Perioperative care for lower limb amputation in vascular disease

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Key points

Lower limb amputation (LLA) secondary to vascular disease is associated with a 30 day mortality as high as 17%. Patients presenting for LLA have significant co-morbidity and are at high risk for perioperative complications. Time is often limited for pre-assessment and optimization; however, it is important to optimize remediable factors in advance of surgery. Phantom limb pain is a significant complication of LLA with up to 70% of the patients experiencing phantom pain at some stage.

There is ongoing development of a national Quality Improvement Framework to reduce mortality.

Lower limb amputations (LLAs) are widely performed. Rates for LLA have remained relatively constant over the last decade, with ~5000 procedures performed per year in the UK. The indications are predominantly vascular occlusive disease and diabetes mellitus, with both conditions present concurrently in a substantial proportion of patients. The proportion of above knee amputations (AKAs) in comparison with below knee amputations (BKAs) has decreased over recent years. A recent UK series showed a BKA:AKA ratio of just greater than 1:1.1

Patients presenting for LLA due to vascular disease are predominantly elderly and have a high prevalence of co-morbid pathology including coronary artery disease, hypertension, cerebrovascular disease, diabetes mellitus, chronic kidney disease, and smoking-related lung disease [e.g. chronic obstructive pulmonary disease (COPD)]. Post-mortem studies report diffuse and severe coronary artery atherosclerosis in up to 92% of the patients requiring LLA for peripheral vascular disease.2 Perioperative cardiac events are common and the leading cause of morbidity and mortality. Patients requiring LLA have 30 day mortality rates as high as 17%.3 AKAs are associated with an increased risk compared with BKA, with mortality rates of 10–17% and 5–10%, respectively.3 In addition, patients undergoing LLA have a high incidence of complications with respiratory and wound infections, poor mobility, and persistent postoperative pain.

Surgery is frequently undertaken on emergency lists and out of hours. This situation creates challenges for perioperative planning and reduces the time available for medical optimization in the preoperative period. Using the available evidence base and concentrating on anaesthetic aspects, this review will describe a focused, best practice approach to the perioperative care for patients undergoing LLA.

Preoperative assessment

Patients undergoing LLA should be recognized as high risk and as a clinical priority. Communication between vascular surgeons and anaesthetic services should facilitate early involvement of a consultant anaesthetist for preoperative assessment and to arrange appropriate additional investigations, intervention, and plan postoperative care. There is often limited time in the preoperative period, particularly if surgery is urgent due to infection or severe pain. It is, however, important to address those factors that can be improved in the available time and identify those patients at particularly high risk. The balance must be made between optimizing medical conditions before operation and the need for surgery.

An expedited and targeted assessment is therefore indicated with the aim of preparing individuals for surgery at the earliest opportunity.

A detailed history of the medical and functional status of the patient should be ascertained. Cardiac symptoms may often be masked due to limited mobility related to claudication, limb ulceration, and general poor functional capacity. A clinical examination should be performed, with particular attention to the cardiorespiratory systems and findings used to guide targeted investigations.

Recommended baseline investigations for individuals being considered for surgery are outlined below:

- **Full blood count.** Identification of anaemia which may require correction (see below). An elevated white cell count should prompt a septic screen. Infection in the ischaemic limb may be the cause but other sources, in particular respiratory infection, should be identified.
- **Urea and electrolytes.** Electrolyte abnormalities (e.g. hypo/hyperkalaemia) and pre-
renal impairment are common in this patient group and can be optimized in the preoperative period.

- **Coagulation screen.** Coagulopathy related to anticoagulants or sepsis can be corrected before surgery. Knowledge of the coagulation status may guide anaesthetic technique.
- **Blood glucose.** Avoidance of persistent hyperglycaemia is important in both diabetics and non-diabetics (see below).
- **Twelve-lead ECG.** In addition to providing a baseline test, the ECG may identify a recent acute coronary syndrome or significant arrhythmia which may require intervention before operation.
- **Chest X-ray.** Indicated in patients with abnormal respiratory clinical examination. Findings of consolidation or fluid overload are amenable to preoperative treatment.

**Further investigations**

Echocardiography should be performed in those patients with clinical findings of a murmur or cardiac failure. The presence of significant valvular disease or severe left ventricular dysfunction should prompt consideration of invasive monitoring and guide postoperative care.

**Respiratory system assessment**

Patients with COPD have a three-fold increase in risk for pulmonary complications in unselected surgery. It is therefore paramount to identify individuals with potential respiratory insufficiency as this will influence anaesthetic management and postoperative care. Recommended investigations to guide such assessment are as follows:

- Arterial blood gases, in particular to identify the presence of respiratory failure.
- Pulmonary function tests. A forced expiratory volume in 1 s (FEV₁) <70% of the predicted value or an FEV₁/forced vital capacity ratio <0.65 indicates a high risk of perioperative complications.

