ORIGINAL ARTICLE

Outcome of Toe Amputation in Diabetic Foot Gangrene Patients at CMH Rawalpindi

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ABSTRACT

Objective: To study the outcomes of toe amputation performed in diabetic foot gangrene patients during hospital admission at CMH Rawalpindi.

Study Design: Cross-sectional study.

Place and Duration of Study: The study was conducted at the Department of General Surgery, Combined Military Hospital (CMH), Rawalpindi, Pakistan from 1st June 2021 to 31st May 2022.

Methods: 146 patients who had undergone toe amputation were followed in this prospective cohort study. The clinical data was collected and analyzed after informed written consent from patients. The size of the ulcer and surgery method were recorded. After toe amputation, the recovery, insulin therapy, re-ulceration, and re-amputation were also recorded with glycated hemoglobin. The data was assessed by using SPSS version 20. The frequency and percentage were calculated for categorical data. For continuous data, mean and standard deviation were calculated.

Results: A total of 146 patients for toe amputations were enrolled in this study. Patients were diagnosed with a mean duration of diabetes of 15.93±3.79 years. There were 121 (82.9%) male participants and 25(17.1%) female participants with a mean age of 49.9±11.11 years. There were 35 (24.0%) patients in which ulcer size < 1 cm^2, 44 (30.1%) patients with ulcer size 1-5 cm^2 and 67 (45.9%) cases were with ulcer > 5 cm^2 in size. Among the individuals studied, 53 (36.3%) showed X-ray examinations confirmed the presence of foot ulcers. Out of the total amputations performed, 70 (48%) were revisited with re-ulceration problems. These patients were counselled for re-amputation out of which contralateral major amputation was highly prevalent. Moreover, as shown in Table 2, ipsilateral ulceration 41 (28.1%), and contralateral ulceration 29 (19.9%) were found in patients who had re-ulceration and re-amputation out of 70 (48%) patients. The mean glycated hemoglobin in these patients was 11.02±2.42. Out of the total amputations performed, 2 (3.77%) patients were due to septicemia, 1 (1.88%) from ketoacidosis, and 3 (5.66%) died from retinopathy comorbid with diabetes.

Conclusion: Our study underscores favorable outcomes, including effective infection control and wound healing, contributing to improved patient care and limb preservation. These findings highlight the importance of timely surgical intervention in managing diabetic foot complications.

Keywords*: Diabetic Retinopathy, Diabetic Foot, Gangrene Patients, Glycated Hemoglobin, Toe Amputation.*

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Introduction

Diabetes is the nation's biggest cause of mortality with a prevalence of 26.7%.[1] Between 10 and 25 percent of those with diabetes may have foot complications such as calluses, abscesses, or even osteomyelitis.[2] Peripheral neuropathy, muscular atrophy, foot deformity, and neuropathic fractures contribute to the 20% of patients who develop diabetic foot disease, which manifests as ulceration,

Charcot joint, fracture, and amputation. Annually, almost one in one hundred people with diabetes may need an amputation. Some people with undiagnosed diabetes first experience symptoms of diabetic foot, a dangerous consequence of diabetes mellitus.[3] Because of improvements in available medical treatment and the discovery of insulin, the average lifespan of people with diabetes has grown leading to an increase in the prevalence of this problem. Non-traumatic lower-extremity amputations in people with diabetes are often caused by a diabetic foot ulcer.[4]

