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Hospital Prevalence of Foot Amputations in Diabetic Subjects and Their Associated Factors at the Medical Clinic II of the Abass Ndao Hospital Center

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Abstract

Introduction: Foot amputation in a diabetic patient is a real public health problem due to its functional and psychological repercussions. The objective was to study the factors associated with amputation in patients monitored for a diabetic foot in the internal medicine hospitalization of the Abass Ndao University Hospital Center (CHU) in Dakar. **Methods**: This was a retrospective, descriptive and analytical study conducted from the records of hospitalized patients over a 24-month period. The analysis included a descriptive phase, followed by a bivariate phase completed by logistic modeling following a descending procedure. **Results**: Of 1499 hospitalized patients, 224 cases had diabetic foot (14.9%). Among the cases of diabetic foot, 198 patients met the inclusion criteria. Their mean age was 61.7 ± 11.3 years, the sex ratio (M/F) was 1.2. Other associated cardiovascular risk factors were high blood pressure (54.0% 107 cases), and smoking (10.9% 21 cases). A history of lower limb amputation was found in 21.2% (42 cases). It was type 2 diabetes in 184 cases (92.9%) and the mean blood sugar was 2.7 ± 1.3 g/l. Chronic complications included neuropathy in 112 cases (78.3%), arteriopathy in 172 cases (86.9%), and chronic kidney disease in 167 cases (84.4%). The mean consultation time was 47.6 days. The main lesions were gangrene (64.6%), ulcer (24.7%), phlegmon (5.6%), and necrotizing fasciitis (5.1%). According to the University of

Texas classification, patients presented with a stage D lesion (86.4%), grade 3 (51.0%). The hospital prevalence of amputation was 57.6% (114 cases), including major amputation in 55.1% (109 cases). The mortality rate was 36.4% (72 cases). Risk factors for amputation were peripheral arterial disease (ORa = 4.96 [1.33 - 18.43] p = 0.017), foot gangrene (Ora = 3.16 [1.24 - 8.04] p = 0.016) and Texas classification grade 3 (ORa = 17.49 [1.67 - 190] p = 0.019). **Conclusion**: The prevalence of foot and amputations remains a health problem. Reducing amputations will necessarily require strengthening prevention through education and early monitoring of diabetic patients.

Keywords

Amputation, Diabetic Foot, Associated Factors, Senegal

1. Introduction

With more than 463 million people affected in 2019, The "epidemic" nature of diabetes mellitus appears to be increasing with estimates of over 700 million people by 2045 [1]. In Senegal, the national survey using the World Health Organization's "STEPS wise" approach reported a 3.2% diabetes rate [2]. Among the chronic complications of diabetes, diabetic foot is a formidable complication with a global prevalence of 6.4% [1] [3]. Fifteen to 25% of diabetics will develop a foot ulceration during their lifetime and 40% to 80% of these ulcerations will become infected [4].

In two studies conducted in Senegal, the prevalence of diabetic foot was 15% to 15.6% in hospitalized patients with an average age of around the fifth decade and a duration of diabetes between 8 and 10 years. According to the University of Texas classification, grade B lesions represented 34% to 59%, followed by grade D lesions between 20% and 26.4%. Gangrene represented 54.60% and osteitis was found in 14.1% [4] [5]. In diabetology hospitalization, diabetic foot evolved on fragile terrain. These were poorly balanced patients with poor prognostic factors for amputation such as arteriopathy, neuropathy and a history of amputation. The prognosis remains gloomy with an amputation rate between 15% and 30% in diabetology hospitalization [4]-[6]. Hospital mortality ranged from 4% to 16% at death.

However, the factors specific to amputation and its morbidity remain little explored. This motivated this work with the aim of characterizing the prevalence and factors related to amputation, as well as its morbidity and mortality in diabetic subjects hospitalized for a foot ulcer at the Abass Ndao Hospital Center.

