

Risk Factors for Lower Extremity Amputation among Diabetic Patients with Diabetic Foot Gangrene in ATBUTH, Bauchi

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Abstract

Background: Diabetic mellitus was described as an evolving global epidemic of the twenty-first century, due to the exponential rise in the number of people with the condition. Lower extremity amputation is one of the common complications of diabetes. With increase in the number of people with diabetes there will also be increase in the number of diabetics going for lower extremity amputation, increasing both the financial as well as psychologic burden of treatment. **Methodology:** A prospective cross-sectional study of all diabetic patients going for lower extremity amputation will be done. All the patients with advanced diabetic foot syndrome needing lower extremity amputation are enrolled (Wagner stage IV and V), both through the clinic and emergency center. Informed consent is obtained from the patient after which data are collected using a structured questionnaire. All the investigation results of the patients were also documented. Data collected are analyzed using the SPSS version 29. Chi-square and student t-test were used to measure significant relationship between the variables at 95% confident interval. **Results:** Within the period of study, which extends from 1st January 2022 to 1st of January 2024, a total of 171 patients were recruited. All diabetic patients with diabetic foot Wagner grade IV and V who presented to the clinic or emergency department were enrolled in the study. We found a significant relationship between gender, previous procedure on the affected limb or amputation of the contralateral limb, knowledge of foot care among diabetics and risk of amputation. There was, however, no statistically significant relationship between. There is no statistically significance relationship between the level of education,

occupation, presence of co-morbidity with the risk of amputation among diabetic patients with foot syndrome. **Conclusion:** Previous lower limb procedure/amputation, male gender, paucity of knowledge on foot care, prolonged duration of the disease and method of treatment are important risk factors for the risk of amputation among diabetic patients with diabetic foot syndrome.

Keywords

Diabetes Mellitus, Lower Limb, Amputation, Risk Factors, Rehabilitation

1. Introduction

Diabetes mellitus has become a major health challenge of the twenty-first century [1], described by Shaban *et al.* as an evolving global epidemic [2]. According to WHO, the number of patients with diabetes type II will rise from 220 million in 2010 to over 300 million in 2025, which is expected to surge to over 640 million by 2040 [3]. There have also been increases in the prevalence of diabetes in Nigeria, affecting all regions of the country [4] with increasing burden of diabetes mellitus comes increase in the burden of its complication, one of which is diabetic foot syndrome, which is a major risk factor for non-traumatic lower limb amputation [5] [6] and the main cause of amputation among diabetic patients. [7] in the Western world, more than 60% of non-traumatic amputation involve diabetic foot syndrome, this has an increase burden on the economic resources and health of diabetic patients by increasing hospitalization rate, reduced quality of life, morbidity and mortality [8]-[10].

Diabetic foot syndrome is defined by WHO as an ulcer on the foot of diabetic patients distal to the malleoli, associated with diabetic-related complications [11]. The practical guideline for formulated by the International Working Group on Diabetic Foot (IWGDF) has defined diabetic foot as a set of symptoms secondary to current of previous diabetes, including skin chapping, ulceration, infections, or destruction of foot tissues [12] [13].

There are different classification and scoring systems for diabetic foot syndrome yet, it's important to note that no universally accepted system has been published till date. Some of the systems in use include; Maggit-Wagner system, University of Texas Classification system, the size (area, depth), sepsis, arteriopathy, denervation system [S(AD)SAD] [14]. Diabetic foot has been categorized according to Wagner's classification into 6-grades, (0 to 5): no ulcers = grade 0; full-thickness skin ulcer = grade 1; ulcer penetrating to muscle, tendon or joint capsule = grade 2; deep ulcer reaching bone or joint with the evidence of deep-seated abscess or osteomyelitis = grade 3; limited gangrene not extending proximal to metatarsal head = grade 4; and gangrene extending proximal to metatarsal head = grade 5 [15].

For the purpose of our study, only patients with Wagner grade IV to V or those diabetics scheduled for lower limb amputation will be recruited.

Diabetes mellitus has been said to increase the risk of lower limb amputation by 15-fold [16] and has been regarded as a major risk factor accounting for more than 50% of all non-traumatic causes of amputation in the US annually [17]. Patients with diabetes mellitus are more than 20 times likely to have a lower limb amputation compared to those without diabetes mellitus [18].

Some risk factors for amputation among these patients have been identified, some of which are; diabetics induced neuropathy, a symmetric polyneuropathy that affects the sensory, motor and autonomic components of peripheral nerves [19], neuropathy will impair the protective reflexes of the foot, predisposing to diabetic foot ulcers that are prone to show relapse creating a vicious cycle that will eventually end in limb amputation [20].

