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Research Article

Retrospective Study of Lower Limb Amputation Causes and Risk Factors in Al-Qassim Region, Saudi Arabia

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ABSTRACT

Background: Limb amputation is one of the oldest medical procedures, dating back to the time of Hippocrates. Different populations report many other medical conditions leading to limb amputation. The diabetic foot was a significant indication of amputation. However, in developing countries, the most common reasons for amputations vary by the hospital.

Methods: This is an observational study conducted by retrospective chart review, at King Fahad Specialist Hospital. The Data was collected from January 2017-January 2022 files that met inclusion criteria. Collected data include age, gender, amputated limb, etiology, limb loss risk factors, and amputation level. Authorization was received from the hospital administration and the approval from Al-Qassim health directorate regional ethical committee.

Results: The study included 315 patients. Most cases were in 2021, representing a 97.6% increase over 2017. We discovered that 66% of the patients were males, with an M: F ratio of about 2:1. Mean age was 58.3 years, with a standard deviation of 13.75. According to BMI, 29.1% were obese, 54.9% overweight, and only 25.6% were of average weight. Amputations were performed on 91.4% of patients below the knee and 59.4% on the toes. 8.6%, on the other hand, were above the knee. In terms of etiology, diabetes was the leading cause of limb loss in 96.30% of patients, followed by peripheral artery disease found in 21.40% of patients, and trauma in about 9.2%.

Conclusion: Over the last 5 years, the incidence of lower limb amputation has increased in the Al-Qassim region. In this study, diabetic foot was a significant indication for amputation. Increasing diabetic patients' awareness of changes in feet, preventing infection, and controlling their diabetes may reduce the incidence of amputation.

INTRODUCTION

Limb amputation is one of the oldest medical procedures, dating back to the time of Hippocrates over 2500 years ago. If limb recovery is not possible, the limb is dead or moribund, viable but nonfunctioning, or threatens the patient's life, and amputation may be the only option. Limb loss has significant economic, social, and psychological consequences, especially in developing countries where prosthetics are unavailable (Ziegler-Graham et al., 2008). The most common cause of amputation in the United States is vascular causes. However, in India and Pakistan, trauma is the most common cause of amputation (Soomro et al., 2013; Pooja & Sangeeta, 2013). Different populations report different rates of other medical conditions leading to limb amputation. In developed countries, peripheral vascular disease is the predominant cause of amputation, whereas, in developing countries, trauma, infections, uncontrolled diabetes, and malignancies are the leading causes (Abou-Zamzam et al., 2003; Olasinde et al., 2002; Magee, 1998; Olaolorun, 2001). In developed countries, most amputees are elderly. However, in developing countries, most amputees are young, and the most common reasons for amputations vary by hospital (Pernot et al., 2002; Rommers et al., 1997; Greive & Lankhorst, 1996).

Complications after amputation, including Superficial incisional infection, deep incisional infection, death, pneumonia, pulmonary embolism, renal insufficiency, stroke, MI, deep venous thrombosis, phantom limb sensation, wound dehiscence, stump osteomyelitis, stump overgrowth, painful bone spur, hypertrophic scar, and severe depression (Hasanadka et al., 2011; Ajibade et al., 2013).

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This study highlights the causes and risk factors for amputation, a prevalent problem in King Fahad Specialist Hospital in Al-Qassim. Decreasing the risk factors and causes helps vascular and general surgeons plan to prevent further increases in the number of amputations in the Al-Qassim region. Despite recent advances in managing diabetes mellitus and many innovations in endovascular treatment, the incidence of lower extremity amputation has not improved. This article will review the most recent epidemiological data on lower extremity amputations.
In 2005, 1.6 million people were living with a limb amputation. Thirty-eight per cent had an amputation due to vascular diseases/peripheral artery disease (PAD), with diabetes mellitus as a comorbidity. By 2050, there will be 3.6 million persons with lost limbs. This number could be reduced by 225,000 if vascular disease incidence rates decreased by 10%. Approximately 185,000 amputations occur annually in the United States (Owings & Kozak, 1998). In Germany, out of 100,000, 25-27 have lost a limb (Moysidis et al., 2011). A 14-year retrospective study was conducted of three thousand two hundred ten amputees who attended the 1977–1990 Riyadh Medical Rehabilitation Centre (RMRC); the average age was 30.5 years, with the males slightly older than the females, and the average age of lower limb amputees was 32.6 years. On the other hand, the average age of upper limb amputees was 21.8 years. Overall, males outnumbered females by a ratio of 6.1:1. In the upper limb amputees, males outnumbered females by 5 to 1. In contrast, in the lower limb amputees, males outnumbered females 6.3 to 1 (that highlights the Disparities in gender and age group in amputations; disparities in access to care are an essential risk factor for amputations that might otherwise be prevented) (Carmona et al., 2005).