Assessment of exercise tolerance in patients listed for amputation is problematic and patients may be relatively immobile due to limb pain. Pharmacological stress testing, for example, dobutamine stress echo, is unlikely to be feasible in the short preoperative period.

The focused assessment allows timely evaluation of relevant information to inform discussions regarding risk between clinicians, the patient, and relatives. In some instances, the risks of the procedure and anaesthesia may outweigh any benefit of lower limb amputation and the patient may not progress to surgery.

**Preoperative optimization**

A focused preoperative assessment allows identification of those factors that can be optimized in an appropriate timescale. Input from specialist teams, in particular cardiology, respiratory, diabetic, and pain teams, with an emphasis on short-term improvements can assist this process. Patients may also warrant postoperative input from medical specialties.

**Pharmacological optimization**

Opportunities for pharmacological methods of risk reduction are limited in the preoperative setting in patients undergoing LLA, due to the often emergent need for surgery.

**Statins**

The utility of perioperative statin therapy in reducing cardiovascular events in vascular patients has been strongly suggested by meta-analyses. The majority of studies available are retrospective and heterogeneity is great, leading to the conclusion that the evidence base is currently inadequate to recommend the acute administration of statin therapy before emergent surgery. The majority of vascular surgical patients would, however, benefit from statin administration for secondary prevention. For those patients already established on statin therapy, discontinuation in the perioperative period is associated with increased risk for adverse cardiac events. In an observational study of 298 statin users who underwent major vascular surgery, discontinuation of statin therapy for a median of 72 h in the perioperative period was associated with a 7.5-fold increase in risk for myocardial infarction and death.

**β-Blockers**

Recent evidence suggests the benefit of β-blockers titrated to heart rate in the perioperative period, but acutely commencing high-dose regimes cannot be recommended due to increased risk of stroke and death seen in large clinical trials.

Established cardiac medication [including β-blockers, statins, aspirin, angiotensin-converting enzyme (ACE) inhibitors, and diuretics] should be managed perioperatively in keeping with recent guidelines (Table 1).

**Specific medical conditions**

**Active cardiac conditions**

The majority of individuals require medical optimization alone as outlined above. However, specific conditions (Table 2) warrant urgent referral and assessment before consideration of surgery. In a proportion of patients, irremediable factors will be present which place the patient at high risk for perioperative mortality, for example, severe aortic stenosis. In these situations, surgery may need to continue in the knowledge of this increased risk when felt to be in the best interests of the patient.

**Minor cardiac arrhythmias**

Those arrhythmias not requiring a specialist assessment, for example, atrial fibrillation, should be rate controlled before operation with appropriate medication. In the acute setting, the target ventricular rate should usually be 80–100 bpm.
**Table 1 Pharmacological risk reduction strategies**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Recommendation</th>
<th>Class of recommendation</th>
<th>Level of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>β-Blockers</td>
<td>Continuation of β-blockers is recommended in patients previously treated for IHD, hypertension, or arrhythmias</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>Statins</td>
<td>It is recommended that statins be continued perioperatively</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>Aspirin</td>
<td>Continuation of aspirin in patients previously treated with aspirin should be considered in the perioperative period</td>
<td>Ia</td>
<td>B</td>
</tr>
<tr>
<td>ACE inhibitors</td>
<td>ACE I should be continued perioperatively in patients treated for LV systolic dysfunction</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Transient discontinuation of ACE I before non-cardiac surgery in hypertensive patients should be considered</td>
<td>Ia</td>
<td>C</td>
</tr>
<tr>
<td>Diuretics</td>
<td>Hypertensive patients should discontinue low-dose diuretics on the day of surgery and resume orally when possible</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Diuretics should be continued in heart failure patients up to the day of surgery, resumed i.v. perioperatively, and continued orally when possible</td>
<td>I</td>
<td>C</td>
</tr>
</tbody>
</table>

*Classes of recommendations

| Class I      | Evidence and/or general agreement that a given treatment or procedure is beneficial, useful, and effective |
| Class IIa    | Conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of the given treatment or procedure |
| Class IIb    | Weight of evidence/opinion is in favour of usefulness/efficacy |
| Class III    | Evidence and general agreement that the treatment or procedure is not useful/effective and in some cases may be harmful |

†Level of evidence

| Level of evidence A | Data derived from multiple randomized clinical trials or meta-analyses |
| Level of evidence B | Data derived from single randomized clinical trial or large randomized studies |
| Level of evidence C | Consensus of opinion of the experts and/or small studies, retrospective studies, registries |

