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Predictors of Mortality and Functional Outcomes Following Major Lower Limb Amputation: A Retrospective Study

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ABSTRACT

Background: Major lower-extremity amputations (MLEAs) impose considerable clinical and socioeconomic burden, with the amputation level markedly affecting postoperative recovery.

Objective: This study compares the outcomes of above- (AKA) and below- (BKA) knee amputations, while identifying key risk factors for postoperative morbidity and mortality at King Faisal Specialist Hospital and Research Center in Jeddah, Saudi Arabia.

Methods: This retrospective study included 138 adult patients of both sexes (aged ≥18 years) who underwent MLEAs. The population was divided into two equal groups based on the level of amputation: AKA and BKA groups.

Results: The mean age was significantly greater in patients with AKA compared to those with BKA ($p=0.007$). Atrial fibrillation was more frequent in AKA cases ($p=0.003$). The lesion site differed significantly between groups ($p<0.001$), with leg lesions more common in AKA and foot lesions more frequent in BKA. Complications occurred more often in AKA than BKA ($p=0.051$), with infection being the most frequent in both groups. Mobility outcomes differed significantly ($p=0.013$), as most AKA patients were immobile, while some BKA patients achieved limited or independent walking. Mortality was higher in AKA (21.54%) than BKA (13.85%) without a significant difference ($p=0.250$). Age, sex, and comorbidities were not significantly associated with mortality.

Conclusions: In this Saudi cohort, AKA was associated with higher clinical risk and poorer functional outcomes compared with BKA. Patients undergoing AKA were generally older and presented with more advanced disease, while BKA patients demonstrated comparatively better postoperative mobility potential.

KEYWORDS: Major lower extremity amputations, Above-knee amputation, Below-knee amputation, Morbidities, Mortality, Complications

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INTRODUCTION

Globally, major lower extremity amputations (MLEAs) cause a considerable amount of morbidity and death while being a life-changing treatment [1]. The impact on one's ability to work, quality of life, and self-perception can have serious societal ramifications [2]. The aging of the world's population and the rise in diabetes mellitus (DM) prevalence are expected to exacerbate the severity of MLEAs [3]. Peripheral vascular disease (PVD) and DM are the primary risk factors for MLEAs [4]. MLEAs are linked to significant rates of postoperative death (30-day mortality 6.6%) and morbidity (30-day complication rate 74%) [5].

The epidemiology of MLEAs exhibits significant regional variation, shaped by disparities in healthcare access, preventive services, and disease burden. The primary global indications for MLEAs are diabetic foot complications, ischemic vascular disease, and traumatic injuries [6].

There are few studies on the results of MLEA in Middle Eastern, despite the fact that these nations are adopting contemporary methods of treating PVD and DM [7]. Saudi Arabia faces a growing burden of diabetic foot disease and vascular complications, yet comprehensive outcome data remain scarce [8].

Saudi Arabia has one of the highest diabetes rates in the world. The International Diabetes Federation Atlas 2024 lists Saudi Arabia as one of the ten nations with the most diabetic adults, at 5.3 million. Diabetes-related healthcare expenses are expected to reach USD 7.3 billion in 2024, a large share of the national healthcare budget [9]. This escalating prevalence has been attributed to accelerated population growth, urbanization, aging, and lifestyle modifications, including unfavorable dietary habits and poor physical activity [10, 11].

Despite the revolution in the management of threatening limb ischemia by interventional radiology and revascularization, the amputation rate is still remarkably high [12]. MLEAs have high risk of early post-operative mortality and morbidities rates [13]. These morbidities include bleeding, wound infection, multi-organ dysfunction, physical limitation, and psychosocial distress, which collectively affect long-term rehabilitation and survival [14].

This study compares the outcomes of above- (AKA) and below- (BKA) knee amputations, while identifying key risk factors for postoperative morbidity and mortality at King Faisal Specialist Hospital and Research Center in Jeddah, Saudi Arabia.

PATIENTS AND METHODS

This retrospective study included 138 adult patients of both sexes (aged ≥18 years) who underwent either emergency or elective MLEAs, in the Vascular Surgery Unit, General Surgery Department at King Faisal Specialist Hospital and Research Center (KFSHRC-J), Jeddah, Saudi Arabia from January 2018 to December 2021.