This study aims to determine whether improved health and effort made a difference by identifying the statistics of amputations in Al-Qassim, enumerating them, and comparing them with previous studies. A survey conducted by Pemayun et al., 2015 found that HbA1c ≥8%, PAD, hypertriglyceridemia, and hypertension have been recognized as predictors of lower extremity amputation. In this study, reasonable glycemic control, the active investigation against PAD, and managing comorbidities such as hypertriglyceridemia and hypertension are essential to reduce amputation risk. The results of this study can help in future prevention planning.

MATERIALS AND METHODS

This observational study, a retrospective chart review, was conducted under criteria among all patients who had lower extremity amputation from January 2017 to January 2022 in the Qassim region, excluding patients with missing data and all medical records before January 2016 and after January 2021. The study was conducted at King Fahd Specialist Hospital in Buraydah Al-Qassim region. Coverage includes 315 cases of lower extremity amputations from January 2017 to January 2022. We had all patients subjected to lower extremity amputation in the Qassim region. Furthermore, we exclude patients other than lower extremity amputation and those who underwent lower extremity amputation outside the Qassim region.

In this retrospective chart review study, we obtained the needed information through patient files using a data collection form at King Fahd Specialist Hospital, Buraydah. The population was identified from hospital databases (operating theatres and medical records). We included all the files that fit our inclusion criteria from January 2017 to January 2022. who went through amputation, ignoring any factor, including race, age, gender, or surgical procedure. Data were retrospectively collected from all files of patients who underwent lower limb amputations. Collected data included age, gender, BMI, co-morbidity and the cause of the amputation, which were collected by trained data collectors and reviewed by study supervisors. We looked through all the files of patients who underwent amputation and the incidences of different pathologies leading to that amputation. We used Google Sheets to enter all the data; our questions focused on age, sex, the amputated limb, etiology and factors for loss, level of amputation, and the number of amputations.

Data were analyzed using IBM Statistical Package for Social Science SPSS Statistics for Windows version 22 (IBM Corp., Armonk, NY, USA). Descriptive statistics have been used to describe the study population that underwent amputation. The mean and standard deviation have been calculated for continuous variables. Frequencies and proportions have been calculated for categorical variables. The Chi-square test has been used to compare proportions for categorical variables; t-tests have been used to compare continuous variables. Nonparametric tests have been used for non-normally distributed variables. P-value ≤ 0.05 was considered statistically significant.

RESULTS

The study was conducted with 315 patients. Most of the operations were completed in 2021, with an increase of 976 % from the numbers in 2017. We found that 66 % of the patients were males, with a 2:1 the Male Female ratio. The patients' ages ranged from 2 to 91 years old, with a mean age of 58.3 years and a standard deviation of 13.75 years. Among the patients, 29.1 % of the patients were obese 45 % were overweight, and only 25.6 % were at average weight according to BMI. 91.4% of amputation surgeries were below the knee, and 184 were at the toe. On the other hand, 8.6 % were above the knee. Regarding the etiology of limb loss, DM was the leading cause of loss in 79.0% of patients, peripheral artery disease was found in 12.1% of patients, and trauma in about 8.9%.

In this study, we collected data for all lower limb amputations that occurred at King Fahd Specialist Hospital, Buraydah Al-Qassim region, in the period between Jan 2017 and Jan 2022. We could identify 474 patients who had lower limb amputations over this time. However, due to incomplete data, 159 patients were excluded from the study, leaving 315 patients. Most amputations were

conducted in 2021, with an increase of 976 % from 2017. The chart below (Figure 1) shows that there has been a significant increase in the number of lower limb amputations over time.

We found that 66 % of the patients were males, with a 2:1 the Male Female ratio. The patients' ages ranged from 2 to 91 years old, with a mean age of 58.3 years and a standard deviation of 13.75 years. 21% were in the 26-50 age group, 67% were between 51 and 75 years old, 9.8% were over 75, and only 2.2% were below 25. The mean weight and height of the patients were 77.1 Kg and 165.8 cm, resulting in a mean BMI of 28.2 Kg/m2. According to their BMI, only 25.6% of the patients were at the average weight, while 45% were overweight and 29.1% were obese. (Table 1).