**Table 2 Active cardiac conditions**

<table>
<thead>
<tr>
<th>Drug Recommendation</th>
<th>Class of recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstable coronary syndromes (recent myocardial infarction, angina on minimal exertion (Class III) or at rest (Class IV))</td>
<td>I</td>
</tr>
<tr>
<td>Decompensated cardiac failure</td>
<td>I</td>
</tr>
<tr>
<td>Severe valve disease, e.g. aortic stenosis</td>
<td>I</td>
</tr>
<tr>
<td>Significant cardiac arrhythmias, e.g. sustained ventricular tachycardia</td>
<td>I</td>
</tr>
</tbody>
</table>

**Respiratory disease**

The presence of an acute respiratory tract infection should prompt initiation of treatment with appropriate antibiotics, oxygen therapy, and physiotherapy before operation. Patients with COPD with infective symptoms should receive corticosteroids in addition, for example, prednisolone at a dose of 30 mg for 7 days. All regular bronchodilator therapy should be continued.

**Diabetes mellitus**

There are currently no studies in general surgical patients to indicate whether blood glucose control improves outcome. A recent consensus statement recommends that blood glucose should be <10 mmol litre⁻¹ in non-critically ill patients. These limits apply to both diabetic and non-diabetic patients. Locally agreed insulin regimes should be in place to achieve this; involvement of diabetic teams may be required.

**Anaemia**

Evidence suggests a haemoglobin level of 8–10 g dl⁻¹ to be safe even in patients with severe cardiorespiratory disease. Perioperative blood transfusion should aim to maintain haemoglobin concentrations in this range.

**Other factors**

**Anticoagulation**

Low-molecular-weight heparin should be withheld for an appropriate duration where central neuraxial block is being considered. The suggested guidelines are that full therapeutic anticoagulation should be omitted for 24 h before operation and prophylactic anticoagulation omitted for 12 h before operation.

Current recommendations suggest that clopidogrel should be omitted for 7 days before central neuraxial block. The risks and benefits of these techniques should be considered on an individual basis for those patients taking clopidogrel.

**Nutrition and fluid balance**

Adequate nutrition should be maintained and prolonged preoperative fasting avoided. An appropriate i.v. fluid regime should be commenced to correct preoperative dehydration and electrolyte imbalances. Regular monitoring of instituted treatment is essential.

**Preoperative pain control**

A large number of patients undergoing LLA will have longstanding and often severe ischaemic pain, with many requiring preoperative opioid analgesia. This pain may have increased in severity in the immediate preoperative period and be a driving force for surgery. In addition, LLA is a surgical procedure that carries one of the highest incidences of persistent post-surgical pain.

Phantom limb pain (PLP) is a significant complication of lower limb amputation with up to 70% of the patients experiencing phantom pain at some stage. Peripheral nerve transaction results in an afferent nociceptive stimulus that initiates spinal cord hyperexcitability. These neuroplastic changes are thought to be
responsible for the development of post-surgical chronic pain syndromes, including PLP.

Pre-emptive analgesia with epidural infusions, intrathecal, and i.v. ketamine has not consistently shown reductions in chronic PLP. Studies have been underpowered and suffered from significant loss to follow-up due to the high mortality rate seen in this patient population. However, pre-amputation pain intensity has been identified as a significant predictor of chronic PLP intensity. Aside from the potential to modulate pain pathways and reduce chronic pain, good preoperative analgesia should be ensured in all patients to reduce the sympathetic stress response and improve perioperative cardiovascular stability. Input from the acute pain service at this stage should develop a multimodal analgesic regime with regular simple analgesics in addition to consideration of oral opioids and agents for neuropathic pain (gabapentin and amitriptyline) where appropriate. Opioid-based patient-controlled analgesia (PCA) may be required in the immediate preoperative period to control severe ischaemic pain where surgery is imminent. The use of epidural infusions, while not demonstrating a reduction in chronic postoperative pain, may provide superior preoperative pain control and their use should be considered.

**Perioperative care**

**Timing of surgery**

Where possible, surgery should be undertaken within 48 h of the team decision to operate and recurrent cancellations avoided. Undertaking LLA on planned lists during daytime, working hours should facilitate this. Unpublished prospectively collected data on 271 patients undergoing LLA in our institution over the past 5 yr suggest that patients who are operated on for major amputation out of hours have a three-fold increase in mortality compared with those operated on in hours. The reasons for this are likely to be multifactorial. The operation should be performed by a senior surgeon, experienced in lower limb amputation procedures. Owing to the high prevalence of cardiac co-morbidity in this patient population, a consultant anaesthetist or senior trainee with appropriate consultant supervision should be responsible for the anaesthetic care of the patient.

