



Diabetic Foot Ulcers: Epidemiology, Management Modalities and Outcome at Benue State University Teaching Hospital Makurdi

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Authors' contributions

This work was carried out in collaboration between all authors. Author PDA designed the study, was involved in the treatment of the patients, literature searches, performed the statistical analysis, wrote the protocol and wrote the first and final drafts of the manuscript. Authors NCA, NJK, DDM, CIE, MO and MPU were involved in the treatment of the patients, literature searches and analyses of the study. Author JIO collected the data and was also involved in the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To determine the epidemiology of diabetic foot ulcers (DFU), types, and the risk factors associated with their development at Benue State University Teaching Hospital, Makurdi Nigeria. To assess outcome of various modalities of treatment and mortality.

Study Design: This was a four year retrospective study of consecutive patients admitted at Benue State University Teaching Hospital Makurdi with diabetic foot ulcers. Data was collected using a proforma form in November and December, 2016.

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Methodology: Data collected from 46 patients files included socio-demographic parameters of age, sex, type of diabetes mellitus, Meggitt-Wagner's grading of the ulcers, fasting blood glucose on the second day of admission, glycaemic control and type of drugs used, duration of ulcers before presentation to hospital, types of ulcers and risk factors for their development, length of hospital stay, surgical modalities of treatment and ulcer defect cover, patients who had amputations and mortality.

Results: Forty six patients files showed that patients with DFU were males in 43.5% of cases and females in 56.5%, with a male: female ratio of 1:1.3. The age range of patients was 25 – 75 years with mean age of 51.6 (\pm 10.4) years. The commonest aetiology for diabetic foot ulceration was peripheral neuropathy seen in 47.8% of cases. Most patients presented with Meggitt-Wagner grade IV ulcers. Vast majority of patients (91.3%) had type 2 diabetes. Honey was the main dressing agent used for the ulcers. Sepsis was the major complication seen. Twelve patients underwent amputations at various levels. Outcome of treatment was healed ulcers in 34.8% of patients, amputations in 26.1% and mortality in 23.9%.

Conclusion: The study showed peripheral neuropathy as the commonest aetiology of diabetic foot ulceration. Health education on proper care of the foot and compliance with anti-diabetic drugs will help in preventing diabetic foot ulceration with its consequences.

Keywords: Amputation; debridement; gangrene; insulin; Meggitt-Wagner; neuropathy.

1. INTRODUCTION

Diabetic foot ulcers (DFU) are the commonest complication of diabetes mellitus [1,2,3,4,5]. The incidence of diabetes mellitus is increasing globally and this is associated with a concomitant increase in the complications, DFU being one of them [1]. World over, the incidence of DFU is 12 – 15% of all patients with diabetes [4]. In the United States, diabetes is the leading cause of non-traumatic lower limb amputation. In all diabetics in the US, 5% of them will develop DFU and 1% of these will end up with amputation [2]. In Nigeria, prevalence of DFU is estimated to be 0.9 – 8.3% [5]. DFU are important cause of morbidity and mortality in patients admitted in hospital [5]. These morbidities include wound infection with cellulitis, abscess formation, osteomyelitis which may progress to gangrene necessitating amputation [1,2,3,4]. 90% of lower limb amputations are due to diabetic foot ulcers [4].

The ulcers may begin with callosities or just blistering for which the patients may ignore as trivial, but these rapidly progress to severe ulceration especially in the presence of poor blood glucose control with infection and eventual gangrene of the limb. The patients may present to the physician/surgeon at any of the stages. But suffice it to say that ulcers at stages 3 and above carry poor prognosis and are the ones likely to progress to amputation or even death of the patient.

An ulcer classification system developed by Wagner is used worldwide and is graded based on the severity and tissue depth of the ulcers [6].

The University of Texas system is another classification used by many other medical centres [6].

