ORIGINAL RESEARCH

Epidemiology of lower-extremity amputations at a second-level hospital in Copperbelt Province, Zambia: A retrospective analysis

Sergiy Karachentsev, Womba Kadochi, Mwamba Simutowe

Department of Surgery, Roan Antelope General Hospital, Luanshya, Zambia

Correspondence: Dr Sergiy Karachentsev (sergiykarachentsev@gmail.com)

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Abstract

Background
While the epidemiology of major limb loss has been largely studied in the Western world, reports on the causes of amputations in developing countries are sparse and discordant. This led us to perform a study on the epidemiology of major lower-extremity amputations at our facility.

Methods
This was a retrospective analysis of a database of lower-extremity amputations seen at a second-level hospital over a 12-year period. Both traumatic and nontraumatic amputations were included in this study. The data focused on patients' demographics, causative factors, and level of amputation.

Results
A total of 55 patients, with a male-to-female ratio of 1.75:1, met the inclusion criteria. Peripheral arterial disease was the leading cause of major lower-limb amputations (n=23), outnumbering cases of complicated diabetic foot infections (n=14); a combination of these conditions occurred in 7 patients.

Conclusions
This study revealed important differences in epidemiological factors for lower-limb amputations in comparison with the available literature from developing nations. Further research is needed to understand the role of different aetiopathological processes that contribute to the higher risk of limb loss in resource-limited settings.

Keywords: amputation, diabetes mellitus, peripheral arterial disease, rural population, Zambia

Introduction

Amputation is a debilitating procedure that severely reduces the quality of life and has major economic consequences for patients, their families, and society.[1] The operation is usually indicated when a part of a limb becomes irreversibly damaged by devastating injury, destructive infection, or critical ischaemia.[2],[3] While diabetes mellitus (DM) and peripheral arterial disease (PAD) are recognizable conditions leading to limb loss in the Western world,[1],[4] few studies have investigated the burden of noncommunicable diseases in developing nations.[5],[6] Given the recent evidence of the adoption of Westernized lifestyles and increased tobacco smoking in Africa,[7],[8] we hypothesized that the incidence of PAD as a reason for amputation in Zambia is rising and that this diagnosis is underreported in clinical practice. This study aimed to fill a knowledge gap regarding the epidemiology of critical leg events with corresponding positive clinical and educational outcomes to stimulate further research in this area.

Methods

This was a retrospective and descriptive epidemiological study of major lower-extremity amputations performed at Roan Antelope General Hospital, a second-level referral hospital in Luanshya, Zambia, from 1 January 2010 through 31 December 2021. This second-level referral hospital has a capacity of 164 beds and operates as the main medical centre in an area with a population of around 200 000 people. Major amputations were classified as below-knee or above-