The study population was divided into two groups based on the level of amputation: AKA group (n = 65) and BKA group (n = 65).

All procedures were conducted in accordance with the institutional research ethics protocols, the regulations of the Saudi National Committee of Bioethics (NCBE), and the principles outlined in the Declaration of Helsinki concerning research involving human subjects.

Exclusion criteria included non-Saudi patients, individuals younger than 18 years, amputations performed outside the KFSHRC-J vascular unit, and amputations due to malignant tumors.

Data collection

Data were extracted retrospectively from electronic medical records using the Research Electronic Data Capture (REDCap) system (Vanderbilt University). Collected variables comprised demographic data (age, sex, smoking status, and comorbidities like diabetes mellitus, hypertension, and peripheral vascular disease), clinical and operative details (site of lesion, history of revascularization, indication and level of amputation, and length of hospital stay), and postoperative outcomes (complications, prosthesis use, mobility status, and mortality rate).

Sample size calculation

G*Power 3.1.9.2 (Universitat Kiel, Germany) was employed to calculate the sample size. We conducted a pilot study with ten cases in each group and observed a mortality rate of 10% in the BKA group and 30% in the AKA group. The following factors were taken into account when determining the sample size: A 95% confidence interval, 80% statistical power, a 1:1 group ratio, and the inclusion of three additional cases in each group to account for potential attrition. Consequently, we enrolled 65 patients in each cohort.

Ethical considerations

The initiative conformed to the guidelines outlined in the Declaration of Helsinki and its subsequent amendments, ensuring compliance with data protection regulations. An exemption from the requirement for informed consent was requested and granted by the Institutional Review Board Ethics Committee of King Faisal Specialist Hospital & Research Centre, Jeddah, Saudi Arabia (IRB 2023-19).

Statistical analysis

SPSS software version 27.0 was used to perform statistical analysis. The Shapiro-Wilk test and histogram examination were used to determine if the data distribution was normal. The unpaired Student's t-test was used to compare quantitative data with parametric distribution, which were reported as Mean ± SD. for data that isn't parametric. Frequencies and percentages were used to describe categorical data, and when necessary, the Chi-square or Fisher's exact test were used for statistical comparisons. Statistical significance was defined as a two-tailed p-value of less than 0.05.

RESULTS

The mean age was significantly higher among patients AKA compared with BKA (65.78 ± 12.39 vs. 59.52 ± 13.72 years, p = 0.007). Although males predominated in both groups, the difference was not significant (p = 0.103). Atrial fibrillation (AFib) was more frequent in AKA cases (p = 0.003). Other comorbidities showed no significant differences between groups (Table 1).

Table (1): Demographic data the studied groups

	AKA (n=65)	BKA (n=65)	P	MD/RR (95CI)
Age (years)	65.78 ± 12.39	59.52 ± 13.72	**0.007**	6.26

					(1.73 : 10.8)
Sex	Male	36 (55.38%)	45 (69.23%)	0.103	0.8(0.61:1.05)
	Female	29 (44.62%)	20 (30.77%)		
Comorbidities		64 (98.46%)	63 (96.92%)	1.00	1.02(0.96:1.07)
Comorbidities	Diabetes mellitus	55 (84.62%)	61 (93.85%)	0.095	0.9(0.81:1)
	Hypertension	58 (89.23%)	55 (84.62%)	0.270	1.07(0.95:1.21)
	Ischemic heart diseases	34 (52.31%)	30 (46.15%)	0.276	1.21(0.86:1.7)
	End stage renal failure	17 (26.15%)	14 (21.54%)	0.410	1.29(0.7:2.39)
	Chronic kidney diseases	14 (21.54%)	13 (20%)	0.756	1.11(0.57:2.17)
	Atrial fibrillation	12 (18.46%)	2 (3.08%)	**0.003**	6.3(1.47:26.98)
	Smoking	3 (4.62%)	4 (6.15%)	1.00	0.78(0.18:3.32)

Data are presented as mean ± SD or frequency (%).MD: Mean difference, RR: Relative risk, CI: **Confidence interval**.
The lesion site differed significantly between groups ($p < 0.001$), with leg lesions more common in AKA and foot lesions more frequent in BKA. History of revascularization, reason for amputation, and hospital stay duration showed no significant differences ($p > 0.05$) (Table 2).