The aetiology of diabetic foot ulceration is multifactorial but the commonest is peripheral neuropathy, accounting for 63% of cause of ulcers [6]. Other factors are trauma, vascular ischemia, infection and so on [6]. The neuropathy is a result of nerve malfunction caused by accumulation of sorbitol and fructose as a result of hyperglycemia and excessive enzymatic actions of aldose reductase and sorbitol dehydrogenase and consequent decrease in myoinositol necessary for normal function of nerve cells. The vascular ischemia involves the peroneal arteries as a result of vasoconstriction and platelet aggregation with consequent thrombosis. Atheromatous plaques deposition in the vessels further worsen the ischemia [2]. Risk factors associated with development of DFU include: a previous ulceration, previous amputation, cigarette smoking, poor blood glucose control, not wearing shoes, foot deformities like hammertoes, charcot foot and low socioeconomic status [1,2]. The ulcer location, size, depth of tissue involvement and appearance is important in assessing the progression of healing or deterioration. Evaluation to determine the aetiology of the ulcer is necessary. A 10-g monofilament is used to test pressure perception on the skin. Inability for the patient to perceive the pressure is an indication that the ulcer is neuropathic [6,7]. A standard tuning fork or a neurologic reflex hammer can also be used to test for loss of protective sensation [6]. Loss of sensation predisposes the

patient to traumatization without his being aware further compounding the problem of delay in giving attention to the injury.

Prevention of diabetic foot ulceration is very important. The patients inspect their feet and hands daily to cleanse the skin and detect and dress traumatic injuries. Moisturizers should be applied but avoiding the web spaces of the hands and feet because excessive dryness predisposes to callosities and easy traumatization. The feet should be well padded with appropriate size shoes and on no account should a diabetic walk about un-shod. The patient with DFU must stop cigarette smoking [7,8].

In spite of prevention and good glycaemic control, if ulcers still develop, the patient should seek medical care. Use of total contact cast, walking frame, crutches and wheel chairs as a means of offloading of the foot to protect the ulcer from pressure effect, is very essential.

Management of DFU involves care of the ulcer by dressings using honey or other dressing agents, vacuum assisted closure and serial debridement. Other supportive therapies are antibiotics, hydrotherapy and use of hyperbaric oxygen. Large size ulcers usually greater than 2.5 to 3 cm require skin cover most commonly skin grafting [1]. Gangrenous limbs always end up with amputation. Revascularization in advanced medical centres will enhance limb salvage without the patient undergoing amputation. All these care require multidisciplinary approach involving the plastic surgeon, vascular surgeon, infectious diseases physician, endocrinologist, podiatrists (specialist in foot care), nutritionist, prosthetist and orthopedic surgeons [6]. In the developed world, especially the United States, DFU is currently noticed to be reducing. However in the developing world, the incidence of DFU is increasing probably due to low socioeconomic status, poor health education and poor nutrition. This study is been conducted as a retrospective one to determine the epidemiology, aetiological factors of DFU and the surgical modalities used in the management of the condition and the outcome in this centre.

2. METHODOLOGY

This was a four year retrospective study of consecutive patients admitted at Benue State University Teaching Hospital Makurdi with

diabetic foot ulcers from March 2012 to February 2016. The hospital is new and was only four years old at the time of concluding the study. This is therefore, a baseline first study on DFU here. Fifty one patients were admitted with diabetic foot ulcers but forty six were analyzed having met the inclusion criteria of having complete medical records. Data collected from the patients files included socio-demographic parameters of age, sex, type of diabetes mellitus, Wagner's grading of the ulcers, fasting blood glucose on the second day of admission using glucose oxidase method, glycaemic control and type of drugs used, duration of ulcers before presentation to hospital, types of ulcers and risk factors for their development, length of hospital stay, surgical modalities of treatment and ulcer defect cover, patients who had amputations and mortality.

2.1 Data Instruments and Collection Strategies

The data was retrieved from the patients files in the plastic, medical and orthopedic clinics; surgical and medical wards; Accident and Emergency and entered into a proforma form. Ethical clearance was granted by the hospital management through the hospital ethical committee. Permission to use these files was sought from the Head of Medical Records. Patients who had diabetes mellitus but have never had an ulcer or who have healed ulcers were excluded from the study.

2.2 Data Analysis

SPSS version 20.0 was used for the statistical analysis. Results were expressed as ratios, means, percentages, tables and bar charts. Chi-square was used for comparison of categorical variables and multivariate analysis. $P = 0.05$ was considered as statistically significant. Good outcome was evaluated as successful healing of ulcer, without amputation.

3. RESULTS

During the study period of four years, total number of diabetics treated on admission and in the outpatient department were 921. Diabetic foot ulceration occurred in forty six patients giving a prevalence of 5%. These forty six patients with complete medical records were recruited in the study comprising 20 (43.5%) males and 26 females (56.5%) giving a male female ratio of 1:1.3 (Table 1).