Frequently, gangrene is the outcome of a skin or soft tissue injury or infection. Gangrene affects the toes, fingers, and limbs. It may also impact the muscles and organs, but this is less often. This illness is marked by discolored skin, numbness, and purulent discharge.[5] These issues weaken the foot's structural integrity and compromise its joints. When the metatarsal heads are enlarged, it results in increased pressure on the sole, leading to the formation of ulcers. The infection spreads from the skin into the deeper tissues, where it causes abscesses and ultimately, osteomyelitis. Diabetic foot complications such as ulcers, infections, and gangrene account for most hospital stays for people with the disease.[2,6] Diabetic foot ulcers are severe medical conditions that may cause serious complications such as infection, necrosis, and even amputation if not treated promptly. Foot problems such as gangrene and necrotizing fasciitis are also frequent. Foot ulcers and deep infections affect 3-4% of people with diabetes and another 15% of people with diabetes will develop foot ulcers at some point in their lives. The risk of amputation of a lower limb rises if an ulcer forms. After amputation, the mortality rates vary, with a range of 13% to 40% within one year, 35% to 65% within three years, and 39% to 80% within five years.[7,8]

Diabetic foot ulcers are prone to infection after the lesion has formed, even though infection is seldom involved in the etiology of these ulcers.[9] Whenever, the treating physician observes live tissue at the ankle or farther distally, distal amputation should be considered. To determine the appropriate amputation level, a thorough evaluation of the patient is required, including but not limited to monofilament testing for neuropathy, transcutaneous oxygen mapping, distal Doppler pressure measurements, Doppler flow studies and measurements of lower extremity blood pressure.[10,11] The preoperative evaluation aims to establish the factors involved in amputation that may affect wound recovery. The complexity of foot ulcers and the high prevalence of comorbidities were also recorded. The postoperative cohort research aimed to track diabetic patients who had toe amputation to identify the variables that contributed to the recovery.

Methods

The cross-sectional study was conducted at the Department of General Surgery, Combined Military Hospital (CMH), Rawalpindi, Pakistan from 1st June 2021 to 31 May 2022 after taking permission from the hospital with reference to letter no 183/7/21 held on April 10, 2021. 146 patients' diabetics planned for toe amputations were enrolled in this study. All patients were hospitalized. From the patient's hospital registry, the age, BMI, sex, smoking history, and size of the ulcer were noted. To determine the long-term effects of toe amputation, 146 patients who showed signs of recovery were again interviewed. Diabetes-related comorbidities, insulin therapy, and initial wound healing were all quantified. Both genders with type 2 diabetes were included in the study. Patients were rechecked for any new ulcers and the need for re-amputations. Patients with type 2 diabetes mellitus and diabetic foot who agreed to have a toe amputated were considered in this study.

Patients with type 1 diabetes and diabetic foot and those who did not live in the study area at the time of their toe amputation (as recorded in the hospital population registry) were excluded from the study. Diabetic foot infection was labeled according to the guidelines provided by the Infectious Diseases Society of America (IDSA). Trans metatarsal amputation (TMA) involves the partial removal of metatarsal bones in the forefoot, often addressing severe infections or non-healing ulcers. Below-knee amputation (BKA) removes the lower leg below the knee joint, while above-knee amputation (AKA) removes the leg above the knee joint, typically necessary for advanced trauma, vascular disease, or

tumors. Partial foot amputation (PFA) targets localized issues, preserving as much foot function as possible, and Syme's amputation (SA) is performed at the ankle joint, retaining the heel pad for weight-bearing capabilities, often used for severe foot deformities or infections when heel preservation is feasible. Healing following amputation was determined when a continuous viable epithelial covering had formed over the open incision and no new ulcerations had developed over the ensuing 2 months. After 2 months' post-operation, if any new wound size was observed it was considered as re-ulceration and re-amputation, and the surgery was suggested if needed.

Results

A total of 146 patients for toe amputations were enrolled in this study. Patients were diagnosed with a mean duration of diabetes of 15.93±3.79 years. There were 121 (82.9%) male participants and 25 (17.1%) female participants with a mean age of 49.9±11.11 years. All the patients were advised to have their affected toes amputated. There were