Table (2): Clinical data the studied groups

		AKA (n=65)	**BKA (n=65)**	**P**
Site of lesion	Toe	1 (1.54%)	5 (7.69%)	**<0.001**
	Foot	22 (33.85%)	40 (61.54%)	
	Leg	42 (64.62%)	20 (30.77%)	
History of revascularization		21 (32.31%)	17 (26.15%)	0.122
Reason for amputation	Ischemia	45 (69.23%)	39 (60%)	0.525
	Infection	18 (27.69%)	24 (36.92%)	
	Trauma	2 (3.08%)	2 (3.08%)	
Length of hospital stay (days)		5 (4 - 14)	5 (4 - 8)	0.405

Postoperative complications occurred more often in AKA than BKA (49.3% vs. 33.8%, $p = 0.051$), with infection being the most frequent in both groups. Mobility outcomes differed significantly ($p = 0.013$), as most AKA patients were immobile, while some BKA patients achieved limited or independent walking. Mortality was higher in AKA (21.54%) than BKA (13.85%) without significant difference ($p = 0.250$) (Table 3).
Data are presented as mean ± SD or frequency (%).

Table (3): Outcomes of the studied groups

		AKA (n=65)	**BKA (n=65)**	**P**	**MD/RR (95CI)**
Postoperative complications	Overall complications	33 (50.77%)	22 (33.85%)	0.051	1.5(0.99:2.27)
	Infection	30 (46.15%)	21 (32.31%)	0.164	1.51(1:2.28)
	Ischemia	2 (3.08%)	0 (0%)	0.498	---
	Stump pain	1 (1.54%)	1 (1.54%)	1.000	2(0.19:21.52)
	Phantom limb	0 (0%)	0 (0%)	---	---
Artificial limb application		4 (6.15%)	10 (15.38%)	0.108	0.42(0.14:1.27)
Prosthesis used		17 (26.15%)	20 (30.77%)	0.560	0.85(0.49:1.47)
Mobility					
Independent		0 (0%)	3 (4.62%)	**0.013**	---
Limited walking		3 (4.62%)	11 (16.92%)		
Immobile		62 (95.38%)	51 (78.46%)		
Mortality					
Alive		51 (78.46%)	56 (86.15%)	0.250	
Dead		14 (21.54%)	9 (13.85%)		
Survival (Days)		74.5(16.75 - 115.75)	227(17 - 316)	0.311	66.5(-54:254)

Binary logistic regression showed no significant predictors of mortality. Age, sex, and comorbidities, including diabetes mellitus, hypertension, ischemic heart disease, renal disease, and AFib, were not significantly associated with mortality ($p > 0.05$) (Table 4).

- Data are presented as mean ± SD or frequency (%). MD: Mean or median difference, RR: Relative risk, CI: **Confidence interval**.

Table (4): Mortality risk in patients with amputation according to demographic characteristics using binary logistic regression

	Alive (n= 107)	**Dead (n=23)**	**P value**	**Odds ratio**	**95% CI**	**P**
Age (years)	62.66 ± 13.35	62.61 ± 13.91	0.986	0.999	0.96 - 1.04	0.98

Sex	Male	69 (64.49%)	12 (52.17%)	0.269	1.851	0.69 -4.93	0.218
	Female	38 (35.51%)	11 (47.83%)				
Comorbidities	DM	95 (88.79%)	21 (91.3%)	0.882	1.406	0.34 - 5.77	0.636
	HTN	94 (87.85%)	19 (82.61%)	0.281	0.720	0.24 - 2.16	0.558
	IHD	54 (50.47%)	10 (43.48%)	0.387	0.904	0.37 - 2.20	0.824
	ESRD	25 (23.36%)	6 (26.09%)	0.855	1.359	0.51 - 3.62	0.539
	CKD	22 (20.56%)	5 (21.74%)	0.968	1.522	0.52 - 4.44	0.442
	Afib	13 (12.15%)	1 (4.35%)	0.248	0.861	0.23 - 3.26	0.826
	Smoking	6 (5.61%)	1 (4.35%)	0.817	0.775	0.19 - 3.17	0.723

- Data are presented as mean ± SD or frequency (%). DM: Diabetes mellitus; HTN: Hypertension; IHD: Ischemic heart disease; ESRD: End-stage renal disease; CKD: Chronic kidney disease; Afib: Atrial fibrillation. CI: **Confidence interval**.