Among diabetic patients, the mean HbA1C was 10.5 (SD=5.8), 46.2 % had HbA1c over 10, and 53.8 % had HbA1c below 10. The study has identified diabetes mellitus (DM) (96.30%), hypertension (HTN) (67.90%), gangrene (40.20%), and all types of ulcers (31.6%) as risk factors among patients who had lower limb amputations. Smoking was found in 8.2 % of the patients, while neuropathies, ischemic heart disease (IHD), and peripheral artery disease (PAD) were reported in 24.1 %, 26.9 %, and 21.4 %, respectively (Figure 2).

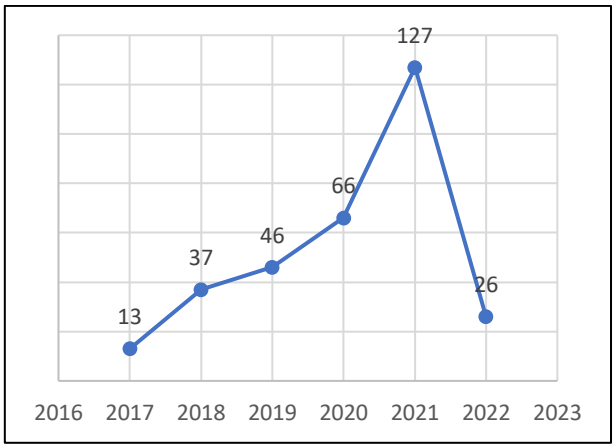

Figure 1: *The frequency of limb amputation over the years between 2017-2022*

In this study, we found that 8.6% were above-the-knee amputation and, 91.4 % were below the knee, 184 of them were at the toe. Only 13% of the patients had previous surgery on the same limb, and there was no difference between the two limb locations. However, it was 50.5% more prevalent on the right limb. Regarding the etiology of limb loss, DM was the leading cause in 79.0% of patients. In comparison, vascular etiology was found in 12.1% of patients, and 93% of vascular cases were found to have diabetes as a comorbidity. Trauma was responsible for 8.9% of amputations. (Table 2).

DM was the leading cause of limb loss in both genders. However, it was higher among females (84.1 % vs. 76.4% of males), while trauma was higher among males (12 % vs. 2.8 % in females). The same was found among

Table 1: *The general characteristics of the patients who underwent lower limb amputation*

Variables		Count	(%)
Gender	Male	208	66.0%
	Female	107	34.0%
Age	< 25 years old	7	2.2%
	26-50	66	21.0%
	51-75	211	67.0%
	> 75	31	9.8%
	Mean (SD)	58.3 (13.75)	
Weight (Kg)	Mean (SD)	77.1 (13.5)	
Height (cm)	Mean (SD)	165.8 (7.4)	
BMI	Underweight <18.4	1	0.4%
	Normal (18.5-24.9)	66	25.6%
	Overweight (25-29.9)	116	45.0%
	Obese (above 30)	75	29.1%
	Mean (SD)	28.2 (4.5)	

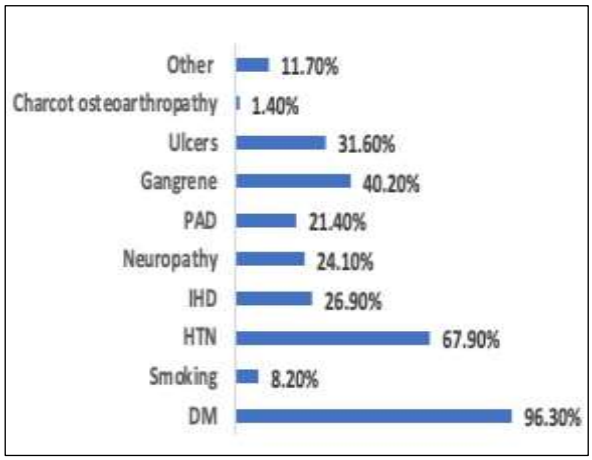

Figure 2: *The incidence of other comorbidities in patients*

different age groups; trauma was the only cause of limb loss in patients under 25 years old and responsible for 22.7 % of amputations in the group aged between 26-50. The vascular reason is significantly more among older patients (13.7% of them were in the age group of 51-75 and 12.9 % in the age group more than 75 years compared to 7.6 % in the 26-50 age group and no vascular cases found in those who's younger than 25 years). Incidence of vascular cause increases with increasing BMI, and it was observed in 14.7 % of obese patients compared with 9.1 % of nonobese patients; however, this difference is not significant (Table 3).

