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Magnitude of lower limb amputation and associated factors among diabetic foot ulcer patients admitted to Adama hospital medical college from January 2013 to December 2017, Adama, Ethiopia

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Abstract

Background and Aim: Diabetes mellitus is one of the most common metabolic disorders which is characterized by numerous long-term complications affecting almost every system in the body. Foot ulcer, which often results in lower extremity amputations, is one of the most common complications associated with the disease. This study was proposed to determine magnitude of lower limb amputation and to identify associated factors with lower limb amputation among Diabetic Foot Ulcer patients admitted to Adama Hospital Medical College from January 2013 to December 2017.

Methods: Institution based cross sectional study design was conducted. Data was gathered from medical records using prepared checklist; data was entered and analyzed by SPSS version 20.

Results: Diabetic Foot Ulcer (DFU) accounted 110(12.9%) out of total DM patient admissions (n= 850) from January 2013 to December 2017. Out of DFU patients, 39 (35.5%) individuals lost their limb(s). The odds of being age of 61 to 69 years, being rural resident, having grade 3 DFU, havingPeripheral Arterial Disease (PAD), positive finding Doppler Ultrasound and Random Blood Sugar (RBS) 400 to 599 mg/dl were 4.16 times, 3.11 times, 6.81 times, 4.66 times, 8.23 times and 1.39 times more risk for lower limb amputation respectively.

Conclusion: Grade 3 DFU, PAD, positive finding Doppler Ultrasound, rural residence and poor glycemic control are factors identified in patients who lost their limb(s) because of DFU. Hence, strict patient education, good glycemic control, early investigation for PAD, early management of foot infection are critical to reduce the risk of lower limb amputation.

Keywords: Diabetic Foot Ulcer, Risk Factors, Ethiopia

Introduction

Diabetes mellitus is one of the most common metabolic disorders which is characterized by numerous long-term complications affecting almost every system in the body [1]. The disease is highlighted for the severity of its complications, in addition to being considered a public health problem in terms of population growth and aging, greater urbanization, the increasing

prevalence of obesity and sedentarism, as well as the increased survival rate from people with diabetes [2].

Diabetes mellitus is associated with significantly accelerated rates of several debilitating microvascular complications like nephropathy, retinopathy, neuropathy, and macrovascular complications such as atherosclerosis and stroke [1, 3]. Foot ulcer, which frequently results in lower extremity amputations, is one of the most common distressing complications associated with DM disease. The appearance of diabetic foot disease is variable, ranging from cellulites, abscesses, and ulcers to gangrene [1,4,5].

Diabetic ulcers lead non-traumatic lower-extremity amputations in 85% of diabetic patients. Moreover, the risk of lower extremity amputation is 15 to 46 times higher in diabetics than in individuals who do not have diabetes mellitus. Diabetic patients with long-term, defectively controlled blood glucose levels are at significant risk for serious complications affecting the lower limbs [6,7]. Foot ulcers and infections are also a major source of morbidity in individuals with DM. The reasons for the increased incidence of these disorders in DM involve the interaction of several pathogenic factors: neuropathy, abnormal foot biomechanics/mechanical stress, PAD, and poor wound healing. The peripheral sensory neuropathy interferes with normal protective mechanisms and allows the patient to sustain major or repeated minor trauma to the foot, often without knowledge of the injury. Disordered proprioception causes abnormal weight bearing while walking and subsequent formation of callus or ulceration. Motor and sensory neuropathy lead to abnormal foot muscle mechanics and to structural changes in the foot (hammer toe, claw toe deformity, prominent metatarsal heads, and limited joint mobility). Autonomic neuropathy results in anhidrosis and altered superficial blood flow in the foot, which promote drying of the skin and fissure formation. PAD and poor wound healing impede resolution of minor breaks in the skin, allowing them to enlarge and to become infected. Many individuals with type 2 DM develop a foot ulcer (great toe or metatarsophalangeal areas are most common), and a significant subset who develop an ulceration will ultimately undergo amputation (14–24% risk with that ulcer or subsequent ulceration) [8–13].