Peripheral arterial disease which is the complete or partial occlusion of the peripheral arteries of the upper and or lower limbs leading to blood supply insufficiency and tissue ischemia [21]; these will also predispose to lower limb ulcers and subsequent amputation in diabetic patients [22].

Foot deformity, metacarpophalangeal joint deformity, pes cavus, hallux valgus, and pes equinus are often seen in diabetic patients [23], motor neuropathy has been implicated as the cause of these deformities; however, the specific course of these deformities is still not clear [24]. These deformities alter the spread of pressure on the foot and this can lead to foot ulceration and thus diabetic foot syndrome and its persistence can lead to lower limb amputation [25] [26].

In this study, we evaluate the other important risk/predisposing factors hitherto neglected, for lower limb amputation among patients with diabetic foot ulcer Wagner's grades IV and V attending both emergency and out-patient unit of the ATBUTH Bauchi who were scheduled for lower limb amputation, with the view to understanding this condition better and possibly reducing the incidence of lower limb amputation among diabetic patients.

2. Methodology

This study is a two-years prospective cross-sectional study of all diabetic patients going for lower extremity amputation in Abubakar Tafawa Balewa University Teaching Hospital Bauchi (ATBUTH) from January 2022 to January 2024. All patients with advance diabetic foot syndrome schedule for lower extremity amputation were enrolled (Wagener stage IV and V), both through the clinic and emergency center. While diabetic foot patients with Wagner stage below IV and those under conservative management of the diabetic foot were excluded from the study, any patient who did not consent to the study was also excluded, patients undergoing lower limb amputation for other disease aside diabetes were also excluded from the study. Data were collected using a structured questionnaire (**Appendix I**). Ethical clearance was gotten from research and ethical committee of ATBUTH. Patients were counselled for the study after which Informed consent was obtained from them (**Appendix II**). Information concerning the patient's biodata, duration of treatment, medication used and compliance, other co-morbidities, evolution of presenting complaints and complications of diabetes developed,

Wagner's grade of diabetic foot at presentation, and all other complaints were taken. Blood samples were taken for glycated hemoglobin and fasting blood sugar, serum electrolyte, urea and creatinine were also done, all other investigation results of the patients done at presentation were also documented. Data collected were analyzed using the SPSS version 29 for the descriptive statistics of the demographic characteristics of the patient. Chi-square test and Student's t-test were used to compare the patients with regard to the qualitative and quantitative variables, respectively. The adjusted odds ratios with 95% confidence intervals (CIs) were calculated as an estimate of the relative risks when a statistically significant difference was found between the frequencies of the variables. Risk factors for amputation were determined through stepwise multiple logistic regression analysis.

3. Results

Within the period of study which extended from 1st January 2022 to 1st of January 2024, a total of 171 patients were recruited. All diabetic patients with diabetic foot Wagener grade IV and V who presented to the clinic or emergency department were enrolled in the study, while the diabetic patient with foot syndrome Wagner's below IV were excluded from the study, patients with peripheral vascular disease schedule for lower limb amputation without diabetes were also excluded from the study. There were 103 male patients and 68 female patients, giving a male to female ratio of 1.5:1.

68 (39.7%) of the patients were civil servants, 47 (27.5%) were farmers, 33 (19.3%) were business men/women and 23 (13.5%) for others, which included housewives, artisan and unemployed. Thirty-seven percent (37%) of the patients had tertiary level of education, 20% had secondary school level education, 22% had primary level education, 12% had Arabic education and 9% had none. **Table 1** shows the demographic data of the patients. Duration of disease from diagnosis was less than 10 years in 13%, 10 - 20 years in 50% of the patients and greater than 20 years in 37%. Sixty-seven percent (67%) of the patients are on oral antidiabetic agents, while 33% are on insulin. Fifty percent of the patients had no knowledge of foot care in diabetics, 33% are informed on foot care while 17% are very well informed. The common co-morbidities seen was hypertension seen among 89.3% of the patients and chronic kidney disease in 20.5% of the patients, 56.2% had no diagnosed co-morbidity. The most common complications seen were: neuropathy 87.9%, vasculopathy 78%, retinopathy 36.5% and nephropathy 32%. Twenty-six patients (15.2%) were less than 40 years of age, 98 (57.3%) were 40 - 60 years of age while 47 (27.5%) were >60 years of age. 28 (16.4%) of the patients died. 18 (64.3%) of the patient that died were of the age range 40 - 60 years, 6 (21.4%) were age greater than 60 years while 4 (14.3%) were less than 40 years of age. 33% of the patients have had prior procedure on the lower limb before ranging from debridement to ray amputation of the toe(s), 67% have never had any procedure on the lower limb before. 13% have had one of their lower limbs amputated and present with the diabetic foot syndrome on the other limb.