Table 1. Socio-demographic characteristics of the patients (n=46)

Variables	Frequency	Percent
Age group (years)		
25-34	2	4.3
35-44	9	19.6
45-54	15	32.6
55-64	15	32.6
65-74	4	8.7
≥75	1	2.2
Sex		
	Frequency	Percent
Males	20	43.5
Females	26	56.5
Ethnic group		
	Frequency	Percent
Tiv	26	56.5
Idoma	9	19.6
Igala	3	6.5
Igbo	3	6.5
Eche-Jukun	1	2.2
Etsako	1	2.2
Igede	1	2.2
Kuteb	1	2.2
Nupe	1	2.2
Total	46	100.0
Religions		
	Frequency	Percent
Christianity	45	97.8
Islam	1	2.2
Educational status		
	Frequency	Percent
No education	17	37.0
Primary	4	8.7
Secondary	13	28.3
Tertiary	12	26.1

The age of the respondents ranges from 25-75 years; with the mean age 51.6 (±10.4) years. Almost all the respondents were Christians (97.8%) and majority had no formal education (37.0%)

Almost all of the participants were Christians, 45 (97.8%) in number except one. Between the two major ethnic groups Tiv and Idoma, the Tiv diabetics with ulcers were 26 (56.5%) while Idomas were 9 (19.6%). Seventeen (37.0%) of the DFU patients were not literate. Age range of

patients was 25 – 75 years with mean age of 51.6 (± 10.4) years. The commonest aetiology of DFU in the study was peripheral neuropathy accounting for twenty two (47.8%) cases, (Fig. 1).

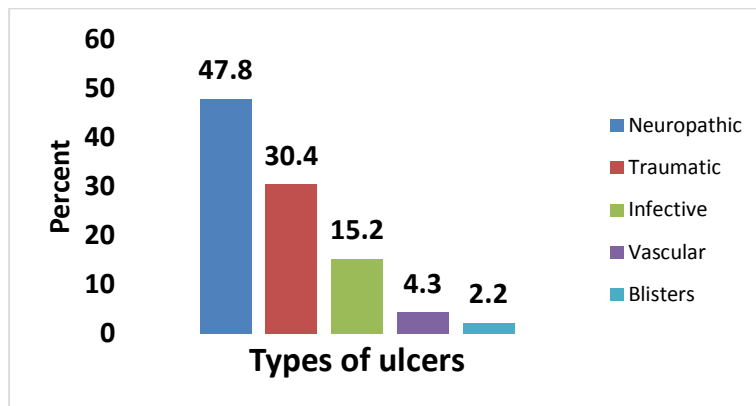


Fig. 1. Types of ulcers

The ulcers typically commenced from the planter aspect of the foot (Figs. 2 and 3).



Fig. 2. A female with right DFU typically arising from the plantar aspect and gangrene of the second and third toes that were amputated

Sixteen patients (34.8%) presented with Wagner grade 4 ulcers (Table 2).

Nine (19.6%) patients presented to the hospital when the ulcer had been present for 28 days (Table 3).

Patients with type 2 diabetes were forty two (91.3%) in number (Table 4). A total of 41

patients (89.1%) presented in hospital with fasting blood glucose levels above 6.6 mmol/L which was done on the second day of admission. The mean fasting blood glucose of the patients was 13.5 (\pm 6.6) mmol/L. Two patients presented with fasting blood glucose levels 2.4 mmol/L and below. On admission, four of the patients were insulin dependent diabetics and a total of 30 (65.2%) of the patients had to be administered soluble insulin as a treatment modality to control the blood glucose and aid healing of the ulcers (Table 4).



Fig. 3. A male with left hind foot ulcer typically arising from the plantar aspect with unhealthy granulation tissue

Table 2. Meggitt-Wagner's grading of ulcers

Grading	Description	Frequency	Percent
0	Foot at risk with deformity or callosities	0	0
1	Superficial diabetic ulcer	7	15.2
2	Ulcer extension to ligament, tendon, joint, or deep fascia but no abscess or osteomyelitis	9	19.6
3	Deep ulcer with abscess formation, osteomyelitis, or joint sepsis	10	21.7
4	Gangrene localised to the fore foot or heel	16	34.8
5	Extensive gangrenous involvement of the entire foot	4	8.7
Total		46	100

Table 3. Duration of ulcers before hospital presentation

Number of days	Frequency	Percent
2.00	3	6.5
3.00	3	6.5
4.00	1	2.2
7.00	2	4.3
10.00	2	4.3
14.00	7	15.2
21.00	8	17.4
28.00	9	19.6
42.00	1	2.2
49.00	1	2.2
56.00	6	13.0
84.00	1	2.2
168.00	1	2.2
730.00	1	2.2
Total	46	100.0

However, additional associated risk factors for DFU were poor glycaemic control in 11 (23.9%) patients, followed by previous ulcer in eight (17.4%) cases (Table 5).

