods have been used more widely and in increasing numbers in recent years *(1)*. There has also been a significant acceleration in general surgery, urology, spinal surgery and gynaecological laparoscopic interventions within the last decade. However, these interventions have also caused a marginal amount of iatrogenic vascular injuries (2, 3).

Data on iatrogenic vascular injuries are limited. In published studies, it was reported that the most important point was to prevent disaster scenarios with early decision-making and proactive intervention (4). Additionally, one should bear in mind the importance of the surgeon's level of competence and lack of experience as important factors for iatrogenic injuries (5).

In such conditions, the surgery team usually has no sufficient time to spare for diagnostic imaging methods in per-operative vascular injuries. Early localization of the injury site, rapid decision-making on the type of surgery, control of bleeding by providing hemodynamic stability, and the competence of the surgeon are the main determining factors.

In this study, we aimed to elucidate the average intervention time, intervention method and outcomes in vascular injuries that occurred during elective operations of various branches in our institution.

Materials and Methods

A total of 18 patients who were intervened during the operation between October 2014 and June 2018 have been analyzed retrospectively. The

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Gender, age, injury site, elective operation, intervention to vascular injury, hemodynamic status, type of anaesthesia, mean operation time, and postoperative status of the patients were obtained from the hospital database. Diagnostic tests and imaging methods were noted; additionally, blood and blood products used during the operation have been investigated. The intensive care unit and service follow-ups of the patients and their controls after discharge were collected from hospital records.

The patient data were collected without including minor injuries, injuries requiring elective intervention, and injuries that did not occur in the hospital. Pure vascular injuries observed during elective surgery were evaluated in the study.

Statistical Analysis: Patient data were evaluated via the SPSS 22 (IBM Corp, Armonk, NY, USA) program. Descriptive analyses were conducted using means and standard deviations of normally distributed variables. Frequencies and percentages were given for categorical and nominal variables.

Results

Of the 18 patients requiring emergency intervention, 60% (n=11) were male and 40% (n=7) were female. The mean age of the patients was 61.80 years (ranging between 46 – 75 years). No imaging modality was used in most cases, as urgent per-operative surgical intervention was required. Sixty per cent of vascular injuries were arterial, and 40% were venous. Thirteen of the patients were treated at the same incision site, and five patients had different (4 patients laparotomy, one patient retroperitoneal) incision localization. Big vessel injuries (aorta, inferior vena cava) occurred in 2 patients.

When the type of intervention was examined, all patients except one were intervened by placing a side or cross-clamp on the vascular structure. Primary repair was performed in 11 patients, end-to-end repair in 2 patients, PTFE graft placement in 1 patient, saphenous vein interposition in 3 patients, and ligation in 1 patient.

In total, 43 units of erythrocytes and 18 units of fresh frozen plasma were utilized. Due to a delay in clinical suspicion and serious blood loss, two patients died during the operation (Table 1).

Discussion

Given the nature of iatrogenic vascular injuries, a majority of the previous research has been conducted in a retrospective manner or limited to case reports. Iatrogenic vascular injuries constitute 48 – 75% of all vascular injuries (6). Iatrogenic vascular injuries can occur in surgical operations, endo-vascular interventions and laparoscopic procedures. Although rare, it is a unique complication that requires rapid treatment (6, 7). Deaths due to vascular injuries remain popular due to Princess Diana's death as a result of pulmonary vein laceration (8).

The increasing number of transluminal balloon angioplasty and endo-venous interventions in recent years contributed to the acceleration of iatrogenic cases. In published studies, in case the vascular surgeon was in the hospital and early intervention had been performed, possible complications were prevented. The rate of complications or sequelae was found to be higher in patients who have been admitted to the hospital after the event or intervened lately (9). In a study conducted in Turkey, the rate of iatrogenic vascular injury was found to be 1% (10). However, its exact prevalence is not known because there are no multi-centred studies involving large patient populations.

Arterial injuries are always more life-threatening than venous injuries, although it varies depending on the type of vascular injury. Hemodynamic instability occurring during the operation can often be the first clue of vascular injury. It can be life-saving if the surgeon keeps this issue in mind and pays attention to the anaesthetist's warnings.