There is no statistically significance relationship between level of education, occupation, presence of co-morbidity with the risk of amputation among diabetic patients with foot syndrome.

There is a significant relationship between gender and risk of amputation. Male gender has a higher risk for amputation than female ($p = 0.0021$).

There is a significant relationship between previous procedure on the affected limb or previous amputation of the contralateral limb with risk for amputation ($p = 0.0011$).

There is also a significant relationship between knowledge of foot care among diabetic patients with foot syndrome with the risk of amputation ($p = 0.0035$). **Table 2** shows the significant risk factors for amputation among diabetic patients in ATBUTH.

Table 1. The Demographic data of the patients.

DEMOGRAPHIC PARAMETERS	n	%
SEX		
male	103	60.23
female	68	39.77
AGE		
<40	38	22.23
40 - 60	99	57.63
>60	34	20.59
LEVEL OF EDUCATION		
Primary (1°)	51	29.94
Secondary (2°)	34	20.33
Tertiary (3°)	46	27.06
Arabic	26	14.56
none	14	8.09
Occupation		
Civil servants	68	39.7
farmers	47	27.5
business	33	19.3
Others	23	13.5

Others: retired, house wives, artisans, unemployed etc.

Table 2. The Significant risk factors for amputation among diabetic patients in ATBUTH.

Risk factors for amputation	%	p-value
SEX		
Male	60.23	0.0021
Female	39.77	

Continued

Previous procedure		
Previous procedure/amputation	46	0.0011
No previous procedure/amputation	54	
Knowledge of foot care		
No knowledge	50	0.0035
Informed	33	
Very well informed	17	
Duration of treatment		
<10 years	13	0.0041
10 - 20 years	50	
>20 years	37	
Treatment option		
Oral antidiabetic	67	0.033
Insulin	33	

4. Discussion

Diabetic foot syndrome is a dynamic and complex clinical foot problems among diabetic patients who have varying clinical spectrum of problems at presentation [27]. One of such problems is the propensity for amputation, diabetic foot syndrome being the major cause of non-traumatic lower limb amputation [28] [29]. 15% of the diabetic patients had diabetes first diagnosed when they were admitted for amputation [30].

An understanding of the major risk factors for amputation among diabetic patients will help reduce this outcome amongst them. In our study, the total patients recruited were 171 out of which Male to female ratio was 1.5:1. That is a higher rate of lower limb amputation seen in male diabetic patients than the female counterparts, this is also similar to other reports, which also shows a male predominance among diabetic patients going for lower limb amputation [31]-[33]. Some have associated the increase in lower limb amputations among male diabetic patients to higher chance of some independent predictors of lower extremity amputation, such as diabetic foot ulceration, peripheral arterial diseases, cigarette smoking and peripheral neuropathy in males than in female diabetic patients [34] [35]. Males are more likely to indulge in risky and unhealthy behaviors, less likely to adhere to their doctors' instructions than female patients [36] [37]. Female patients are also more likely to adhere to dieting and healthy eating than males. These behaviors will cause a continual increase in blood glucose level and with it the complications of diabetes mellitus which can predispose to lower limb amputation.

Other predictors of amputation among diabetic patients were the duration of diabetes mellitus, as much as 50% of our patients going for lower limb amputation

had diabetes mellitus for 10 - 20 years while 37% of the patients had diabetes mellitus for more than 20 years. This is also similar to other studies that show higher rate of lower limb amputation among patients who have had diabetes mellitus for a longer period [38]-[40]. Rodrigues et al. highlighted that longer diabetes duration was a major risk factor for lower limb amputation and thus emphasizing the need for earlier detection and management of diabetes to prevent such complications [41].

Knowledge of foot care among diabetic patients is also a major risk factor for lower limb amputation, 50% of our patients going for lower limb amputation lack any knowledge of foot care in diabetes, 33% were informed of foot care among diabetes but only 17% were well informed about foot care in diabetes, thus, the risk of amputation among diabetic patients reduces with knowledge of foot care among diabetics ($p = 0.0021$). Type of antidiabetic medication used by the patients; Sixty seven percent (67%) of the patients going for lower limb amputation are on oral antidiabetic agents, while 33% are on insulin. Hence, lower limb amputations in diabetic patients are more common among those on oral antidiabetic agents than those using insulin ($p = 0.001$). Some studies have associated the use of SGLT2 with increased risk of diabetic foot syndrome and amputation [42]. There is a significant relationship between previous procedure on the affect limb or previous amputation of the contralateral limb with risk for amputation ($p = 0.0011$) [43] [44].