DISCUSSION

The incidence of amputation may differ not only between different countries but also within a single country due to many factors, including the degree of modernization, the standard of living, and accessibility to medical and surgical treatment. This paper aims to provide a better view of the physical and pathological distribution of amputations in the Qassim region of Saudi Arabia. In our study, the

incidence of amputations increased by 976% in 2021 compared to patients registered in 2017 .

Table 2: *The general characteristics of the amputation*

		Count	(%)
Procedure	Above knee amputation	27	8.6%
	Below knee amputation	288	91.4%
Amputated limb	Right	158	50.5%
	Left	155	49.5%
Above-knee amputation (N=27)	Above knee	26	96.3%
	Hip disarticulation	1	3.7%
Below-knee amputation (N=288)	Low total knee	69	24%
	High total knee	5	1.7%
	Metatarsal	26	9%
	Foot	3	1.04%
	Toe	184	64%
Previous surgery on the same limb	Yes	41	13%
	No	274	87%
Aetiology of limb loss	DM	249	79.0%
	Trauma	28	8.9%
	Vascular	38	12.1%

This study emphasizes the diabetic foot as a significant risk factor for lower limb amputation, contrary to what is reported in developed countries where peripheral vascular disease is the leading cause of limb amputation (Pernot et al., 2002; Rommers et al., 1997; Greive & Lankhorst, 1996). In this study, we found a significant male predominance among lower limb amputees with a male-to-female ratio of 2:1. This is consistent with the results of several previous studies regardless of ethnicity and geographic distribution (Carmona et al., 2005; Lim et al., 2006). This male predominance may be because men have more severe peripheral artery disease, are more prone to accidents and injuries, and have higher smoking rates. Our study showed that trauma is the first and only cause of amputation in patients under 25 and 22.7% between 26 and 50 years of age. Similar to the previous study's outcome, trauma is the most common cause of amputation in young people (Lim et al., 2006). Moreover, we found that vascular disease-related amputation frequency was higher in the elderly. Another explanation for this association between the male gender and amputation rates is that male patients receive less foot care than female patients because men may seek medical attention later than women for foot problems. In our study, trauma accounted for 8.9% of lower limb amputations, the third leading cause of amputation after diabetes and vascular disease. A previous study found that trauma is the second leading cause of amputation in developed countries. However, this was the first cause of amputation in developing countries (Uccioli et al., 1995). In a previous study in Nigeria, the authors reported that diabetes was the cause of amputation in 26% of cases (Muyembe & Muhinga,1999). This is similar to previous studies showing that elderly patients have more than one disease attributed to vascular pathology (Fried et al., 2004; Giurato et al., 2017; Mishra et al., 2017; Hamalainen et al., 1999). Additionally, estrogen lowers vascular pathology (Jonasson et al., 2008). Which may explain the increased incidence of amputation in post-menopause.

According to this study, diabetes mellitus was the main etiology in 79% of lower limb amputations. The rising rates of diabetes mellitus may cause a high lower limb amputation rate, highlighting the significance of early detection, medical education, reasonable glycemic control, and patient compliance. Around 40 to 60 per cent of all lower extremity amputations are caused by diabetes; in some regions, this number may be as high as 70-90%. The most severe type of ulcers in diabetes patients are heel ulcers, which usually necessitate below-the-knee amputations (Younes et al., 2004). Diabetes patients are more prone to experience painful and distressing postoperative consequences, including surgical site infections, sepsis, and death. This situation has adverse financial outcomes, increased morbidity, protracted postoperative hospital admissions, sepsis, and mortality (Panos et al., 2021). Additionally, Diabetes patients may have a higher risk of ulcers that invite infections, deep wounds, and osteomyelitis, which may necessitate amputation. On the other side, diabetic neuropathy may cause numbness, deformity, and irregular gait, which may attach to a higher likelihood of foot pathology, raising the risk of lower limb amputation when combined with DM-related vascular abnormalities (Al-Turaiki & Al-Falahi,1993). When it comes to a diabetic foot ulcer, previous ulcers increase the risk of future ones (Al Wahbi et al., 2016). In our study, ulcers were present in 31.6% of patients who underwent amputation. Within a year after their wounds heal, 20–58% of individuals experience another ulcer (Sarvestani & Azam, 2013).