2. Patients and Methods

This was a retrospective, descriptive and analytical study based on the records of patients hospitalized from January 1, 2021 to December 31, 2022 in the internal medicine department of the Medical Clinic II of the Abass NDAO University

Hospital. The study focused on All patients hospitalized in the said department for a foot injury during the study period. Diabetic foot ulcer is defined as any wound, infected or not, occurring on the foot in a diabetic person [7]. Patients whose records were unusable were not taken into account. The data were collected using a survey form developed for this purpose. The dependent variable was lower limb amputation during the study period. The parameters studied were as follows:

- **Sociodemographic data**: age groups, gender, profession, socio-economic level and geographical origin according to the four regional axes defined by the national agency of statistics and demography of Senegal (ANSD) [6]:
- Data on Diabetes: type, duration of development, level of balance, pre-existing chronic complications and other cardiovascular risk factors.
- **Data on diabetic foot ulcer**: time to the first consultation, mode of onset, duration of progression, type of lesion and presence of infection. Neuropathy was retained in view of functional signs (paresthesia, pain), disorders of osteo-tendinous reflexes and an inability to feel the pressure applied by a 10 gram Semmes-Weinstein monofilament (sensitivity test). Arteriopathy of the lower limbs was retained in view of a reduction or abolition of peripheral pulses (posterior tibial and pedal) and the appearance of the foot and confirmed by arterial Doppler [8]. Based on clinical, radiological and ultrasound data, the University of Texas classification [5] made it possible to divide foot lesions into 4 stages (A, B, C, D) and 4 grades (0, 1, 2, 3). The presence of other macroangiopathies such as ischemic heart disease, coronary artery disease and stroke was also taken into account.
- **Paraclinical data**: these were blood sugar, glycated hemoglobin, inflammatory assessment (hemogram and C-reactive protein), microalbuminuria and creatinine clearance according to the MDRD formula (Modification of Diet in Renal Disease). Bacteriological and mycological sampling was carried out and analyzed according to the profile. Depending on the context, we also performed an electrocardiogram, a standard X-ray of the foot to look for signs of osteitis, an eye fundus to look for diabetic retinopathy [9] [10].
- **Therapeutic and evolutionary data**: the type of treatment (medical, surgical) and the evolutionary modalities (amputation, recurrences, death, improvement) [9] [10].

Data analysis: The data were entered with Epi Info 7 software and analyzed using R statistical software, version 3.6.1. The descriptive analysis was performed during the univariate analysis with proportions calculated for qualitative variables, the position parameters (mean and median) and dispersion (standard deviation and range) were calculated for quantitative variables. For the analytical study, cross-references of variables between the occurrence of amputation and the other variables were performed. The Chi 2 test, the Fisher test and the t test were used with an alpha risk of 5%. The Bartlett test was used to study the homogeneity of variances, with distributions considered homogeneous for a p value greater than 0.05 [7]. The odds ratio (OR) surrounded by its confidence interval (CI) was

used to quantify the strength of the link. Finally, to take into account confounding factors, a multivariate analysis was then performed. The latter used a simple logistic regression model, following a step-by-step descending strategy, taking into account in the initial model all the variables whose p-value was less than 0.20 [11]-[13] and the variables that were already identified as risk factors in subsequent work. Thus, the variable whose removal leads to an improvement of the model by the maximum likelihood test was removed from the model. This was done until no removed variable could lead to an improvement of the model. The Akaike information criterion (AIC) was used to choose the most parsimonious model. The Hosmer Lemeshow test was used to see the adequacy of the final model.

Ethical considerations: After obtaining permission from the head of department we started our study. The data was secured. Measures were taken to preserve the anonymity of the patients. The data was used for research purposes only.

3. Results

A total of 198 files were retained out of the 1499 patients hospitalized during the study period. The diabetic foot files numbered 224, representing a hospital prevalence of 14.9%. The mean age of our series was 61.7 years ± 11.3 years, and a sex ratio (M/F) of 1.2. The majority of diabetics surveyed came from the West axis of Senegal (90.9%), followed by diabetics from the South axis and the center in 3.5% and 2.5% respectively.