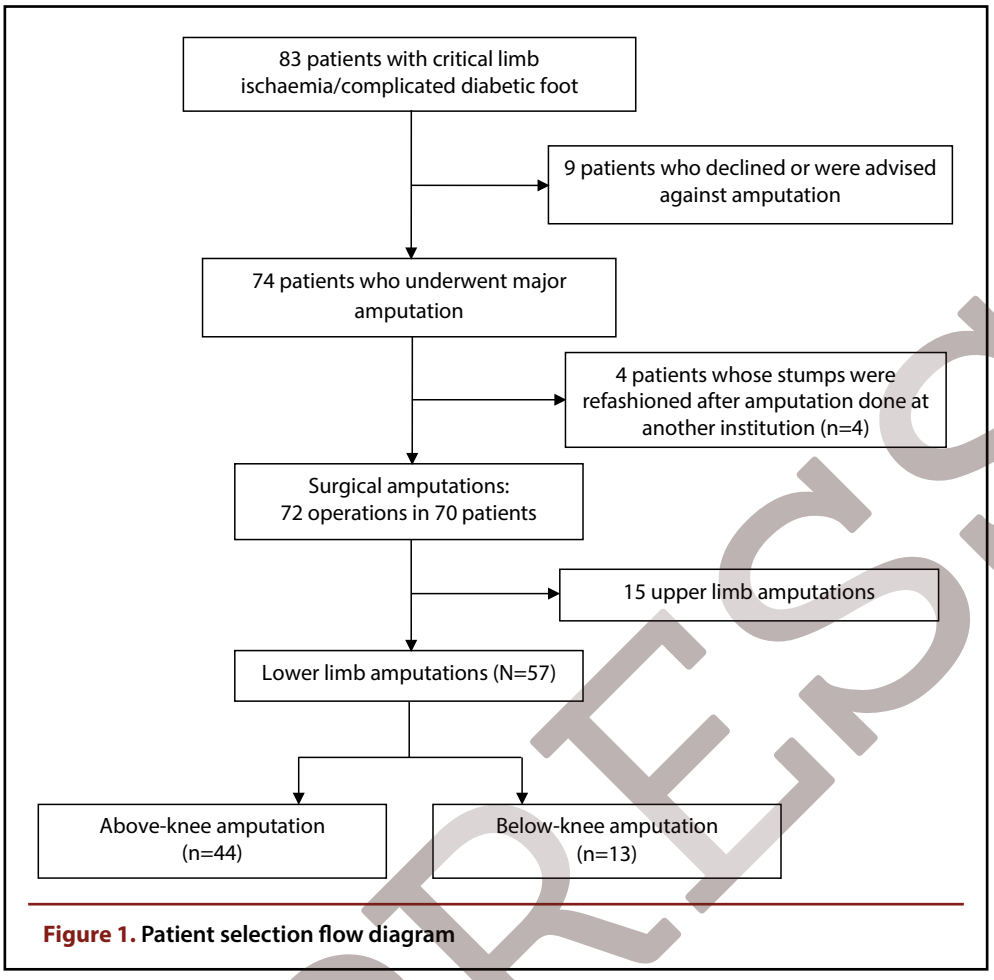

Figure 1. Patient selection flow diagram

knee amputations. All patients who underwent major lower extremity amputations at our institution were included in the study. Patients who refused amputation and those who were primarily amputated at other institutions and transferred to our hospital with complications after the procedure were excluded from the study. The selection of the study sample is shown in Figure 1. Participants were identified through a surgeon's personal registry and operative case logs, and perioperative variables were obtained by reviewing medical records. The study was conducted in accordance with the ethical principles of medical research and the Declaration of Helsinki. Permission to conduct the study and publish results was granted by the Roan Antelope General Hospital Ethical Committee (number 05/22), and confidentiality was maintained in that no patient-identifying information was included in the process of data collection.

The diagnosis of diabetic foot infection was made on the basis of clinical criteria, including a positive medical history of diabetes and the presence of lower-extremity soft-tissue infection extending in some patients deeply to involve the bone, otherwise termed osteomyelitis.

The clinical diagnosis of PAD was based on medical history, identification of risk factors (such as hypertension and a history of smoking), examination of peripheral pulses, and systolic bruits on vessel auscultation. In recent years, Doppler ultrasonography of the axial vessels by specially trained staff has been introduced in the hospital, and we found it useful in anatomical and haemodynamic vascular assessments. The final diagnosis was confirmed intraoperatively by macroscopic examination of the transected femoral or tibial arteries. One of the authors, a consultant and specialist in vascular surgery, performed 86% of the amputations and supervised the management of the study patients. In patients with PAD, extremity ischaemia was categorized according to the Rutherford classification (1986, revised 1997)[9]; in diabetic patients, we applied the WIfI (wound, ischaemia, and foot infection) classification system proposed by the Society for Vascular Surgery in response to the increasing prevalence of limb ischaemia among people with DM.[9] Chronic limb ischaemia was defined by a duration of symptoms of >2 weeks.[10] Chronic limb-threatening ischaemia was defined as documented PAD in association with ischaemic rest pain or tissue loss (ulceration or gangrene).[11] Patients with limb trauma were assessed using the Advanced Trauma Life Support methodology; the extent of injury was classified in terms of Injury Severity Score (ISS).[12] A Mangled Extremity Severity Score (MESS) was calculated for each patient with a crush injury to a limb.[2] Continuous variables were evaluated as medians with ranges, as the variables were not normally distributed; categorical data are presented as frequencies and percentages.