Some patients had more than one risk factor, and the diabetes had been present for eight years before development of ulcer. Honey was the principal dressing agent used for dressing all the ulcers (Table 6).

Hypertension was a co-morbidity seen in 35 (76.1%) patients. Other co-morbidities were diabetic retinopathy 8 (17.4%) and nephropathy 3 (6.5%). Sepsis as a complication arising from the DFU was diagnosed in 27 (58.7%) patients. No bacteria were isolated in 20 (43.5%) ulcers while in 26(56.5%), different species were isolated by culture. Gram-negative bacilli, constituted (73.9%) while gram-positive

staphylococcus aureus was isolated in 12 (26.1%) cases (Table 7).

There were bilateral lower limb ulcers in two patients while 22 had a right or left lower limb involvement each (Table 8).

Serial surgical debridement of the ulcer was done in 24 (52.2%) patients while 12(26.1%) had amputations (Table 9).

Only three (6.5%) patients accepted and underwent a skin graft procedure to achieve skin cover of the ulcer. Majority of the patients refused skin grafting (Fig. 4).



Fig. 4. A female with right heel ulcer and left big toe ulcer who did not give consent for skin grafting. The ulcer on the left big toe has healed but the one on the right has not in spite of having healthy granulation tissue

Table 4. Types of diabetes, fasting blood glucose levels on admission and anti-diabetic received

Variables	Frequency	Percent
Types of diabetes		
Type I	4	8.7
Type II	42	91.3
Total	46	100.0
Fasting blood glucose mmol/L		
Frequency		
≤2.4 and below	2	4.3
2.5-6.5	3	6.5
≥6.6	41	89.1
Total	46	100.0
Anti-diabetic received		
Frequency		
Injection Insulin	30	65.2
Oral hypoglycaemic	16	37.8
Total	46	100.0

Table 5. Additional risk factors for DFU

Risk factor	Frequency	Percent
None	19	47.8
Poor glycaemic control	11	23.9
Previous ulcer	8	17.4
Previous amputation	2	4.3
Cigarette smoking	1	2.2
Obesity	1	2.2
Hemiplegia	1	2.2
Hyperlipidemia	1	2.2
Total	46	100.0

Table 6. Dressing agent used for patients and other supportive therapies

Dressing agent	Frequency	Percent
Honey only	35	76.1
Antimicrobial + honey	2	4.3
Hydrotherapy + honey	9	19.6
Total	46	100.0

Length of hospital stay was one day to 112 days with mean stay of 35 (\pm 33) days. Fourteen (30.4%) patients were admitted 43 days and beyond. The outcome of treatment was healed ulcers seen in 16(34.8%) patients. Mortality occurred in 11(23.9%) patients and was due to septicaemia and its sequelae multiple organ dysfunction syndrome. Some patients refused to give consent for amputation and so they died.

4. DISCUSSION

During the study period of four years, total number of diabetics treated on admission and in

the outpatient department were 921. Diabetic foot ulceration occurred in forty six patients giving a prevalence of 5%. Our study showed that diabetic foot ulceration occurred in the middle age commonest, at mean age of 51.6 (\pm 10.4) years at Benue State University Teaching Hospital and that both sexes are equally at risk. The DFUs tended to occur after eight years of diagnosis of diabetes.

Shahi et al. found in their study in North India that risk factor for development of DFU was age above 50 years [9]. This was seen in other studies as well [10,11]. Shahi et al. [9] showed that the male sex developed diabetic foot ulcers more frequently (71.13%), probably because they were prone to doing outdoor jobs to raise money for the upkeep of their families. Other studies showed similar male preponderance to diabetic foot ulceration for same reason [10,11]. Our study showing almost equal gender predisposition to diabetic foot ulceration may be because of the females engagement in more outdoor activities now due to the global economic meltdown in order to raise money to complement the males in taking care of the family. The patients tended to develop ulceration as complication after 4 – 8 years of diagnosis of diabetes in Northern India and bears semblance to our study.