Risk factors for foot ulcers or amputation include male sex, diabetes for >10 years, peripheral neuropathy, abnormal structure of foot (bony abnormalities, callus, thickened nails), PAD, smoking, trauma, peripheral arterial occlusive disease, history of previous ulcer or amputation, visual impairment, and poor glycemic control. Large calluses are often precursors to or overlie ulcerations [6, 9].

Diabetic foot lesions have significant health and socioeconomic problems holding adverse effects on the quality of life of the patient and imposing a considerable economic burden on the patient's family. In developing countries, foot ulcers are one of the most feared and common complications of DM. They are a major cause of disability, morbidity, and mortality among diabetic patients, and it has been estimated that 15% of all persons with diabetes will have an ulcer at some stage of their life [14]. Furthermore, lower-limb amputation is associated not only with significant morbidity and mortality but also with major psychosocial and financial consequences [15]. Complications of diabetes are increasing over the years and identifying these associations can be a strategy to outline measures to minimize the onset of early complications [16].

Worldwide, the number of people with diabetes has substantially increased between 1980 and 2014, rising from 108 million to current numbers, 422 million that are around four times higher. 40% of this increase is estimated to result from population growth

and ageing, 28% from a rise in age specific prevalence, and 32% from the interaction of the two [17]. Diabetes affects people in both urban and rural settings worldwide, with 64% of cases in urban areas and 36% in rural. It is estimated that 179 million people have undiagnosed Type 2 diabetes [18].The number of people with undiagnosed Type 2 DM is rapidly increasing, and there is a proportionately increased risk of developing complications in this group, many of whom have unidentified disease [19].

In 2012 there were 1.5 million deaths worldwide directly caused by diabetes. It was the eighth leading cause of death among both sexes and the fifth leading cause of death in women in 2012 [17].Such a profound demographic shift is likely to yield a corresponding increase in the prevalence of diabetes chronic complications, including those in the lower limb, the diabetic foot [20].

In developed countries, one in every six people with diabetes will have an ulcer during their lifetime. The risk is even higher in developing countries [14]. In Sub-Saharan Africa, fast uncontrolled urbanization and changes in standard of living are responsible for the rising epidemic of DM and the observed increase presents a substantial public health and socioeconomic burden in the face of scarce resources. The prevalence of undiagnosed diabetes mellitus is high in most countries of sub- Saharan Africa, and individuals who are unaware they have the disorder are at very high risk of chronic complications. WHO estimates the number of cases of diabetics in Ethiopia to be about 800,000 in 2000 and projected that it would increase to about 1.8 million by the year 2030 [1].

Diabetic foot ulcer is one of the long-term complications of diabetic mellitus with the life time risk up to 25%, yet many of the occurrences could be prevented. Even though preventive strategies have been shown to be cost-effective, diabetic foot ulcers still occur frequently and are a challenge for the individual and for the health system [14].

The risk of ulceration and amputation among diabetic patients increases by two to four folds with the progression of age and duration of diabetes regardless of the type of diabetes [21]. Identifying the role of risk factors contributing to this condition will enable health providers to set up better prevention programs that could result in improving patients' quality of life and henceforth, reducing the economic burden for both the patient and the health care system. Early recognition and treatment of patients with diabetes and feet at risk for ulcers and amputations can delay or prevent adverse outcomes [22,23].

Although, the determinants of diabetic foot ulcer are not the same across different socioeconomic and demographic factors and progresses of disease within the institution. Thus, assessing factors affecting diabetic foot ulcer in different areas is crucial to prevent the devastating effect of foot ulcer among diabetes patients. Therefore, this study aimed to determine magnitude of lower limb amputation and to identify associated risk factors of lower limb amputation among DFU patients attending the diabetic clinic at the Adama Hospital Medical College, Adama, Ethiopia.

Therefore, the finding of this study will help to decrease the occurrence of diabetic foot ulcer and its complication in the area, as this will help policy makers and health care staff better understand the DM burden and associated comorbidities.

Materials and methods

Study Area, Period and Design

This study was conducted in Adama Hospital Medical College (AHMC), Adama, Ethiopia. Adama Hospital Medical College is a referral hospital, which was organized as teaching hospital since 2012, and is serving as a teaching, helping the community in treating and preventing the disease and has been used

as a research center. Total catchment population of AHMC is 5 million; 2,518,000 males and 2,482,000 females.The study was carried out from February 19 to March 29, 2018 in AHMC.