However, we found no statistically significant relationship between the level of education of the patient, occupation and presence of co morbidity with the risk of amputation among diabetic patient with foot syndrome.

5. Conclusion

Diabetic foot syndrome and lower limb amputation have become an evolving epidemic with increasing number of diabetics globally. There is equally an increase in these complications.

Previous lower limb procedure/amputation, male gender, paucity of knowledge of foot care in diabetes, prolonged duration of the disease and method of treatment are important risk factors for amputation among diabetic patients with diabetic foot syndrome.

Further prospective, suggestibly Multicenter studies with higher sample size are indicated to validate these findings to have a more elaborate and better understanding of this condition.

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Ethical Approval

Ethical approval was obtained from the ethical board of Abubakar Tafawa-Balewa

University Teaching hospital, Bauchi to conduct the study.

Author Contribution

All authors have been directly involved with the various aspects of the study. We attest to the fact that all authors have participated in the research, read the manuscript, attest to the validity and legitimacy of the data.

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Conflicts of Interest

The authors declare that they have no conflict of interest.

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Appendix I

RISK FACTORS FOR LOWER EXTREMITY AMPUTATION AMONG DIABETIC PATIENTS WITH DIABETIC FOOT GANGRENE IN ATBUTH, BAUCHI.

QUESTIONNAIRE

- 1) NAME.....
- 2) Hospital No.....
- 3) AGE: <30 [] 30 - 45 [] 46 - 55 [] 56 - 65 [] >66 []
- 4) SEX: males [] females []
- 5) Level of education: none [] primary [] secondary [] tertiary [] others specify.....
- 6) Occupation: civil servant [] farmer [] artisan [] business [] others specify.....
- 7) Method of glucose control: dietary and lifestyle modification [] insulin [] oral antidiabetic agents [], others specify
- 8) Wagener grading: grade I [] grade II [] grade III [] grade IV [] grade V []
- 9) Ankle brachial index: <0.9 [] 0.9-1.4 [] >1.4 []
- 10) Clinical features of the limb: darkening of skin [] loss of skin hair [] absence distal pulses [] superficial ulcers [] deep ulcers []
- 11) Knowledge of foot care in diabetes:
No knowledge of foot care []
informed about foot care in diabetes []
very well informed about foot care in diabetes []
- 12) Duration of disease (from diagnosis to interview):
<10 years []
10 - 20 years []
>20 years []
- 13) Previous surgical procedure on affected limb (debridement, wound care. etc.) Yes [] No []
- 14) Previous amputation of contralateral limb: Yes [] No []
- 15) Level of amputation:
below knee amputation []
above knee amputation []
- 16) Wound drainage use; none [] yes []
- 17) ASA: grade I [] II [] III [] IV [] V []

- 18) Choice of anesthesia: |SAB [] General [] others specify.....
- 19) Packed cell volume (PCV/Hb).....
- 20) Na.....K.....Cl..... Urea.....Creatinine.....
- 21) FBS.....
- 22) Glycated haemoglobin.....
- 23) Outcome measures after surgery:
 - flap necrosis []
 - re-amputation []
 - wound breakdown []
 - others, specify

Appendix II

CONSENT FORM

I/parent/Guadian (to).....of have agreed to voluntary participate in the **RISK FACTORS FOR LOWER EXTREMITY AMPUTATION AMONG DIABETIC PATIENTS WITH DIABETIC FOOT GANGRENE IN ATBUTH, BAUCHI.** conducted by DR STEPHEN YUSUF et al of Department of Orthopaedic, Abubakar Tafwa Balewa University Teaching Hospital, |Bauchi state.

This is self-sponsored research expected to last for 1year with the patient participating form the duration of admission to three (3) months posts operative period.

There is no additional cost, benefit or risk to the participants. The participation is also voluntary and the participants are free to terminate their participation at any given time with no consequence.

In event of injury or side effect of the research, the participant takes full responsibility of treatment.

I am also aware that the research is randomized double blind with randomization carried out by the researcher and that I won't be notified about the group I fall into.

The participants will be updated about the progress of research and the outcome upon completion.

No potential conflict of interest.

Signed and date.
Participant/guardian.

Signed and date.
Researcher