Although signs of arterial injuries occur earlier in elderly patients, hypotension may not present itself in younger patients until 30-40% of the total blood volume is lost (11). Regarding our experience, patient management during the operation was the main determinant factor that delayed the intervention because the surgeons did not pay enough attention to vital warnings and did not suspect vascular injury.

It is sometimes possible to ensure the stability of the patient by placing a cross-clamp on the bleeding vessel. Blind clamping should be avoided as this can sometimes damage the vessel. The cross-clamp provides adequate exposure and allows good repair, and the possibility of damage to the vessel wall is low. Plaque on the posterior wall is common, especially in the femoral artery, and therefore, a side clamp can be placed.

Table 1. Outcomes of Interventions in Vascular Injuries

Injury Site	Type of ınjury	Elective operation	Spesifik vascular intervention	Blood Products given	Anesthesia	Outcome
Left iliac artery posterior wall	Disc punch	Lumbar disc surgery	Retroperitoneal approach, cross-clamp, primary repair	Four units of erythrocyte suspension	General	Successful
Abdominal aortic posterior wall	Disc punch	Lumbar disc surgery	Emergency laparotomy, cross-clamp Aortotomy, posterior repair	12 units of erythrocytes	General	Unsuccessful
Right carotid artery anterior-posterior wall	Dialysis catheter - dilator	Dialysis catheter insertion	Exposure, cross country clamp,	Four units of plasma	Local	Successful
Right subclavian artery anterior wall	Dialysis catheter-dilator	Dialysis catheter indication	End-to-end anastomosis	Two units of erythrocytes	Local	Successful
Right popliteal artery full-thickness incision	Bone saw	Total knee replacement	Subclavian approach, cross-clamp	not given	General	Successful
Right carotid artery	Dialysis catheter-dilator	Dialysis catheter indication	Primary repair	Four units of erythrocytes	Local	Successful
Front wall / vena cava inferior	Blunt clamp	Nephrectomy	Exposure, side clamp,	Two units of plasma	General	Successful
Inferior vena cava	Blunt dissection	Hysterectomy	Saphenous vein interposition	not given	General	Successful
Longitudinal laceration	Blunt clamp	Hysterectomy	Exposure, cross-clamp	Two units of erythrocytes	General	Successful
Left iliac vein	Exposure - retraction	Thyroidectomy	Primary repair	Two units of plasma	General	Successful
Longitudinal laceration	disc punch	Lumbar disc surgery	Exposure, side clamp,	Four units of erythrocytes	General	Successful
Left iliac venlaceration	Blunt clamp	Intrabadominal tumor resection	Plejit-assisted primary repair	Two units of plasma	General	Successful
Innominate vein laceration	Blunt clamp	Intrabadominal tumor resection	Exposure, cross-clamp,	Two units of erythrocyt	General	Successful

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Right iliac vein injury	Blunt dissection	laparoscopic pelvic operation	Longitudinal primary repair	Two units of plasma	General	Successful
Hepatic vein injury	Blunt dissection	Laparoscopic pelvic operation	Exposure, cross-clamp	not given	General	Successful
Hepatic vein injury	Dissection	Oncological surgery-Urology-Gynecology	End-to-end repair	Two units of erythrocytes	General	Unsuccessful
Right external iliac artery injury	Tumor excision	Sarcoma-upper extremity	Exposure,	not given	General	Successful
Right external iliac vein injury	Tumor excision	Sarcoma-upper extremity	Clampless primary repair	not given	General	Successful
Total: 18 patients	Mean age: Mean±SD:61.80		Mean intervention time Mean±SD:12.50			

Otherwise, hemorrhagic shock may cause severe damage to the patient.

Our surgical approach during the repair of peripheral artery injury was to control the proximal healthy part of the artery to reduce the possibility of blood loss. After locating the injury site, we provided proximal and distal bleeding control with an embolectomy catheter when necessary. We primarily evaluated and repaired the injury to the arterial wall and also sometimes needed a second surgeon to locate and control the bleeding focus in major vessel injuries. For this reason, it is advantageous to have two cardiovascular surgeons at the beginning of the intervention in large-volume centres. Most of the time, we controlled the bleeding with primary repair. Although the surgical method to be used for revascularization may vary according to the nature of the wound and injury, there are publications stating that primary repair should be the first option and that primary repair and end-to-end anastomosis are the preferred methods (12).