Institution based cross sectional study was undertaken by using medical records of DM patients who were admitted to AHMC from January 2013 to December 2017.All patients ≥ 15 years of age with type 1 or type 2 DM admitted with a diagnosis of DFU to AHMC medical ward from January 2013 to December 2017were included in the study. Diabetic patients ≥ 15 years of age admitted for other complication(s) rather than DFU; and patients who were amputated for other indication complication of DM from January 2013 to December 2017were excluded from the study.

The sample size was determined based on sample size calculation for single population, considering the prevalence of DFU among diabetic patients who were attending diabetic clinic follow-up at Gondar University Hospital, 2016, to be 13.6% which was institution based cross-sectional study [14]; level of confidence 95%, and margin of error 5%, the sample size for our study was calculated to be 180 (n = 180).

But when the medical files were retrieved, there were only 110 patients admitted from January 2013 to December 2017. So that all these (110) patients with DFU were included in the study.

Data collection, processing & analysis

- After study units were selected from registration book the patients' card were checked for consistency.The data was collected using checklist or prepared questionnaire which depends on the variables available on patients' medical records.
- All DM patients' file with DFU at admission from January 2013 to December 2017 was checked and entered, cleaned and analyzed using SPSS version 20 software.
- A summary result was presented by frequency tables. Bivariate analysis like binary logistic regression was done to see the existence of association between dependent and independent variables.

Ethical consideration

- Prior to the commencement of the study, ethical clearance was obtained from Institutional Review Board (IRB) of AHMC.

Results

Socio-demographic Characteristics

Out of 850 patients with DM admitted to medical ward of AHMC from January 2013 to December 2017, DFU patients were 110(12.9%). Majority of the patients' age was between 51 and 60 years; 30(27.3%), followed by 41 years to 50 years; 22(20.0%), ≥ 70 years: 18 (16.4%), 61 years to 69 years: 17 (15.5%), ≤ 30 years: 16(14.5%), 31 to 40 years; 7(6.4%). Males account 78(70.9%) and females were 32(29.1%). Oromos were 53(48.2%) and Amhara 43(39.1%). Regarding religion, Orthodoxies were 56(50.9%), Muslims 34(30.9%) and Protestants 20(18.2%). 73(66.4%) of total admissions were urban and 37(33.6%) rural dwellers. The mean age of patients and duration of DM was 10 years and 53 years respectively. More than half of patients were type 2; 85(77.3%), Type 1; 25(22.7%). 65 (59.1%) of patients admitted with DFU needed surgical intervention including debridement and lower limb amputation. Out of study units 39 (35.45%) individuals lost their limb(s); 27(69.2%) were males and 12(30.8%) were females. Of amputated patients, 19(48.7%) were major amputation and 20(51.3%) were minor amputation.

Identified Associated Factors of Lower Extremity Amputation

The results of binary logistic regression showed that the odds of age 51 to 60 years, being male, diabetes duration ≤ 5 years, having grade 3 DFU, having hypertension, Having WBC 11000 to 15000 cell/mm3, positive Doppler finding, having RBS 400 to 599 mg/dl were 2.66 times, 1.88 times, 2.22 times, 16 times, 1.88 times, 3.12 times, 3.5 times, 2.04 times more risk to be amputated when compared with control groups respectively. But on multivariate analysis, the odds of being age of 61 to 69 years, being rural residency, having grade 3 DFU, having PAD, positive finding Doppler Ultrasound, RBS 400 to 599 mg/d were 4.16 times, 3.11 times, 6.81 times, 4.66 times, 8.23 times and 1.39 times more risk for lower limb amputation respectively. (Table 2).

Table 1: Socio demographic characteristics of DFU patients admitted to medical ward of AHMC from January 2013 to December 2017.

