

Postoperative care and analgesia in vascular surgery

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Abstract

Patients undergoing major vascular surgery are high risk for myocardial infarction, renal failure, respiratory complications and death. Invasive procedures confer greater risk of complication, with patients undergoing open aortic surgery being at highest risk. Endovascular procedures are less invasive, yet not devoid of potentially serious complications. Reduction of myocardial oxygen demand is key: stabilizing cardiovascular parameters, maintaining normothermia, adequate volume resuscitation and effective analgesia. Continuation of preoperative risk-reduction strategies including aspirin, beta-blockers and statin therapies are critical, and should be continued in the postoperative period. Maintaining a high index of suspicion for procedure-specific complications is essential in order to reduce morbidity and mortality in these patients.

Keywords Pain relief; postoperative care; vascular surgery

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Postoperative sites of care

Vascular surgery is associated with significant perioperative morbidity and mortality. Over one-third of patients are 75 years and older with an average of 1.7 comorbidities such as hypertension, diabetes, chronic lung disease and ischaemic heart disease, consequently increasing the risk of complications and readmissions.¹ Patients undergoing vascular surgery therefore require close postoperative monitoring.

The risk of postoperative complications can be quantified using scoring systems such as the American Society of Anesthesiologists (ASA) classification, Lee Revised Cardiac Index and the Customized Probability Index (CPI). The CPI is a modification of the Revised Cardiac Index incorporating clinical risk factors, medication and type of vascular procedure.² Scoring systems are most useful in identifying low-risk patients, rather than stratifying medium and higher risk patients. (See *Preoperative assessment of patients for major vascular surgery* on pages 257–261 of this issue.)

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Learning objectives

After reading this article, you should be able to:

- recognize the factors involved when considering the most appropriate site of postoperative care for vascular patients
- list the common postoperative complications of vascular surgery
- understand the analgesic options available to patients having vascular surgery

It is necessary to identify the most appropriate environment for early recognition and treatment of postoperative complications. The site of care should be equipped with staff familiar both with the operative procedures, and their associated complications. An appropriate level of monitoring and nursing care should be applied. The major factors to consider when determining the most appropriate postoperative site of care are outlined in [Table 1](#).

Appropriate decisions relating to the need for intensive care after surgery are key to high-quality patient care. Accurately identifying which patients are at high risk of complications or death after vascular surgery remains difficult. Significant active research in this area focuses on cardiopulmonary exercise testing, quantifying patient frailty and perioperative testing of cardiac biomarkers troponin, brain natriuretic peptide (BNP) and N-terminal pro-BNP. Parallel investigations of other patient groups may help inform this process (e.g. National Emergency Laparotomy Audit).

General postoperative considerations

The primary objective in the postoperative management of the vascular patient is decreasing myocardial oxygen demand through stabilization of haemodynamics, haemostasis, rewarming and control of pain. It is therefore essential to know the preoperative blood pressure, cardiac function including known arrhythmia and nature or presence of any valvular disease or pulmonary hypertension, in order to guide the postoperative management of the individual.

Myocardial ischaemia

Myocardial infarction (MI) is the most common cause of death following vascular surgery, and its incidence may be up to 6.3%–8.5%.^{5,6} This is likely related to the high prevalence of asymptomatic coronary artery disease in this patient population. An isolated troponin leak following vascular surgery is also strongly associated with a significant increase in 30-day mortality risk ([Table 2](#)). This analysis supports the consideration of routine troponin testing postoperatively in all vascular patients,⁶ although in many cases, the most appropriate follow up or intervention is currently unclear.

The pathophysiology of perioperative MI is complex and poorly understood. Perioperative tachycardia plays a role in the development of perioperative ischaemia. It is also hypothesized that in the early postoperative period patients probably have a flow-mediated hypoperfusion, exacerbated by hypotension and thrombosis, secondary to hypercoagulability and inflammation.⁷

Factors influencing site for postoperative care

Factor	
Type and extent of surgery	The extent of perioperative physiological insult and the requirement for surgery-specific monitoring of potential postoperative complications influence choice of site of postoperative care
Age and comorbidities	Chronic heart failure, chronic obstructive pulmonary disease (COPD), coronary artery disease (CAD) and chronic renal failure are all predictors of increased mortality in surgical vascular patients ³
Cardiopulmonary functional capacity of the patient	Perioperative haemodynamic stability must be considered. In some centres preoperative cardiopulmonary exercise testing (CPET) can be used to quantify physical fitness and triage patients to postoperative care facility, rationalizing the use of critical care beds. Patients with an anaerobic threshold (AT) of <11 ml/kg/min may benefit from postoperative critical care. ⁴ Combining at least one other variable, for example ventilatory equivalent for CO ₂ with AT improves prognostic precision in most populations ²
Emergency versus elective surgery	Emergency operations independently increased perioperative morbidity and mortality risk. ³ These patients may be physiologically and haemodynamically compromised, and therefore higher risk