**Aims of anaesthesia**

The aims of anaesthesia should be to maintain cardiovascular stability, normovolaemia, normothermia, avoid anaemia, and to provide good analgesia into the postoperative period. Antibiotic prophylaxis, guided by local policy, should be given within 60 min before start of surgery. Consideration should be given to invasive monitoring in those patients with significant cardiac disease or in those acutely unwell due to sepsis.

**Anaesthetic technique**

**Regional anaesthesia**

Anaesthetic options include central neuraxial block or general anaesthesia, both of which may be complemented by peripheral regional techniques. The surgical time required for lower limb amputation allows single-shot spinal techniques to be used. Regional anaesthesia has several theoretical benefits in this population including improved postoperative respiratory function and attenuation of the stress response to the surgery. Postoperative cognitive dysfunction is a recognized complication of major surgery in the elderly. Available evidence shows that in patients randomized to receive either general or regional anaesthesia, the incidence of cognitive impairment in the first week after surgery is reduced in those receiving regional anaesthesia. This difference does not persist at 3 months. Reduction in early postoperative cognitive dysfunction or delirium with the use of regional anaesthesia may have important implications for compliance with medical therapy, functional recovery, and length of stay.

Spinal or epidural anaesthesia is relatively contraindicated in patients with systemic manifestations of sepsis and those who are anticoagulated. General anaesthesia may be more appropriate in these patients.

**General anaesthesia**

Controlled or spontaneous ventilation is appropriate. A stable induction and attenuation of the cardiovascular response to tracheal intubation are primary considerations due to the high prevalence of ischaemic heart disease. The particular anaesthetic technique chosen is probably less important than attention to cardiovascular stability, intravascular volume, normothermia, and analgesia.

**Perioperative measures to reduce chronic post-surgical pain**

The use of local anaesthetic infusions via surgically placed sciatic nerve catheters has been shown to provide improved pain relief and reduce opioid requirements in the immediate postoperative period, while not demonstrating a lasting effect on postoperative chronic pain. Despite a lack of evidence for the efficacy of peripheral nerve block in reducing phantom pain, the reduction in acute postoperative pain and opioid-sparing effect make these techniques important to consider in this patient group.

**Postoperative care**

Owing to the high incidence of postoperative morbidity and mortality, utilization of critical care services should be given early consideration. These decisions should be made, where possible, before surgery. Avoidance of hypoxia, tachycardia, hypotension, and anaemia is of importance in patients at risk of postoperative myocardial ischaemia. Patients should receive supplemental oxygen for the first 72 h after operation.

**Postoperative pain relief**

Attention to good pain control is essential for patient comfort and to reduce sympathetic catecholamine surges with their resultant effects. A balanced analgesic regime should be established. Acute
pain service management in the postoperative period is desirable, with patients usually requiring PCA or regional catheter techniques. All patients should, in addition, receive regular simple analgesia in the form of oral or i.v. paracetamol. The routine use of non-steroidal anti-inflammatory drugs is not recommended due to increased risk of gastrointestinal and renal toxicity in this population.

The onset of phantom pain is usually within the first 7 days after amputation. As previously mentioned, a convincing reduction has not been demonstrated using pre-emptive regional analgesia or regional techniques used intraoperatively. A trial examining the effect of gabapentin started on the first post-amputation day did not find a reduction in incidence or intensity of phantom pain. 16 PLP remains common and difficult to prevent and treat.

Rehabilitation

Once through the immediate postoperative period, there should be prompt referral to a local amputee rehabilitation team for early mobilization and physiotherapy. This period provides an opportunity to aggressively institute measures for secondary prevention, both for cardiovascular and peripheral vascular disease. Optimization of medical treatment, with institution of statins and anti-platelet agents, smoking cessation advice, and optimization of diabetic control are important considerations for reducing the risk of subsequent loss of a second limb.

The future

Lower limb amputation surgery is an area of current national interest. The significant and persistent mortality associated with lower limb amputation has prompted action from the Vascular Society and Vascular Anaesthesia Society of Great Britain and Ireland (VASGBI) with the ongoing development of a Quality Improvement Framework. Owing to the underlying disease states that lead to the need for amputation and the associated co-morbidity, this patient group is likely to remain at high risk for perioperative complications. To reduce mortality, systematic, co-ordinated, multidisciplinary input is required. The care pathways put in place for the management of patients admitted with fractured neck of femur, with best evidence guidelines and a collaborative approach would seem an appropriate parallel to draw with fractured neck of femur, with best evidence guidelines and a collaborative approach would seem an appropriate parallel to draw with a fractured neck of femur, with best evidence guidelines and a collaborative approach would seem an appropriate parallel to draw with.

Conflict of interest

None declared.

References


Please see multiple choice questions 9–12.