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Perioperative management in amputations: Narrative review

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Abstract

Amputation is defined as the partial or total removal of upper or lower limbs and is a frequent procedure, with approximately 5,000 cases annually in the United Kingdom and 150,000 in the United States. In Colombia, the incidence is estimated to be between 200 and 300 amputations per 100,000 inhabitants, with 10% of the population reported as having a disability in 2010. The main causes of amputation include occlusive vascular diseases, diabetes mellitus, neuropathy, and trauma, with elderly patients with comorbidities being the most affected. The incidence of amputations is directly related to peripheral arterial disease, neuropathy, and soft tissue damage, with diabetes mellitus present in 82% of cases in the United States. The level of amputation depends on the viability of the soft tissues to cover the bone, and patients show a high postoperative mortality rate within 30 days, along with complications such as respiratory infections, wound infections, limited mobility, and postoperative pain. This narrative review gathered updated information from 25 articles obtained from databases such as PUBMED and ScienceDirect, highlighting the importance of an interdisciplinary approach to improve postoperative outcomes in patients with lower limb amputation. This allows for the development of pertinent evidence-based recommendations to achieve the best possible outcomes when managing patients requiring amputation as part of their treatment.

Keywords: Amputation; Perioperative care; Health status indicator; Quality of life; Patient outcomes assessment

1. Introduction

Amputation is defined as the partial or total removal of an upper or lower limb. Currently, amputations are frequently performed, accounting for approximately 5,000 cases per year in the United Kingdom (1). In the United States, this figure is around 150,000 patients per year (2). In Colombia, the incidence of amputations is estimated at between 200 and 300 people per 100,000 inhabitants, and in 2010, DANE reported that there were 893,694 people with disabilities, representing 10% of the Colombian population (3).

The main indications for amputation include occlusive vascular disease, diabetes mellitus, neuropathy, and trauma, with an incidence of approximately 20%, primarily associated with infection and the extent of soft tissue damage. Most commonly affected are elderly individuals with comorbidities such as coronary artery disease, hypertension, cerebrovascular disease, diabetes mellitus, chronic kidney disease, and pulmonary disease. The incidence of amputation is directly related to peripheral arterial disease, neuropathy, and soft tissue damage(4). Additionally, the rising incidence of diabetes mellitus is a key factor, as it is estimated that 82% of amputations in the United States are associated with this condition.

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The level of amputation primarily depends on the viability of soft tissues, which are necessary to provide adequate bone coverage. These patients have a high 30-day postoperative mortality rate, with a high incidence of complications such as respiratory and wound infections, limited mobility, and postoperative pain (2). Following amputation, the process must focus on rehabilitation, desensitization, and soft tissue care, ensuring proper pain management and optimal shaping of the residual limb (4). This includes the use of prostheses until the residual limb has matured, to facilitate long-term mobility and prevent deformities such as contractures.

The perioperative management of amputations is limited and biased in terms of adequate assessment and treatment, mainly because most of these procedures are performed in an emergency setting. This creates challenges in perioperative planning and reduces the time available for medical optimization in the preoperative period. There is no comprehensive, evidence-based consensus that ensures the best outcomes in these cases. Therefore, the objective of this narrative review is to compile updated information supported by evidence-based medicine to establish optimal measures shared by different studies available in the literature.

A review of 25 articles from recognized databases such as PUBMED and ScienceDirect was conducted, focusing on patients requiring lower limb amputation. The review highlights the importance of an interprofessional approach to the care of these patients, primarily based on factors that act as predictors of postoperative amputation outcomes.

2. Optimization of the Patient Prior to Amputation in the Context of Diabetes Mellitus

Before defining amputation as a definitive treatment, it is crucial to optimize the patient from a medical perspective, considering preexisting conditions that may influence postoperative outcomes. One of the most important factors is the presence of diabetes mellitus. In 2005, Balachundhar et al. published a study demonstrating a statistically significant difference in long-term survival between diabetic and non-diabetic amputee patients. Over a 10-year period, diabetic patients exhibited lower survival rates, making diabetes a predictor of long-term mortality. Additionally, perioperative cardiac complications, age over 64 years, history of heart failure, myocardial infarction, and renal disease requiring dialysis are also associated with a higher risk of mortality. These factors are essential for appropriately planning perioperative management, which will be analyzed in this review (5).