Table 1: Pre-operative characteristics of the patient

Characteristics		**Mean**	**Std. Deviation**
Age		49.93	11.111
BMI		20.72	5.276
The mean duration of diabetes		15.60	3.799
Groups		**Frequency**	**Percent**
Sex	Male	121	82.9
	Female	25	17.1
Smoking	No	20	13.7
	Yes	126	86.3
Ulcer size	<1CM^2	35	24.0
	1-5CM^2	44	30.1
	>5CM^2	67	45.9
X-Ray Foot Ulcer	No	93	63.7
	Yes	53	36.3
Comorbidities			
History of CABG	No	126	86.3
	Yes	20	13.7
Retinopathy	No	140	95.9
	Yes	6	4.1
Ischemia	No	130	89.0
	Yes	16	11.0
Liver disease	No	132	90.4
	Yes	14	9.6
Neuropathy	No	141	96.6
	Yes	4	2.7
Neuro-Ischemia	No	134	91.8
	Yes	12	8.2
Hypertension	No	133	91.1
	Yes	13	8.9
Operation method			
Single-toe ray amputation		26	17.8
Single-toe amputation		32	21.9
Multiple toe ray amputation		25	17.1
Multiple toe amputation		26	17.8
Great toe amputation		27	18.5
Great toe ray amputation		10	6.8

35(24.0%) patients in which ulcer size < 1 cm^2, 44 (30.1%) patients with ulcer size 1-5 cm^2 and 67(45.9%) cases were with ulcer > 5 cm^2 in size. The single toe amputation was the surgical procedure that was used the most (21.9%). Among the individuals studied, 53 (36.3%) showed, X-ray examinations confirmed the presence of foot ulcers, as can be shown in Table 1.

All the patients were admitted to the hospital. The results reveal that 119 (81.5%) of patients recovered after the initial amputation. Hence, 76 (52.1%) patients were dropped off and did not revisit the hospital. But 70 (48%) were revisited with re-ulceration problems. These patients were counseled for re-amputation out of which contralateral major amputation was highly prevalent. Moreover, as shown in Table 2, ipsilateral ulceration 41 (28.1%), and contralateral ulceration 29 (19.9%) was found in patients who had re-ulceration and re-amputation out of 70 (48%) patients. The mean glycated hemoglobin in these patients was 11.02±2.42. According to our survey, two patients died due to septicemia, one from ketoacidosis, and three from retinopathy comorbid with diabetes.

Table 2: Clinical outcome of the patient after toe amputation

Clinical outcomes after toe amputation	Frequency (n)	Percent (%)
Recovery	119	81.5
Insulin Therapy	133	91.1
HbA1C	11.0±2.42	
Re-ulceration		
Drop off	76	52.1
Ipsilateral ulceration	41	28.1
Contralateral ulceration	29	19.9
Re-amputation		
Not Applicable	76	52.1
Ipsilateral minor amputation	10	6.8
Contralateral amputation	9	6.2
Ipsilateral major amputation AK	12	8.2
Contralateral major amputation	22	15.1
Ispilateral major amputation BK	8	5.5
Contralateral major amputation BK	9	6.2

Below the knee amputation (BKA), Above-the-knee amputation (AK)

Discussion

Every year, approximately 2-6% of individuals with diabetes experience delayed wound healing and frequently develop persistent foot ulcers. These ulcers are significantly associated with a heightened possibility of requiring either minor or major amputation if left untreated.[3] A significant rate of re-ulceration, further amputation, and death is seen among amputees. There is less research data available on toe amputations than major amputations in diabetic patients.[4] Cerqueira et al. (2022) reported that 64.1% of amputations were carried out on the toes of individuals diagnosed with diabetes.[12] However, in this research all enrolled patients had gone through toe amputation. One of the most frequent complications in diabetic patients and the main reason for hospital admissions for diabetics is diabetic foot (DF).[13] Another significant consequence is diabetic foot syndrome (DFS), which usually co-occurs with ulceration.[14] Our findings indicate that elevated HbA1c levels (11.0±2.42) represent a significant risk factor for amputation in patients. Correspondingly, Pemayun et al. (2015) discovered similar results in their study, where a majority of patients requiring lower extremity amputation due to diabetic foot ulcers exhibited high HbA1c levels exceeding 8% (64 mmol/mol) (p=0.002).[15] These results show that HbA1c>9% (>75 mmol/mol) is an independent risk factor for delayed wound healing.[3,15] In our study, certain comorbidities were present like CABG (13.7%), retinopathy (4.1%), ischemia (11.0%), liver disease (9.6%), neuropathy (2.7%) and neuro-ischemia in (8.2%) patients. Quite higher prevalence's reported by the Boulton et al. (2018) that rates of ischemia (85.4%) and ischemia-associated neuropathy (42.6%).[16] Verrone et al. (2016) also reported the same findings retinal impairment (42%) and nephropathy (26%) emerged as the two most prevalent microvascular complications.[17] Patients with diabetes may be able