Variables and their categories (n= 110)		Frequency	
		n	%
Age	≤ 30	16	14.5
	31 to 40 years	7	6.4
	41 years to 50 years	22	20.0
	51 to 60 years	30	27.3
	61 years to 69 years	17	15.5
	≥ 70 years	18	16.4
Sex	Male	78	70.9
	Female	32	29.1
Residency	Urban	73	66.4
	Rural	37	33.6
Ethnicity	Oromo	53	48.2
	Amhara	43	39.1
	Afar	2	1.8
	Somali	2	1.8
	SNNP	9	8.2
Religion	Muslim	34	30.9
	Protestant	20	18.2
	Orthodox	56	50.9

Table 2: Factors that were associated with lower limb amputation among DFU patients admitted to medical ward of AHMC from January 2013 to December 2017.

Variables			Lower Limb amputation			
		DFU(n=110)	Yes; n(%)	No; n(%)	COR (95% CI)	AOR (95% CI)
Age	Age ≤30	16	4 (25)	12 (75)		
	31 to 40 years	7	2 (28.6)	5 (71.4)	3 (0.96, 9.30)	0.59 (0.01, 22)
	41 yrs to 50 yrs	22	6 (27.3)	16 (72.7)	2.5 (0.48, 12.88)	0.58 (0.01, 24.8)
	51 to 60 years	30	15 (50)	15(15)	2.66 (1.04, 6.81)*	1.31 (0.28, 6.11)
	61 yrs to 69 yrs	17	8 (47)	9 (53)	1 (0.48, 2.04)	4.16 (1.04, 16.63)**
	≥ 70 years	18	4 (22.2)	14(77.8)	1.12 (0.43, 2.91)	3.23 (0.71, 14.61)
Sex	Male	78	27(34.6)	51(65.4)	1.88 (1.18, 3.01)*	0.89 (0.34, 2.34)
	Female	32	12(37.5)	20(62.5)	1	1
Residency	Urban	73	30(41.1)	43(59.9)	1	1
	Rural	37	9(24.3)	26(75.7)	2.24 (0.83, 6.02)	3.11 (1.46, 6.59)**
Type of DM	Type 1	25	7(28)	18(72)	1	1
	Type 2	85	32(37.6)	53(62.4)	0.66 (0.24, 1.71)	2.73 (0.11, 65.6)
Duration of DM	Newly	9	2 (22.2)	7 (77.8)	1	1
	≤ 5 years	29	9(31)	20(69)	2.22 (1.01, 4.88)*	0.34 (0.05, 2.27)
	6 to 9 years	16	6(37.5)	10(62.5)	1.66 (0.6, 4.58)	0.67 (0.19, 2.38)
	10 to 14 years	33	11(33.3)	22(66.7)	2 (0.97, 4.12)	0.98 (0.23, 4.23)
	≥ 15 years	23	11(47.8)	22(52.2)	1.09 (0.48, 2.47)	0.7 (0.21, 2.33)

Freq. of admission	Once	58	14(24.1)	44(75.9)	1	
	Twice	38	18(47.4)	20(52.6)	1.11 (0.58, 2.1)	1.59 (0.04, 55.9)
	Three times	11	5 (45.5)	6 (54.5)	1.2 (0.36, 3.93)	2.76 (0.06, 110.86)
	Four times	3	2 (66.7)	1 (33.3)	0.5 (0.04, 5.51)	4.66 (0.09, 235.92)
Grades of DFU	Grade 1	6	1 (16.7)	5 (83.3)	1	
	Grade 2	17	1 (5.8)	16 (94.2)	10.25 (3.67, 28.61)	0.78 (0.65, 9.93)
	Grade 3	45	4 (8.8)	41(81.2)	16 (2.12, 120.64)*	6.81 (4.91, 9.45)**
	Grade 4	34	25(73.5)	9 (26.5)	0.36 (0.16, 0.77)	0.79 (0.45, 23.89)
	Grade 5	8	8 (100)		0	0.86 (0.23, 34)
Follow up	Yes	45	14(31.1)	31(68.9)	1	
	No	65	25 (38.4)	40 (61.6)	1.6 (0.97, 2.63)	0.35 (0.06, 1.81)
Trauma	No	41	18(43.9)	21(56.1)	1	
	Yes	69	21(30.4)	48(69.6)	1.27 (0.69, 2.36)	3.93 (0.89, 17.34)
PAD	Yes	57	29(50.8)	28(49.2)	0.96 (0.57, 1.62)	4.66(1.07, 20.32)**
	No	53	10(18.7)	43(81.3)	1	
HTN	Yes	38	14(36.8)	24(63.2)	1.88 (1.15, 3.05)*	1.49 (0.57, 3.83)
	No	72	25(34.7)	47(65.3)	1	
WBC count	< 11000	38	14(10.5)	24(89.5)	1	
	11000 to 15000	39	17(43.5)	22(56.5)	3.12 (1.41, 6.92)	0.54 (0.17, 1.68)
	> 15000	33	8 (24.2)	25(75.8)	1.29 (0.68, 2.43)	1.27 (0.46, 3.49)