Table 1

A reduction in myocardial oxygen demand is key to reducing the incidence of postoperative myocardial events. Patients should be normothermic, and control of haemodynamics and pain is crucial. Patients should be maintained on their usual cardiac medications perioperatively, withdrawal of beta-blockers in patients on long-term therapy is associated with increased mortality, although starting beta-blockers *de novo* immediately preoperatively may even cause harm,⁸ especially if anaemia exists

Mortality associated with isolated troponin leak

	30-Day mortality
No troponin elevation	2.3%
Isolated troponin leak	11.6%
Perioperative MI ^a	21.6%

^a A myocardial infarction is defined as a troponin elevation with one reading >99th percentile of the upper reference limit, with at least one of the following: symptoms of ischaemia; ECG changes of new ischaemia; or development of new pathological Q waves or evidence of new regional wall motion abnormality on echocardiography, absence of these signs or symptoms but a level of troponin detected in the blood above the lower limit of reliable detection is termed an isolated troponin leak.⁶

Table 2

or hypotension occurs.⁹ Similarly, the discontinuation of statins postoperatively is a predictor of adverse postoperative cardiac events.¹⁰ Antiplatelet therapy requires individualized consideration, particularly in the presence of coronary artery stents.

Renal complications

Factors associated with increased risk of acute kidney injury (AKI) in the postoperative period include:

- pre-existing renal failure
- emergency surgery
- peripheral vascular occlusive disease
- suprarenal aortic clamp
- ruptured aneurysm
- radiological contrast
- use of vasopressors
- perioperative use of nephrotoxic medication¹¹

Development of this complication carries with it a significant increase in mortality in vascular patients (OR 2.2).¹² The above risk factors are often unavoidable, but a major contributor to the development of AKI is hypotension and renal ischaemia and most commonly observed in patients with pre-existing chronic kidney disease.

The perioperative strategy should be goal directed ensuring adequate intravascular volume, haemoglobin and renal perfusion while avoiding nephrotoxin exposure.² Inotropes and vasopressors may be indicated to maintain adequate mean arterial pressure. Pre-existing renal failure requires good communication with the patient's nephrologist to plan timely renal replacement therapy and ensure appropriate fluid balance and opportunity to let anticoagulant effects subside.²

Pulmonary complications

Postoperative respiratory failure is associated with an increased mortality both in the short (30-day mortality of 36.5%) and long term.¹⁰ Pulmonary complications are a significant cause of morbidity after vascular surgery, and cause significant prolongation of ICU and hospital stay.¹³ Ventilatory equivalents of carbon dioxide (VE/VCO₂) as measured during CPET has emerged as an important variable in predicting pulmonary complications in patients undergoing AAA repair.¹⁴ A value above 42 may suggest the patient is at risk of significant postoperative pulmonary morbidity and allow clinicians to appropriately plan support and discuss this with the patient.¹⁴

Advanced age, smoking and associated chronic lung disease frequently accompany vascular disease. Acute respiratory problems should be identified and treatment started, a delay in surgery may be necessary.² The incidence of pulmonary complications is largely dependent upon the type of surgery performed. Open repair of aortic aneurysms requires a laparotomy and/or thoracotomy and therefore carries a more significant risk than for those undergoing surgery for peripheral occlusive disease, endovascular aortic aneurysm or carotid artery disease.

Endovascular repair of thoracic aneurysm is less invasive than open but can be complicated by haemothorax requiring drainage and invasive ventilation in the perioperative period. Patients selected for thoracic endovascular repair maybe unfit for open repair and therefore less able to tolerate such complications.

Typical pulmonary complications that may occur following vascular surgery include:

- atelectasis
- pneumonia
- prolonged mechanical ventilation with requirement of tracheostomy
- the requirement for reintubation
- respiratory failure
- acute respiratory distress syndrome (ARDS).

In postoperative patients in general there have been few interventions that have demonstrated a reduction in pulmonary complications. Anecdotal evidence suggests incentive spirometry and physiotherapy using chest percussion, intermittent positive pressure ventilation and deep-breathing exercises can reduce pulmonary complications following open abdominal surgery.

Patients at greatest risk of ARDS are those who have undergone repair of a ruptured abdominal aortic aneurysm (AAA) associated with massive transfusion of blood products. All ventilated patients will benefit from protective lung strategies.

Gastrointestinal complications

Gastrointestinal complications are most commonly encountered in patients who have undergone surgery for a ruptured AAA (rates of 15–16%). Potentially lethal complications include bowel ischaemia and abdominal compartment syndrome. Colonic ischaemia affects less than 2% of patients undergoing elective AAA repair but carries a mortality rate of 40–65%.¹⁰ A high index of suspicion should be maintained in the presence of a persistent acidosis, high fluid requirements and refractory shock. If diagnosis is delayed there may be progression to full transmural ischaemia, with a mortality of 80–100%.

Patients who are particularly at risk of abdominal compartment syndrome are those who have received large volume fluid resuscitation and blood products. The syndrome is described as:

- global hypoperfusion and oliguria
- low cardiac output
- hypotension
- high ventilatory pressures (caused by reduced pulmonary compliance)

Intravesical pressure can be measured to aid diagnosis; high intra-abdominal pressures, or low abdominal perfusion pressures place patients at high risk of compartment syndrome. Decompressive laparotomy should be considered, although the resulting open abdomen (laparostomy) presents a significant management challenge due to ongoing losses of volume and protein, along with increased risks of bowel injury, infection and fistula.