to avoid the development of atherosclerosis by making positive lifestyle adjustments. Healing of ulcers may be aided by reducing the prevalence of atherosclerosis, which in turn reduces peripheral arterial lesions and the severity of ischemia.[17] The study conducted in Germany found that patients aged 80 and more had a risk of amputation five times higher than those aged 40 to 59. More than two-thirds of amputees were beyond the age of 60. The average patient age in this analysis was 69.5 9.2 years. Many cardiovascular and cerebrovascular problems including macro- and micro-vascular issues are common in the elderly.[18] These findings highlight the critical role that age and preoperative function play in determining long-term outcomes following surgery. Death rates were found to be three times as high for patients over the age of 70 as they were for those under the age of 50.[18]

In our study, we noted that some patients who had previously undergone amputations required subsequent amputations. Correspondingly, Liu R et al. (2021), in their research, observed a high incidence of both ipsilateral and contralateral repetitive amputations. They reported a repetitive amputation rate of 19% at one year and 37.1% at five years for all contralateral and ipsilateral amputations.[19] Murdoch DP et al. (2007) demonstrated that individuals who underwent more extensive toe or first-ray amputations often needed additional amputations within the first year after the initial procedure. Their findings indicated that 60% of patients underwent a second amputation, 21% required a third, and 7% had a fourth.[20] Furthermore, our study revealed that the extent of ulcer involvement strongly influenced the necessity for repetitive surgery or amputation. This aligns with the results of Malay et al. (2006), whose study reported a 63.87% failure rate to heal after 20 weeks of a prior lower extremity amputation (LEA) in patients with ulcers on the toe and metatarsal (forefoot), and a 67.11% failure rate to heal in those with ulcers extending from the tarsal to the hindfoot (Full foot).[21]

In addition to wound healing and survival rates, re-amputation and severe amputation rates were shown to be lower in individuals with significant impacts on daily living activities after amputation. Twenty percent of the risk might be mitigated by engaging in postoperative exercise. When it comes to treating the symptoms of the illness rather than the disease itself, amputations are sometimes the only option for elderly patients who are bedridden and suffering from several comorbidities. Despite this, re-amputation and death rates remain alarmingly high, severely diminishing the quality of their lives. Few studies have reported death rates after amputations.[22]

Conclusion

The prevalence of foot amputations among individuals with diabetes is very high. Our study underscores favorable outcomes, including effective infection control and wound healing, contributing to improved patient care and limb preservation. These findings highlight the importance of timely surgical intervention in managing diabetic foot complications. Amputation risk factors include comorbidities such as smoking, hypertension, diabetic nephropathy, retinopathy, ulcer extent at amputation, and elevated HbA1c levels. Timely treatment for these patients can reduce the global amputation rate from diabetic foot ulcers.

Authors Contribution

ITC: Idea conception, study designing, data collection, data analysis, results and interpretation

MJM: Idea conception, study designing, manuscript writing and proof reading

MAAM: Study designing, data analysis, results and interpretation, manuscript writing and proof reading

TR: Idea conception, data collection, data analysis, results or interpretation, manuscript writing and proof reading

RMA: Study designing, data collection, data analysis, results and interpretation

MTM: Study designing, data collection, data analysis, results and interpretation

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