DISCUSSION

In the current investigation, the mean age was significantly higher among patients with was significantly higher among patients AKA compared with BKA with males predominating in both groups. AFib was more frequent in AKA cases. The lesion site differed significantly between groups, with leg lesions more common in AKA and foot lesions more frequent in BKA. History of revascularization, reason for amputation, and hospital stay duration showed no significant differences.

In the current study, postoperative complications occurred more often in AKA than BKA, with infection being the most frequent in both groups. Mobility outcomes differed significantly (p=0.013), as most AKA patients were immobile, while some BKA patients achieved limited or independent walking. Mortality was higher in AKA (21.54%) than BKA (13.85%) without significant difference. Binary logistic regression of this research showed no significant predictors of mortality. Age, sex, and comorbidities, including diabetes mellitus, hypertension, ischemic heart disease, renal disease, and AFib, were not significantly associated with mortality.

Similarly, previous studies [15-17] reported that the mean age of patients undergoing AKA was significantly higher than those undergoing BKA**.** This may be explained by the clinical reality that older patients often present with more advanced ischemia or non-salvageable tissue loss. The predominance of DM in this cohort provides a plausible explanation, as DM is well known to precipitate major amputations at younger ages, especially when onset occurs early and complications accumulate rapidly [18, 19].

Male predominance was observed in both groups, consistent with trends reported globally [7, 20].

In line with the findings reported by Virolainen and colleagues [21] who reported that patients undergoing AKA were older, more often female, and exhibited markedly higher one-year mortality (52% vs 32%) compared with BKA. However, they found that long-term corticosteroid use significantly increased the risk of surgical wound complications (SWCs) in both BKA and AKA, guillotine amputation prior to BKA was independently protective, and that BKA itself carried more than a fourfold higher risk of SWC compared with AKA.

Also, Morisaki and co-authors [22] found a mean age of 77.3 ± 11.2 years, with 67.9% of patients diagnosed with DM and 35.8% having hemodialysis. Primary amputation patients made up 61.9% of the sample, with AKA at 66.9% and BKA at 33.1%. Overall wound complications were 13.3%, including 10.3% in AKA and 19.5% in BKA. In multivariate analysis, female sex and BKA were significant wound complications risk variables. The 30-day mortality rate was 7.6%, with pneumonia, sepsis, and cardiac deaths at the top. Multivariate analysis showed that decreased serum albumin was associated with 30-day mortality.

In contrast to our analysis, Pitsenbarger et al. [23] observed that a preoperative diagnosis of CKD was correlated with numerous comorbidities, a reduced 1-year follow-up rate, and increased mortality at both 1 and 5 years. Kaplan-Meier analysis demonstrated significantly reduced 5-year survival rates in patients with any stage of CKD (62%) compared to those without CKD. Higher five-year mortality was independently associated with moderate CKD and severe CKD. Also, Zakriya et al. [13] observed that patients receiving MLAE had a mortality rate of 6.6% after 30 days. CKD and WSI were found to be significant predictors of mortality after 30 days.

Our failure to detect these associations may reflect underpowering or differences in perioperative care, but it underscores that meticulous infection control and CKD management are critical to improve outcomes.

Consistent with international recommendations, the findings of this study reinforce the importance of multidisciplinary foot care teams, early detection of diabetic foot complications, and aggressive management of PAD to reduce the need for MLEA [24, 25].

This study has several **limitations**, like its retrospective design, single-center setting, and limited sample size. The tertiary care population likely represents more severe disease than the general community. Important variables like socioeconomic status,

detailed functional scores, and laboratory markers were not consistently available. Furthermore, distinguishing between PAD and diabetes-related neuropathic disease is inherently challenging due to their coexistence.

CONCLUSIONS

In this Saudi cohort, AKA was associated with higher clinical risk and poorer functional outcomes compared with BKA. Patients undergoing AKA were generally older and presented with more advanced disease, while BKA patients demonstrated comparatively better postoperative mobility potential.

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