The commonest aetiology of diabetic foot ulceration at Benue State University Teaching Hospital was peripheral neuropathy (47.8%) and the ulcers typically started on the plantar aspect of the foot. Shahi et al. study showed a 75.25%

Table 7. Distribution of patients by sepsis and bacteria isolated from ulcers

Sepsis	Frequency	Percent
Present	27	58.7
Absent	19	41.3
Total	46	100.0
Bacteria	Frequency	Percent
Gram-negative bacilli		
<i>Proteus spp</i>	6	13.0
<i>Escherichia coli</i>	4	8.7
<i>Klebsiella spp</i>	1	2.2
<i>Pseudomonas spp</i>	1	2.2
Mixed growth of <i>Escherichia coli</i> and <i>Pseudomonas</i>	1	2.2
Gram-positive cocci		
<i>Staphylococcus aureus</i>	12	26.1
None	20	43.5
Total	46	100.0

Table 8. Anatomical location of ulcers

Location	Frequency	Percent
(R) foot medial plantar aspect	1	2.2
(L) big toe=D1,3x3 cm ulcer	1	2.2
(L) big toe 2x2 cm	1	2.2
(L) D2 ulcer on plantar aspect	1	2.2
(L) foot, plantar aspect	1	2.2
(L) big toe 6x3 cm	1	2.2
(R) foot, medial aspect (instep)	1	2.2
(R) foot lateral plantar aspect	1	2.2
(R) foot lateral aspect 7x4 cm	1	2.2
(R) foot plantar aspect 10x6 cm & 4x2 cm	1	2.2
(R) foot dorsum 10x7 cm	1	2.2
(R) foot medial aspect 12x1 cm + (L) foot 8x4 cm	1	2.2
(R) foot dorsum 14x12 cm with foot gangrene	1	2.2
(R) D2-5 web space with gangrene	1	2.2
(R) big toe 2x1 cm	1	2.2
(R) heel 10x8 cm, + (L) big toe medial aspect	1	2.2
(R) foot dorsum and plantar aspect 24x18 cm	1	2.2
(L) foot plantar aspect 6x10 cm	1	2.2
(R) heel 6x5 cm	1	2.2
(L) foot dorsum 8x6 cm	1	2.2
(L) foot dorsum of 2 nd metatarsal 8x6cm	1	2.2
(L) big toe plantar aspect	1	2.2
(L) foot medial malleolus 6x6 cm	1	2.2
(L) foot dorsum 12x6 cm	1	2.2
(L) forefoot plantar ulcers with gangrene	2	4.3
(R) forefoot plantar ulcers with gangrene	5	10.9
(L) forefoot 6x4 cm /(L) knee 3x2 cm	1	2.2
(L) forefoot 8x10 cm/hindfoot 6x4 cm	1	2.2
(L) forefoot lateral aspect 8x4 cm	1	2.2
(L) forefoot D1 2 3 5x2 cm	1	2.2
(R) big toe/dorsum 25x12 cm	1	2.2
(R) D1 D2 plantar aspect 7x6 cm	1	2.2
(L) foot plantar aspect	1	2.2
(L) foot lateral aspect 2.5x1.5 cm	1	2.2
(R) foot lateral aspect 6x3 cm	1	2.2
(L) foot medial plantar aspect	1	2.2
(R) foot plantar aspect 6x5 cm	1	2.2
(L) thigh posterior aspect 16x10 cm	1	2.2
(R) foot plantar aspect 16x10 cm with gangrene of the foot	1	2.2
(L) foot dorsum 10x6 cm	1	2.2
(R) whole forefoot plantar web spaces with gangrene	1	2.2
Total	46	100.0

occurrence of peripheral neuropathy as cause of ulcers. This was followed by peripheral vascular disease and hypertension in 29.89% of their patients. Ngim observed peripheral neuropathy as the commonest aetiology of diabetic foot ulceration in 67% of his study patients while Akaniyene found neuropathy, peripheral vascular disease and walking unshod as the risk factors associated with development of DFUs in Calabar Nigeria [10,12]. Peripheral neuropathy was found

in addition to other risk factors like peripheral vascular disease, Charcot foot deformity, hallux valgus, previous amputation, hypertension, smoking, dyslipidaemia, inappropriate foot wear, poor glycaemic control and increased BMI in other studies [13,14,15,16]. Peripheral vascular disease was seen much in other studies [9,12,13,14,15,16], but in our centre it was not common (4.3%).