Concerning cardiovascular risk factors, high blood pressure was found in 107 cases (54.0%), and smoking in 21 cases (10.9%) and sedentary lifestyle in 176 cases (89.0%) of cases. A history of lower limb amputation was found in 42 patients (21.4%) of diabetics.

The mean duration of diabetes was 12.1 years ± 8.9 years. The median was 10 years with extremes of 0 and 42 years. Type 2 diabetes represented 92.9% (184 patients) of cases and 64.8% (105 patients) were unbalanced. Among the chronic complications of diabetes Neuropathy was present in 78.3% (112 patients) of cases, Arteriopathy was found in 86.9% (172 patients) of diabetics, Chronic kidney disease (CKD) represented 84.4% (167 cases) of diabetics surveyed, it was at the early, moderate to terminal CKD stage in 41.7%, 28.6% and 4.7% respectively. However, the cardiovascular events found were: stroke in 9.7% (19 cases) of patients, and ischemic heart disease in 17.8% (26 cases) of cases.

The mean blood glucose level was 2.7 g/l ± 1.3 with extremes of 0.4 and more than 6 g/l. The ECG was abnormal in 143 patients (72.3%).

Regarding diabetic foot, 52.8% (104 cases) of patients had made their first consultation at the hospital level. The average duration of the evolution of diabetic foot was 47.6 days ± 71.3 days. The median was 30 days with extremes of 2 and 730 days. The foot lesion occurred spontaneously in 70.4% of cases (139 patients) and the types of lesion found were gangrene in 128 cases (64.6%), a foot ulcer in 49 cases (24.7%), a phlegmon in 11 cases (5.6%), and necrotizing fasciitis in 10 cases (5.1%). Overall, foot infection was found in 185 patients (93.4%) and the

most associated complications were: anemia in 167 cases (93.8%), osteitis in 74 cases (61.2%).

According to the University of Texas diabetic foot classification, the majority was stage D (86.4%), followed by stage B (8.1%). The most common grade was grade 3 (51.0%), followed by grade 2 (39.4%). Among the diabetics surveyed, no stage A or grade 0 was found.

In terms of therapy: for hyperglycemia, subjects were on ADO in 81 cases (41.0%), and on insulin in 75 cases (38.0%). A proportion of 10 patients (5%) were on ADO and insulin combination, and the rest had no diabetes treatment. Regarding the foot lesion, all the diabetics surveyed had received antibiotic therapy, local care, analgesics and anti-tetanus serum therapy. Surgical debridement was found in 24 cases (12.1%) of individuals and only one patient had received revascularization.

Amputation was found in 107 patients (57.8%), of whom 46 patients had major amputation (55.4%). In our study, the proportion of deaths was 36.4%, or 72 patients. Table 1 shows the foot characteristics of hospitalized patients.

Table 1. Distribution of diabetics according to the characteristics of the diabetic foot.

Variables	Absolute Frequency (n)	Relative Frequency (%)
Mode of Occurrence of the Injury		
Spontaneous	114	70.4
Minimal Trauma	48	29.6
Type of injury		
Gangrene	128	64.6
Ulcer	49	24.7
Phlegmon	11	5.6
Necrotizing Fasciitis	10	5.1
Texas University Stadium Classification		
Stage A	0	0
Stage B	16	8.1
Stage C	11	5.5
Stage D	171	86.4
Texas University Classification Grades		
Grade 0	0	0
Grade 1	19	9.6
Grade 2	78	39.4
Grade 3	101	51

Analytically, amputation did not correlate with socio-demographic parameters (sex, geographical origin and professional activity). Clinically, high blood pressure was associated with amputation, in fact hypertensive subjects had two times less risk of amputation ($p = 0.026$ and OR = 0.50 [0.28 - 0.93]).