In the context of diabetic patients requiring amputation, all efforts should focus on achieving adequate glycemic control (2). The Diabetic Foot Committee has established clinical criteria and diagnostic markers to guide the management of these patients. According to a study conducted by Anıl Gülcü et al., blood parameters such as glycated hemoglobin (HbA1c) ≥7.05%, with a sensitivity of 86% and specificity of 59%, C-reactive protein (CRP) with a cutoff point of 4.05 mg/dL, and creatinine with a value of 1.6 mg/dL are predictive markers of reamputation. Additionally, low albumin levels were associated with increased plasma glycation and HbA1c, correlating with poor postoperative prognosis due to impaired wound healing. CRP was also identified as a predictor of active inflammation, directly linked to an increased risk of amputation in patients with diabetic foot (6).

These findings reinforce the importance of adequate metabolic control in diabetic patients prior to amputation, as there is a higher incidence of both surgical and non-surgical complications, including systemic pulmonary embolism, wound infections, and increased mortality (7, 8). However, some studies suggest that inadequate metabolic control is not directly related to reamputation or mortality, implying that delaying the procedure until optimal metabolic control is achieved may not be necessary (9).

The Danish Society of Endocrinology recommends strict HbA1c control as part of the preoperative protocol, with levels ranging between 7-11 mmol/L, although it is acknowledged that HbA1c levels may not be fully adjustable in patients scheduled for amputation (10). However, an optimal HbA1c value in the perioperative context of amputations has not been established, remaining a topic of controversy. This is an area of interest for future research, using standardized perioperative values for diabetes-related complications in other major surgeries as a reference.

To date, no specific data on amputations are available, but we propose using the optimal values recommended for the perioperative period of major surgeries in general. The French Society of Anesthesia and Intensive Care Medicine (SFAR) and the French Society for the Study of Diabetes (SFD) suggested in 2018 postponing elective surgeries in patients with HbA1c levels >9% or <5% due to the risk of hypoglycemia (11). Meanwhile, the Joint British Diabetes Societies recommended in 2016 maintaining HbA1c levels below 8.5% (69 mmol/mol) (12). In general, outside the surgical planning context, the optimal random blood glucose level should be 10 mmol/L in non-critical patients (13).

3. Perioperative Analysis in Patients with Vascular Disease and Its Impact on Major Amputation

The perioperative analysis of patients with vascular disease, including coronary artery disease with or without heart failure, must be thorough and meticulous (14). This involves conducting key tests, such as a complete blood count to identify the presence of anemia and determine the need for correction. Optimal preoperative or post-transfusion hemoglobin values range between 8-10 g/dL (15). In these cases, preoperative or intraoperative transfusion is recommended. A study conducted by Tze-Woei Tan et al. demonstrated that the administration of transfusions did not significantly affect perioperative mortality nor did it increase cardiac complications following a major amputation (16).

White blood cell evaluation is essential to determine the necessity of additional tests in cases of suspected infection. Similarly, coagulation tests should be corrected prior to the procedure to guide anesthetic management and prevent hemorrhagic complications (15). The performance of an electrocardiogram (ECG) is indispensable, given the high prevalence of coronary artery disease in this population, which increases the risk of perioperative morbidity and mortality.

In addition to these routine tests, cardiac function assessment must be detailed. Parameters such as stroke volume, end-diastolic volume, end-systolic volume, and heart rate can be measured using echocardiography (14). The pharmacological optimization of these parameters is crucial in the preoperative period, although it may be limited in cases of urgent surgery.

Regarding pharmacological treatments, the continuation of statin use is important, as their discontinuation is associated with a higher risk of mortality and perioperative complications. Beta-blockers are beneficial for the management of heart failure and arrhythmias, provided they are appropriately adjusted to perioperative heart rate. In contrast, diuretics should be discontinued 24 hours before surgery in hypertensive patients but should be continued in those with heart failure (15).