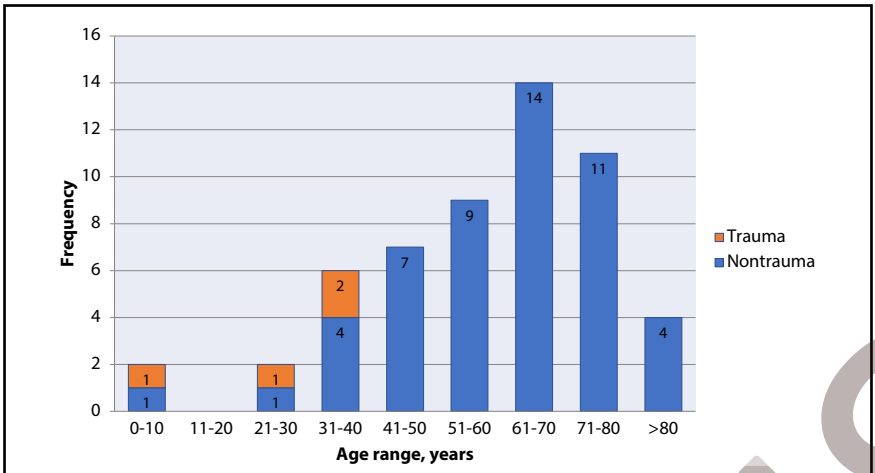

Figure 2. Age distribution of the study sample

Results

Over a 12-year period, 57 major lower-extremity amputations were performed on 55 patients with a 1.75:1 male-to-female ratio. One revision surgery (ipsilateral conversion to a higher level of amputation) was performed on a 3-year-old patient with injuries sustained in a road traffic crash because of necrosis of the skin flap and muscles after a below-knee amputation. One patient underwent consecutive bilateral above-knee amputations 16 months apart. The amputees ranged from 2 to 89 years of age, and 69% of the study participants were ≥50 years of age (Figure 2). The demographics of the study sample, along with causative factors and indications for major lower-extremity amputations, are presented in the Table. Forty-four patients (80%) underwent lower-limb amputations above the knee joint, and 51 of the patients (93%) underwent amputations necessitated by causes other than limb trauma. Chronic limb-threatening ischaemia was the main broad indication for performing leg ablation.

The most common causative factor for major limb amputation was PAD (n=23, 42%), followed by DM (n=14, 25%) and trauma (n=4, 7%). Seven patients (13%) underwent amputations precipitated by a combination of PAD and DM. Most patients with peripheral occlusive conditions gradually developed tissue loss and distal necrosis in chronically devascularized limbs (Rutherford grade III category 6). In all but 2 patients with peripheral vascular disease, the underlying pathological process was atherosclerotic stenosis or occlusion of the axial artery (aortoiliac segment, n=4; femoropopliteal segment, n=17; tibial arteries, n=7). In 1 patient, gangrene of the lower extremity was caused by postembolic occlusion of the common femoral artery. We also diagnosed a patient with end-stage Buerger's disease, an occlusive inflammatory vasculitis that affects small and medium vessels.[13] Acute extremity ischaemia (Rutherford acute ischaemia category III) was diagnosed in 2 patients with thrombosis of the femoropopliteal segment and in 1 2-year-old patient who presented with acute idiopathic gangrene of the foot, likely as a complication of severe malaria.

Patients with DM presented with extensive and deep foot ulcers, signs of progressive local (osteomyelitis), and systemic infection (sepsis). Hyperglycaemia in such patients is difficult to control. Additionally, 7 of these patients (13%) exhibited necrotic changes that varied from dry necrosis of 1 toe to high gangrene of the leg in association with pulse deficit (WIfI grades 2–3) due to the presence of PAD.

Among the patients who underwent amputations because of traumatic injuries, 3 presented with polytrauma (ISS, median 40, range 40-45; MESS, median 7.5, range 7-8), and 1 presented with an isolated traumatic subtotal amputation of the leg. Trauma was caused by road traffic crashes (n=3) and a fall from height (n=1). Deep progressing infection leading to major amputation was caused, apart from diabetic foot infection, by a septic burn (n=1), AIDS (n=1), and a snake bite (n=1). Another indication for amputation was a tumour of the lower limb (n=3; 1 patient with a Marjolin's ulcer of the foot and 2 other patients whose tumours grossly resembled squamous cell carcinoma but were not histologically confirmed).