Doppler finding	Not done	15	3 (2)	12 (98)	1	
	Normal	27	6(22.2)	21(67.8)	0.93 (0.55, 1.56)	1.97 (0.38, 10.09)
	Positive	58	30(51.7)	28(48.3)	3.5 (1.41, 8.67)*	8.23(2.06, 32.87)**
RBS level (mg/dl)	75 to 179	32	1(3.1)	31(96.9)	1	
	≥ 600	70	1(1.4)	69(98.6)	1.28 (0.63, 2.58)	2.65 (0.21, 32.92)
	400 to 599	70	23(32.8)	47(67.2)	2.04 (1.24, 3.36)*	1.39(1.22, 15.55)**
	180 to 399	32	14(43.7)	18(66.3)	1 (0.06, 15.98)	4.69 (0.07, 279.07)

Note: Freq.= Frequency; (*) variable with p value of < 0.05 in univariate analysis (**) statistically significant associations in multivariate analysis. '1' reference group.

Discussion

Our study revealed that 12.9% of total admissions with DM patients were because of DFU. This is in line with the study done in Gondar and Arbaminch, Ethiopia, that the prevalence of DFU was 13.6% and 14.8% respectively [14,24]. This result is not consistent with the study done at Black Lion Hospital which shows 39% of patients were admitted with a diagnosis of DFU [22]. The possible reason for this is that Black Lion Hospital is the largest referral hospital in Ethiopia; and many patients from district hospital were referred to it.

Males (70.9%) outweigh females (29.1%); the mean age of presentation and duration of diabetes that developed DFU is similar with the study conducted in Gondar, Ethiopia, and India [14,25]. This may be because of the societal role of majority of males in Ethiopia is outside home that it prone them to trauma. Majority of patients with DFU found between the ages of 41 years to 50 years (27.3%) which is consistent with the study done in Arbaminch, Ethiopia. [24]. More than 92% of patients were categorized to DFU Wagner grade ≥ 3 which is similar with study done in India [25]. The possible explanation is that patients seek medical care when the condition complicates.

Out of admitted DFU patients, 39 (35.5%) were lost their limb/s because of DM associated complications. Out of a total 39 individuals who underwent lower limb amputation, 27(69.2%) were males and 12(30.8%) were females; 19(48.7%) were major amputation and 20(51.3%) were minor amputation.This study is similar with the study done by Jesus-Silva et al., regarding gender, males (65%) and females (35%); but the finding of major amputation (54.1%) and minor amputation (45.9%) is slightly different when compared to our study [26]. The possible explanation is that surgical team wanted to preserve the limb(s) although major amputation is inevitable. In addition, the patients' medical condition might be poor and as a resultthe patientmight not fit for major surgery. According to the study done by Emma Melander in Sweden, 83% and 69.1% of patients who underwent LEA had hypertension and retinopathy respectively. The mean age of women and men was 79.5 yrs. and 74.6 yrs. respectively [27]; which

contradicts the result revealed by this study that 36% and 12.8% of amputated patients had hypertension and retinopathy respectively. This difference may be because of good health care practice in developed country and complication is expected as age increases. In addition, the diagnosis of HTN and retinopathy may be missed in our study.