4. Perioperative Management in Patients with Chronic Kidney Disease

Chronic kidney disease (CKD) is defined by a glomerular filtration rate (GFR) of less than 60 mL/min/1.73 m^2, which implies a higher long-term mortality risk following surgery. Proper perioperative intervention in these patients is crucial to optimize their management. Predictors of poor prognosis in CKD patients include serum creatinine >2 mg/dL, the need for hemodialysis, elevated blood urea nitrogen (BUN >40 mg/dL), and poor nutritional status (17).

Although it is unclear whether better metabolic control of CKD directly improves postoperative outcomes, rehabilitation and postoperative functional independence are often compromised in these patients, particularly in those requiring hemodialysis. Functional outcomes are generally poorer compared to non-dialysis patients (18).

Therefore, perioperative strategies should focus on risk stratification and the optimization of critical factors to reduce postoperative complications (19). One key factor is the control of serum potassium levels, which must be maintained within normal ranges. General anesthesia should be avoided in patients with potassium levels >5.5 mEq/L due to an increased risk of arrhythmias. Additionally, arterial blood gas monitoring is essential to assess acidosis, a characteristic of decompensated CKD, which reduces the effectiveness of systemic anesthetics.

Bleeding management is another crucial aspect, as platelet dysfunction induced by elevated uremia levels is common in CKD patients. A hemodialysis session is recommended one day before the surgical procedure to optimize uremia levels. It is also essential to preserve the vasculature of the limb used for hemodialysis, particularly for arteriovenous fistula creation.

Blood pressure control should be rigorous, ensuring the continuation of antihypertensive treatment, except for diuretics, which should be discontinued 24 hours before surgery (20). Additionally, the use of antihistamines, decongestants, and nonsteroidal anti-inflammatory drugs (NSAIDs) should be avoided in the preoperative period.

Correction of hemoglobin and hematocrit levels is also key, as hematocrit values between 20-26% are associated with a higher risk of postoperative complications. Although blood transfusion may be indicated, intraoperative transfusion should be avoided due to the risk of hyperkalemia associated with potassium release during transfusion (21).

4.1. Amputations in Patients with Severe Soft Tissue Damage: Infections

In patients presenting with septic shock, a staged reconstruction amputation is recommended. In cases of extensive cellulitis, prior intravenous antibiotic therapy is suggested before proceeding with amputation, as it may allow for a more distal level of limb preservation.

4.2. Amputations in Patients with Severe Soft Tissue Damage: Traumatic Injuries

High-energy trauma may be associated with immediate amputations due to the severity of the injury itself or may require secondary amputation due to extensive soft tissue damage. In these cases, an initial comprehensive evaluation following the Advanced Trauma Life Support (ATLS) protocol is essential.

Various authors have proposed multiple scoring systems to classify injury severity and determine the indication for amputation. Advances in reconstructive techniques now allow for limb salvage in patients who, decades ago, would have required amputation. However, it is crucial to recognize that failure in limb salvage can significantly increase morbidity and mortality(22).

The most commonly used scoring systems include:

- **MESS (Mangled Extremity Severity Score):** Assesses soft tissue injury, limb ischemia, presence and duration of shock, and patient age.
- **Predictive Salvage Index (PSI):** Focuses on warm ischemia, bone and muscle damage, and the extent of vascular injury.
- **Limb Salvage Index (LSI):** Considers arterial compromise, nerve damage, ischemia, soft tissue injury, shock, and patient age.
- **NISSSA:** Evaluates nerve injury, ischemia, soft tissue damage, skeletal injury, shock, and patient age.

Among these, the MESS score is the most commonly used, although there is no consensus on its reliability in predicting functional outcomes or the need for secondary amputation. While this is not the primary focus of this review, it is important to highlight that proper patient stratification directly impacts clinical outcomes (22).