Table 9. Surgical treatment given, length of hospital stay and outcome of treatment

Surgical treatment	Frequency	Percent
Serial debridement	24	52.2
Amputation	12	26.1
Skin grafting	3	6.5
Discharge against medical advice	7	15.2
Total	46	100
Length of stay (days)	Frequency	Percent
1-7	12	26.1
8-14	6	13.0
15-21	4	8.7
22-28	3	6.5
29-35	4	8.7
36-42	3	6.5
≥43	14	30.4
Total	46	100.0
Outcome	Frequency	Percent
Healed ulcer	16	34.8
Amputation	12	26.1
Death	11	23.9
Discharge against medical advice	7	15.2
Total	46	100.0

The traumatic lesions that precipitated the development of DFU in our study were mostly burns and majority of the patients did not notice the injury until a few days later further confirming that they had peripheral neuropathy prior to the trauma.

Poor glycaemic control was a common additional risk factor in development of ulcers in our study. Majority of the patients had to be given soluble insulin injection to reduce the blood glucose level and aid healing. Hyperglycaemia causes ulcers conceivably by decreasing myoinositol content necessary for neuronal function as a result of excessive actions of the enzymes aldose reductase and sorbitol dehydrogenase due to accumulation of fructose and sorbitol. Shahi et al. found that most of their patients with DFU were on insulin. An important co-morbidity of hypertension was present in majority of the patients with ulcer in our study. This was virtually diagnosed at same time of diagnosis of the diabetes so most likely was a complication of the diabetes.

Honey was the wound dressing agent used on all the patients. Topical antimicrobials were used in addition to honey on two patients whose ulcers were heavily infected and malodorous. Honey was found to be potent and caused wound healing in many of the ulcers. This has been documented by other authors [17,18,19].

Gram-negative bacilli (*proteus*, *escherichia coli*, *klebsiella* and *pseudomonas species*) were the commonest bacteria isolated in our study. This agrees with other studies [20,21,22]. El-Tahawy found in his study in Saudi Arabia and Gadepalli et al. in India that Gram-negative aerobes were the commonest bacteria infecting diabetic foot ulcers by 47% and 51.4% respectively [20,21]. However, other studies found *staphylococcus aureus* to be predominant [23,24,25]. In terms of limb involvement, our study demonstrated that both lower limbs are at equal risk of developing diabetic foot ulceration and indeed bilateral limb involvement can occur. Serial surgical debridement was done in majority of the ulcers and some patients had to undergo the procedure up to five times before the ulcers cleaned out and started healing. This is the experience of several surgeons [26]. Only three patients gave consent for skin grafting upon counseling and underwent the surgery. Lower limb amputation, majority being major amputations was common and seen in 26.1% of patients. This compares well with Wang et al. in Saudi Arabia but is high when compared to other studies [27,28,29]. In our study, some of the patients that died were those who refused ablation due to fear of amputation and others that discharged against medical advice also were mostly those who refused amputation and or had no money for the surgery. The amputation rate would have definitely been higher if they had given consent for and undergone the surgery. The mean hospital stay

was 35 (\pm 33) days which was long and definitely had cost implications to the patients and their relatives. Other studies have documented similar long hospitalizations as well as increased cost for treatment of diabetic foot ulcers [30,31].

Healed ulcers as outcome of treatment was fair only as it occurred in 34.8% of patients. This was because most of the patients refused skin grafting. Other authors have documented better healing of diabetic foot ulcers as much as 55 – 77% [28,29]. Mortality of 23.9% was high and similar with some studies [27,32]. This was because many of the patients in our study presented late with grade four and five ulcers whose etiology was peripheral neuropathy which carries worst prognosis.

5. LIMITATIONS

The number of patients involved in the study was limited because this is a new teaching hospital that is just five years old. A higher data in future studies may give a better epidemiology of DFU in this environment.

6. CONCLUSION

The study showed peripheral neuropathy as the commonest aetiology of diabetic foot ulceration with other associated risk factors like poor glycaemic control which are preventable. Health education on proper care of the foot and compliance with anti-diabetic drugs by the patients will go a long way in preventing diabetic foot ulceration with its consequences.

CONSENT

Consent for clinical photos to be taken and published in the manuscript were obtained from the three patients whose clinical photos have been inserted.

ETHICAL APPROVAL

Ethical clearance was granted by the hospital management through the hospital ethical committee of Benue State University Teaching Hospital Makurdi.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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