Concerning comorbidities, PAD is the most common comorbidity identified followed by HTN which is consistent with the study done in Arbaminch, Ethiopia. According to the study done in Arbaminch, Ethiopia by Bedilu Deribe et al., 40.6%, 34.7% and 28.1% of patients with DFU had kidney disease, HTN and PAD respectively; which is slightly different from our study except HTN (36%) [24]. This might be because of difference in study design. Patients with PAD were high (74.3%) in this study for which admission might be necessarily when compared to the patients on follow up. In the study done by Quilici et al. in Brazil showed 95%, 67%, 42.6% and 24.5% of patients for whom LEA was done had PAD, HTN, retinopathy and nephropathy respectively [28]. It showed that PAD was the most common comorbidity associated with LEA which is in line with our study.

In our study. regarding associated factors of lower limb amputation; age 51 to 60 years, male gender, rural residency, type 2 DM, diabetes duration ≤ 5 years, grade 3 DFU, grade 4 DFU, no regular follow up, having trauma history, PAD, DFU more than two episodes, WBC count > 15000 cells/µl, positive finding Doppler ultrasound, RBS level of 400 to 599 mg/dl were identified on binary logistic regression which showed positive OR as displayed in *table 2,* which is consistent with the study done in Arbaminch and Gondar, Ethiopia [14,24]. The odds of being age of 61 to 69 years [AOR =4.16; 95% CI (1.04, 16.63)], being rural resident [AOR =3.11; 95% CI (1.46, 6.59)], having grade 3 DFU [AOR =6.81; 95% CI (4.91, 9.45)], having PAD [AOR =4.66; 95% CI (1.07, 20.32)], positive finding Doppler Ultrasound [AOR =8.23; 95% CI (2.06, 32.87)] and RBS 400 to 599 mg/d [AOR = 1.39; 95% CI (1.22, 15.55)] were 4.16 times, 3.11 times, 6.81 times, 4.66 times, 8.23 times and 1.39 times more risk for lower limb amputation respectively. This result is quite different from this study because of that, although the patients had comorbidities, it might not be a risk for LEA (Lower Extremity Amputation) in countries which have good income. Those variables might not be controlled in this study.

Conclusion

Diabetic foot problems especially lower limb amputations are common in diabetics and pose serious health problems for developing countries. This study showed that magnitude of lower extremity amputation was 39 (35.45%) and revealed associated factors of lower limb amputations among DFU patients admitted to medical ward from January 2013 to December 2017. Age of 61 to 69 years, being rural residency, having grade 3 DFU, having PAD, positive finding Doppler Ultrasound, RBS 400 to 599 mg/dl were strongly associated with lower limb amputation.

Strict patient education at community and hospital level and on mass media is very important for decreasing complications associated with DM. In addition, good glycemic control, early investigation for PAD, early management of foot infection and management of comorbidities such as PAD and HTN are critical to reduce the risk of lower limb amputation.

Recommendations

We would like to recommend primarily the management team which includes primary care physicians, nurses and specialists from different departments that they should educate the DM patients orally, using written material and through television or radio channel how they should care for their foot,

glycemic control, adherence to medication. This issue should include the government body to facilitate for patient education.

Our second recommendation is for primary care physician who is the front line for the patient who come for medical care. The physician should record all history and physical examination relevant to DM. For example, history of smoking, alcohol, adherence to medication, income, educational level, family history of DM and foot care experience should be recorded on medical files of each patient. Regarding physical examination, the examiner should do all pertinent physical exams especially HEENT, cardiovascular system, genitourinary system, musculoskeletal and central nervous system and record on medical files. In addition, relevant laboratory examination such as UA, HbA1c, culture from wound, ABI, ECG and others should be done to know the status of patients. The reason is that it helps both the patient primarily and the researcher.

Our other recommendation is for radiologist who is responsible for examining the patient regarding Doppler ultrasound for suspected PAD patients. As this study revealed the predominant cause or risk for DFU is PAD. So, it is useful for patients if he/she measures the ABI; it announces the patient for early prevention. Lastly, since this study is retrospective, we would like to recommend other investigators to do further prospective research in this area.

Limitations

Some relevant information used for the study was not found on medical files of patients. This problem prohibited the investigators to pick other associated factors for DFU although the factors are there. Calculated sample size was based on the previous study conducted in Gondar, Ethiopia, which was not coincided with this study and that made us difficult to select study units statistically.

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