Discussion

This study investigated the epidemiology of major lower-limb amputations using data collected over 12 years at a second-level hospital in Luanshya, Copperbelt Province, Zambia. The principal finding in our series was that most patients who underwent lower limb amputations had occlusive peripheral vascular disease, either as an isolated condition or in combination with DM. This finding could explain the high proportion of older men in the study sample, as both male sex and increased age are known to be risk factors for the development of cardiovascular disease.[9],[14] Although our data contradict the results of other studies on the topic from sub-Saharan Africa,[15],[16] there is evidence indicating an epidemiological transition towards noncommunicable diseases, including cardiovascular disease and DM, in low- and middle-income countries.[7],[17]

We observed that nontraumatic causes significantly outnumbered trauma as reasons for amputations, and our patients were more likely to be amputated above the knee joint. Conversely, Aljarrah et al. observed a nearly 4-fold predominance of below-knee amputations over above-knee

Table. Patient characteristics

Variable	Quantity
Sex	
Male	35 (64)
Female	20 (36)
Median age, years (IQR)	62.5 (47-74)
Underlying cause	
PAD	23 (42)
DM	14 (26)
PAD + DM	7 (13)
Trauma	4 (7)
Deep necrotizing infection	3 (6)
Tumour	3 (6)
Idiopathic gangrene	1 (2)
Comorbidities	
Hypertension	21 (38)
HIV/AIDS	5 (9)
Cerebrovascular disease	3 (6)
Congestive cardiac failure	2 (4)
Indication	
CLTI	29 (52)
ALI	3 (5)
Progressing infection	17 (30)
Mangled extremity	4 (7)
Tumour	3 (5)
Anatomical level of amputation	
Below knee	13 (20)
Above knee	44 (80)
Bilateral interval amputation	1 (2)
Revision	1 (2)

All values are n (%) unless otherwise indicated.

ALI, acute leg ischaemia; CTLI, chronic limb-threatening ischaemia; DM, diabetes mellitus; IQR, interquartile range; PAD, peripheral arterial disease

amputations in their patients.[18] The high proportion of above-knee amputations in our study could be attributed to a high level of occlusive atherosclerotic vascular disease (aortoiliac and femoropopliteal segments) in most of our patients, which requires a higher-level amputation if no vascular reconstruction is planned. Indeed, studies finding high proportions of below-knee amputations have tended to enrol younger patients with trauma or DM as the main factors leading to limb amputations.[19],[20] It is likely that trauma patients had unaffected arteries prior to their injuries, and patients with DM frequently exhibit infrapopliteal arterial damage.[21]

Another interesting finding in our study was that only 10% of our patients with PAD presented with acute limb ischaemia, with the others exhibiting signs of progressively developing chronic limb-threatening ischaemia. This contrasted with a study conducted in Jordan,[18] which found that major lower-extremity amputations were associated with almost equal proportions of acute and chronic limb-threatening events. Importantly, gradual ischaemia development provides a window of opportunity for performing revascularization and limb salvage in specialized vascular surgery units under the condition that occlusive vascular pathology is suspected by a primary care clinician. Recent studies and guidelines[10],[14],[22] suggest that timely detection of limb ischaemia is essential for improving the treatment outcomes of patients with adverse limb conditions.

DM carries a high risk of major limb amputation,[21],[23],[24] and our research corroborates this fact. Notably, 7 patients in our study presented with a combination of DM and PAD, and the coexistence of these limb-threatening has been observed in previous studies.[1],[25] A strong association between DM and accelerated atherosclerosis has been known for many years,[4] and it is well established that chronic hyperglycaemia and atherosclerotic occlusive vascular disease are mutually reinforcing, and a combination of these conditions has a significant impact on amputation rates.[3],[4],[6] Zeadin et al.[26] and Yuan et al.[27] present comprehensive descriptions of the molecular and cellular machinery underlying the formation of atherosclerotic plaque in DM. In our study, we observed that DM-associated amputations were performed because of septic complications of diabetic foot infection, usually in well-perfused extremities. In contrast, the usual indication for amputation in patients with both DM and PAD was ischaemia. It seems that in the context of concurrent DM and PAD, the former condition could accelerate the formation of atherosclerotic plaques inside the arterial wall, gradually narrowing the vessel lumen and ultimately leading to the development of tissue ischaemia and necrosis. As such, in patients with DM and PAD, DM should be considered as a stage in the development of atherosclerotic disease and an important comorbidity.