5. Malnutrition

Malnutrition, defined by the World Health Organization (WHO) as inadequate or unbalanced nutrition, can result from a poor or excessive diet. Its assessment can be simplified using unidimensional indicators such as low serum albumin, low body mass index, and zinc deficiency, or through multidimensional indicators such as nutritional screening scores.

According to reports from the Food and Agriculture Organization (FAO), in 2017, it was estimated that one in five people worldwide suffered from chronic undernutrition, and more than 2 billion people experienced micronutrient deficiencies (23).

Given its significance as a key determinant of health, it is essential to examine the relationship between malnutrition and the risk of amputation. The biological understanding of malnutrition in the pathophysiology of chronic limb-threatening ischemia shows an increased risk of both amputation and mortality in malnourished patients (24). Therefore, evaluating and correcting nutritional status is a crucial part of the preoperative management of these patients.

6. Rehabilitation

The primary focus of rehabilitation is to ensure early mobilization through physical and respiratory therapy when necessary, pain management, patient education to improve mobility and prevent contractures, as well as guidance on the use of transfer devices and the management of underlying conditions (15).

To achieve this, proper stump management is essential and can be accomplished through:

- **Stump desensitization** using gentle massage, vibration, constant pressure, and active massage therapy to prevent skin adhesion and facilitate sensory transmission. This should be performed two to three times a day for at least five minutes and is associated with adequate postoperative pain control in 85% of patients.
- **Stump volume reduction** to improve the healing process through the use of soft, semi-rigid, or rigid bandages.

- **Early use of a temporary prosthesis** instead of crutches, which allows for better adaptation and accelerates bipedal gait restoration.

Pain management is directly related to functional recovery and reintegration. Identifying risk factors that could contribute to increased pain requires both preoperative and postoperative approaches.

Routine preoperative use of opioids has been associated with increased post-amputation pain. However, other medications such as gabapentin and ketamine, when used in the preoperative period, have demonstrated positive outcomes in both preoperative and postoperative pain scores. Their administration for two weeks before and up to six months after surgery has been shown to reduce the incidence of phantom limb pain.

Although clear guidelines exist, pain management in amputations is complex and should be assessed comprehensively by pain specialists, as it impacts multiple social, economic, health, and quality-of-life factors for both the patient and their support system.

To identify risk variables, manage pain with the lowest effective medication dose, and minimize adverse effects and postoperative complications, it is recommended that patients receive pain management consultation 1-2 weeks before surgery. This allows for the selection of pharmacological, interventional, or integrative methods tailored to the patient's needs.

It is essential to highlight that rehabilitation should not follow a rigid, standardized protocol for all patients but must be individualized with a comprehensive approach. For example, in patients with chronic kidney disease (CKD), it is recommended to extend the rehabilitation period or increase the intensity while adjusting frequency to prevent excessive fatigue (18).

7. Conclusion

Of the 25 reviewed articles focusing on the perioperative management of patients undergoing amputation, 9 describe the negative impact of diabetes as a primary comorbidity in this patient population. These studies highlight the need to implement measures to optimize metabolic status. However, while general recommendations exist for the control and optimization of biochemical parameters in major surgeries, the reviewed literature reveals limitations regarding a consensus on specific optimal biochemical parameters for patients undergoing lower limb amputations. To date, there is no clinical practice guideline that comprehensively addresses the particularities of these patients.

Additionally, 9 studies emphasize the importance of understanding the pathophysiology of renal disease and peripheral vascular disease, given their negative impact on the amputation process and subsequent rehabilitation. Although progress has been made in identifying biochemical levels and optimal parameters for perioperative optimization, no consensus was found in the literature that systematically organizes these parameters or clearly correlates them with improved survival specifically in amputee patients.

Regarding rehabilitation, multiple globally available protocols were identified, each with sequenced phases of management. These protocols have demonstrated a statistically significant positive impact on the functional outcomes of amputee patients.

This literature review underscores the need for clinical trials investigating biochemical parameters, sociodemographic factors, underlying comorbidities, and other influential factors in patients undergoing amputation. Correlating these factors with survival rates and long-term functional outcomes will allow for the development of improved management and optimization guidelines for this patient population.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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