Thromboembolism

Patients undergoing vascular surgery are at increased risk of developing venous thromboembolism. Potential risk factors include advancing age, limb ischaemia, venous injury and lengthy surgery. This group of patients are often hypercoagulable, increasing their risk of DVT or arterial graft occlusion and should receive antithrombotic measures postoperatively. Regional anaesthesia is an option for postoperative analgesia, and reduces the risk of thromboembolism.

Haemorrhage

Postoperative haemorrhage following vascular surgery may be torrential and life threatening. Immediate management should consist of direct pressure to the area where possible and

restoration of an adequate circulating volume. Appropriate targets are haemoglobin >9 g/dl, platelets >75,000, fibrinogen >2 g/l². Calcium and magnesium should be replaced as necessary, also aiming for normothermia, normocapnia and avoidance of acidosis. Administration of tranexamic acid is useful if fibrinolysis is identified. A period of permissive hypotension may be required.²

Thromboembolism remains a concern and early use of thromboelastography or thromboelastometry may prove useful in guiding administration of blood products. Rarely recombinant factor VIIa is required. Arterial thrombotic complications are a significant risk.² The decision to administer should be a joint decision with anaesthetist, haematologist and surgeon.

Neurological complications

It is important to detect deterioration in neurological observations after specific vascular procedures. Spinal cord ischaemia can occur post thoracic aneurysm repair, thoraco-abdominal aortic reconstruction, haemorrhagic stroke after carotid endarterectomy or epidural haematoma in patients with a thoracic epidural.

Postoperative hypertension occurs in 66% of patients post carotid endarterectomy.² Hypertension is associated with myocardial ischaemia, arrhythmias, haematoma formation, haemorrhagic stroke and cerebral hyper-perfusion syndrome.² Onset maybe delayed but provision should be available for rapid treatment and CT imaging if required.

Spinal cord ischaemia is a risk after open or endovascular thoracic aneurysm repair. Risk factors during endovascular repair are extensive stent coverage below T9, occlusion of the left subclavian artery or hypogastric artery and previous AAA repair.² Provision should be available to monitor CSF pressures and volumes postoperatively with the ability to immediately institute inotropic or vasopressor support to maintain adequate spinal cord perfusion pressure.

Analgesia

Provision of high-quality postoperative analgesia has become recognized as an important goal in modifying the risk of major postoperative complications. Postoperative pain is recognized as one of many factors contributing to the surgical stress response, and pain control is known to reduce myocardial oxygen demand. There is evidence that pain free patients have lower rates of myocardial ischaemia despite having no differences in vital signs compared to those patients with poor analgesia.¹⁵

In addition to simple analgesics, options available for postoperative analgesia depend on the type of surgery. Controversy surrounds the choice of postoperative analgesia in open aortic surgery. Epidural analgesia provides better analgesia when compared to use of intravenous opiates, especially during movement, for the first three postoperative days. There is also evidence to show that the duration of postoperative tracheal intubation and mechanical ventilation is significantly shorter in patients with an epidural, and overall rates of MI, acute respiratory failure, gastrointestinal and renal complications are reduced by epidural analgesia. There is no current evidence to confirm a mortality benefit compared to use of opiate analgesia however.¹⁶ An alternative to thoracic epidural is administration

of intrathecal diamorphine in high dose for open abdominal surgery or low dose for peripheral vascular surgery in the lower limb. This can be used for pain relief over the first 18–24 hours with additional intravenous opioid available.²

Peripheral vascular surgery and carotid surgery lends itself to the use of regional anaesthesia either alone, or in combination with general anaesthesia or sedation. Nerve blocks can avoid many of the disadvantages of both general and neuraxial anaesthesia. The technique chosen will depend on the site of surgery. Perineural catheter infusions post amputation can provide analgesia for up to 7 days, providing equivalent analgesia to epidural with lower incidence of immobility, motor block and urinary retention.² There is no evidence of overall patient benefit from local anaesthesia compared to general anaesthesia for carotid surgery however. Likewise, there is little evidence to demonstrate a reduction in phantom limb pain by using epidural analgesia for peripheral surgery.

Patients undergoing vascular surgery may present with contraindications to many of these methods of analgesia, particularly if anticoagulants and antiplatelet agents are used. Opiates are the traditional mainstay of postoperative analgesia; however, recent awareness regarding side effects and persistence of chronic pain has led a trend toward a multimodal analgesic approach, combining different classes of drugs at low dose to achieve synergistic effect. The aim is to reduce acute pain and the extent of secondary hyperalgesia postoperatively by reducing perioperative spinal cord sensitization.² Gabapentin, ketamine, magnesium and dexmedetomidine all have a role as possible analgesic adjuncts in the vascular patient especially when regional techniques are contraindicated.

The decision-making process about the optimal approach should be a combined one between surgeon, anaesthetist, patient, and cardiologist where necessary. ◆

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