Studies investigating the epidemiology of amputations in low- and middle-income countries indicate that diabetic complications and trauma are leading causes of limb loss. For example, in studies conducted in Senegal[19] and Cameroon,[28] diabetic foot infection was responsible for amputation in 53% and 67% of patients, respectively. High rates of trauma-related amputations have been observed by investigators in Kenya[29] and Nigeria.[20] Conversely, PAD was indicated as a causative factor in only 3.8% of major limb amputations in a study by Ogundele et al.[30] in Nigeria; Diao et al.[19] determined a rate of 17.9% in their study conducted at a hospital in sub-Saharan Africa. Other researchers have identified acute and chronic limb ischae-

mia,[16] 'vasculopathy of unknown origin',[15] 'dysvascular non-diabetic cause',[29] and 'diabetic foot gangrene'[30] as indications for amputation. Many patients with PAD fall into these categories, and we suggest that the incidence of PAD in SSA is higher than reported.

Inconsistencies in the research results may be attributable to several factors. First, varying population characteristics, quality-of-life indicators, and dietary factors undoubtedly have major impacts on disease profiles globally.[3],[25] Second, healthcare system capacity shortcomings, a lack of trained surgical personnel in resource-scarce settings, and a low degree of awareness about the rising incidence of noncommunicable diseases can complicate the diagnostic process, especially for patients with multiple comorbidities.[5],[14] As a result, a high proportion of patients with limb ischaemia may never receive specialized surgical care.[28]

Many published research reports on this topic do not explicitly state the reasons for amputation, and such publications have varying aetiologic definitions, which brings about challenges in comparing and reproducing related findings. As Meffen and colleagues[23] suggest in a systematic review report, there is a need for an international consensus on amputation-related definitions, a standardized medical code list, and extensive large-scale research to establish guidelines for using primary care data in amputation epidemiology.

One of the strengths of this study was that the study sample—derived from a second-level hospital in a rural setting—reflected the predominantly rural inhabitants of sub-Saharan Africa, and the study findings could reflect a general trend in the development of critical limb conditions. Although this was not the first study to explore the epidemiology of amputations in Zambia,[16] our findings will be of interest and value to clinicians and policymakers in Zambia and beyond.

Limitations

Our study had several limitations. This was a single-institution study with a small number of patients, performed in an environment with limited diagnostic and therapeutic resources. Next, although essential information was acquired from a surgeon's personal database, details of the examination and procedures were obtained retrospectively by a review of the operative case logs and medical records, and some data were incomplete or unclear. To minimize the problem of missing physiological variables, we performed imputation of missing data from other information available in the patient file. For example, assessments of extremity ischaemia according to the Rutherford, WIfI, ISS, and MESS criteria—if absent in the files—were performed with consideration of the descriptions of the respective patients' bone and soft tissue injuries and vascular statuses. We acknowledge that this approach may have generated bias, and the aforementioned limitations may reduce the external validity of the study. Nevertheless, with an individualized approach to every case in question and strict adherence to methodological standards, we were able to derive useful information from which to draw conclusions.

Conclusions

This study revealed the epidemiological characteristics of lower-extremity amputations in our community. The findings demonstrated a high proportion of PAD as a cause of major limb amputation. We hope that our data and considerations will provide useful information for healthcare professionals in their undertaking of daily practice and research to improve the outcomes of adverse limb events. We also expect that policymakers will see the need to invest in trained personnel and materials to diagnose PAD early and prevent major lower-extremity amputations. However, since our findings are somewhat different from those reported previously, they need to be validated by larger-scale prospective studies to obtain better insight into the epidemiological picture of major limb amputations in our setting.

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