A study conducted in Saudi Arabia in 1993 found that the total number of amputees was 32100 between 1977 and 1990, with a general increase in new cases since 1981 (Al-Turaiki & Al-Falahi,1993). The incidence of extremity injuries has increased over the last decade, which can be caused by various mechanisms (Al Wahbi et al., 2016). A retrospective study conducted in Iran examined demographics such as age, sex, the amputated limb, etiology of limb loss, and level of amputation and discovered that the mean age was 39.26, the male gender had more amputations than the female, the toe was the most amputated, and trauma was the most common cause (Sarvestani & Azam, 2013). A retrospective study conducted in Riyadh, Saudi Arabia, at the Sultan Bin Abdulaziz Humanitarian City revealed that the average age was 45, the male gender had more amputations, the vascular cause was more common, and trauma came after. The most common type of amputation was a transtibial amputation, followed by a trans-femoral amputation (Shahine et al., 2022). A meta-analysis study published in 2020 by Chunmei Lin et al. found that male sex, a smoking history, osteomyelitis, gangrene, male sex, lower body mass index, a history of foot ulcers, and a higher white blood cell count are all risk factors for amputation in diabetic patients. An earlier meta-analysis of diabetic patients found that males were 1.3 times more likely than females to have lower limb amputation (Lin et al., 2020).

Table 3: *The relation between the etiology of limb loss and general characteristics of the patients*.

Variables		Aetiology of limb loss						P-value
		DM		Trauma		Vascular		
		Count	(%)	Count	(%)	Count	(%)	
Gender	Male	159	76.4%	25	12.0%	24	11.5%	0.025*
	Female	90	84.1%	3	2.8%	14	13.1%	
Age	< 25 years old	0	0.0%	7	100.0%	0	0.0%	0.000*
	26-50	46	69.7%	15	22.7%	5	7.6%	
	51-75	177	83.9%	5	2.4%	29	13.7%	
	> 75	26	83.9%	1	3.2%	4	12.9%	
BMI	Underweight	1	100.0%	0	0.0%	0	0.0%	0.919
	Normal	75	82.4%	7	7.7%	9	10%	
	Overweight	114	80.8%	12	8.5%	15	10.6%	
	Obese	59	71.9%	9	10.9%	14	17.1%	
Procedure	Above knee amputation	22	81.5%	3	11%	4	14.8%	0.000*
	Metatarsal	22	83.3%	2	8.3%	2	8.3%	
	Amputation of toes	150	81.5%	3	1.6%	31	16.8%	
	Foot/ High/ low total knee	48	63.2%	20	26.3%	8	10.5%	

This study has several limitations. First, missing data were inevitable because our analysis was a retrospective study. The hospital discharge database as a source of our information was administrative and not primarily intended for research purposes. Consequently, many variables that affected the outcomes were not recorded or considered; we should have addressed the severity of PAD in distinct gradation, which might have affected the work and if there was coexistence of DM and PAD simultaneously. Fourth, the data used in this study was generated from one hospital, limiting its generalizability to other hospitals.

CONCLUSION

We reported that there had been an increase in the incidence of lower limb amputations over the last five years in the Qassim region. This study highlights the diabetic foot as the primary indication for lower limb amputation. Increasing the awareness among diabetic patients about the care of the foot, noticing any change in the foot, preventing infection, and controlling their diabetes could lead to reducing the incidence of amputation. Considering specialized foot care, well-trained podiatry teams, and educational programs might decrease these numbers in the future.

AUTHOR CONTRIBUTIONS

AA and IA conceived and designed the study; SEA and AMA conducted research; TA and OA provided research materials and collected and organized data; RA and SHA analyzed and interpreted data; and EA wrote the initial and final drafts of the article. All authors have critically reviewed and approved the final draft and are responsible for its content.

DECLARATIONS

Ethical Approval

Ethical approval was obtained through the Qassim Research Committee and the National Ethical Committee. The code number is (H-04-Q-001). All participant information was handled confidentially by assigning a study code number instead. Given the retrospective cohort nature of the study, no harm was done to the patients. All data were collected and maintained in electronic format.

Participants Consent

Not Applicable.

Source of Funding

This research received no specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest

All authors have declared that no financial support was received from any organization for the submitted work. All authors have declared that no other relationships or activities could appear to have influenced the submitted work.

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