Systemic heparinization (0.5 or 1 cc Heparin) must be performed before cross-clamping arterial and venous structures. However, if the patient has multiple bleeding foci in injuries or if bleeding control has not been achieved yet, administering heparin may be inconvenient (13).

The factor that determines the type of repair to be made is the damage caused by the injury. We repaired our two patients with anterior and posterior wall injuries by performing an aortotomy and an arteriotomy after cross-clamping. In total knee prostheses, even if the full-thickness incision connected to the cutting tool is easily repaired with the end-to-end anastomosis technique, the anastomosis may be damaged again due to the anatomy of the knee joint and the manipulations in the postoperative period. While intervening for vascular injuries in the popliteal fossa, we acted by considering the postoperative period. Therefore, we recommend saphenous vein interposition, if possible, in popliteal injuries. It is possible to pass the saphenous vein through a synthetic vein graft, thus avoiding the damage and folding problem that will occur in the saphenous.

Most of the patients with whom we had intervened were those who were operated under general anaesthesia. However, we urgently treated the patient with two carotid artery injuries under local anaesthesia. Carotid injuries often occur outside the hospital and, unfortunately, can have fatal consequences. However, if the catheter is still in the vascular bed and there is not much blood loss, local intervention should be considered, especially in catheter-related injuries in the hospital. General anaesthesia should be preferred in major bleeding carotid cases. It provides comfort and ease of operation for the surgeon. In addition, it should be preferred to prevent negative situations that may develop as a result of the patient's agitation.

Another important factor is to keep the hemodynamics stable until the patient is treated. In most of our cases, applying pressure to the injury site, giving enough blood and colloid was sufficient to provide stability. Technically, the

success of vascular intervention may not be enough to keep the patient alive. If what needs to be done before the intervention is not done or if it is late, a process that is difficult to reverse may be faced. Complications can be encountered in all surgical and interventional procedures. Although lack of education and experience is decisive, there are points to be considered in order to prevent vascular complications.

Bleeding due to vascular injury is a common cause of critical morbidity and mortality in the peri-operative period. The surgeon must act quickly to initiate appropriate repair by targeting damage control and stabilization of the patient. Planning the surgery and consulting an experienced surgeon is crucial for successful management. Catastrophic bleeding needs to be controlled, and in case of arterial injury, it is often necessary to restore perfusion (14).

Being sensitive to the tissue during the first intervention is a factor that reduces the risk of injury. According to our experience, exposure is insufficient in small incisions, and when retraction is made excessively, the surrounding tissues are damaged. In the cases in which we had intervened, we saw that faulty exclusion, blunt dissection and hasty behaviour caused injuries. Another important point was that concomitant injuries should be carefully evaluated, and if bleeding continues and hemodynamic stability does not occur, another bleeding focus should be investigated.

Today, optimal treatment and care of the patient with vascular injury is a basic need. While endo-vascular developments are promising, they are still being made on a limited scale. Basic surgical skills continue to be necessary; however, acquiring and maintaining these skills is becoming increasingly difficult (15). In particular, new courses and training programs and joint training on trauma surgery, vascular surgery, emergency care and resuscitation should be organized. Even though more and more minimal, less risky and more comfortable interventions/operations are preferred, vascular injuries can always come as a surprise.

Iatrogenic injury may occur during tumour excisions adjacent to vascular structures. In addition, due to tumour invasion, the vessel can be excised segmentally in tumour and vascular structures. Especially in high-volume hospitals where tumour surgery is performed, cardiovascular surgery teams should be invited to tumour councils for cases where there will be a risk of vascular injury. The risk of mortality and morbidity can be reduced by making necessary pre-operative preparations for possible injuries and by joint case planning.

The main limitation of this research could be attributed to its retrospective nature in a single-center experience with a low number of patients. Multicenter studies with larger sample sizes should be conducted to achieve comprehensive outcomes.

As a result, the surgeon should accurately and quickly evaluate findings such as unexplained hypotension, tachycardia, loss of pulse or heat loss during the operation and should suspect vascular injury. It is possible to reduce mortality and morbidity rates when iatrogenic vascular injuries are diagnosed early.

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Informed Consent: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008. Informed consent was obtained from all participants.

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