Mean blood glucose was 2.9 g/l in diabetic amputees and 2.6 g/l in non-amputees (p = 0.075). The occurrence of amputation was statistically correlated with arterial disease with a higher probability of "more" compared to those without PAD (p = 0.017 and OR = 2.92 [1.17 - 6.75]). The type of foot lesion was statistically related to the occurrence of amputation. Indeed, diabetics with foot gangrene had a 5.12 times higher risk of amputation than those with a foot ulcer (p < 0.001 and OR = 5.12 [2.46 - 10.61]).

The occurrence of amputation was also linked to the presence of a foot infection (OR = 3.96 [1.02 - 15.45] p = 0.049) and osteitis increases the probability of amputation (OR = 2.74, p = 0.013).

With the University of Texas classification of diabetic foot, a statistically significant association was found with the occurrence of amputation. Indeed, stage D (compared to stage B) and grades 2 and 3 (compared to grade 1) were the major determinants of amputation (p < 0.001). Table 2 represents the factors associated with amputation in diabetics.

Table 2. Diabetes-related amputation factors.

Characteristics of Diabetes	Amputation Prevalence (%)	P
Type of Diabetes		
Type 2	57.6	0.779
Type 1	61.5	
Diabetes Imbalance		
Yes	61.6	0.211
No	51	
Neuropathy		
Yes	63.7	0.093
No	46.7	
Arteriopathy		
Yes	61.3	0.017
No	36	
Stroke		
Yes	42.1	0.14
No	59.8	
Ischemic Heart Disease		
Yes	60	0.986
No	59.8	
ECG		
Normal	59.5	0.663
Abnormal	63.5	
Renal Failure (RF)		
Yes	55.3	0.783
No	58.3	

Regarding the modeling of factors associated with amputation, we note after adjustment, it was possible to identify the determinants of amputation in patients with a diabetic foot and these determinants were represented by: arterial occlusive disease of the lower limbs (ORa = 4.96), the type of lesion (ORa = 3.16) and the grade and high stage of the classification according to the University of Texas (ORa = 17.49). In our model, the variables age and sex were taken into account because they were strongly found in the literature as factors associated with amputation. Table 3 represents the factors associated with amputation in simple logistic regression.

Table 3. Factors associated with amputation in simple logistic regression.

Variables	OR Adjusted	95% CI	P
Socio-Demographic Determinants			
Age (in Years)	0.97	0.94 - 1.01	0.149
Sex			
Female	1	-	-
Male	1.35	0.61 - 2.99	0.459
Paraclinical Clinical Determinants			
Diabetes Imbalance			
No	1	-	-
Yes	2.33	0.87 - 6.23	0.091
Arteriopathy			
No	1	-	-
Yes	4.96	1.33 - 18.43	0.017
Duration of Foot Development (in Years)	1	0.99 - 1.01	0.2
Type of Lesion			
Ulcer	1	-	-
Gangrene	3.16	1.24 - 8.04	0.016
Necrotizing Fasciitis	0.79	0.14 - 4.46	0.79
Phlegmon	1.98	0.22 - 18.12	0.547
Texas University Classification Grades			
Grade 1	1	-	-
Grade 2	5.93	0.55 - 64.44	0.144
Grade 3	17.49	1.61 - 190	0.019

4. Discussion

The limitations were its retrospective nature in a hospital setting. The main limitation stems from the absence of certain specific information concerning the diabetic patients surveyed. Indeed, some files were incomplete in relation to paraclinical explorations for reasons of financial accessibility. As a result, information was not available on retinopathy, nephropathy and HbA1c. The second limitation is due to the lack of socio-economic data (socio-economic level, cost and costs of

hospitalization, including amputation).

The hospital prevalence of diabetic foot was 14.9%, similar to results found in most African countries [14]-[18].

In hospitalized patients with diabetic foot, we had objected to a hospital prevalence of amputation of 57.8%. These numbers were consistent with data from African literature which varied between 40% and 62% [19]-[22]. This high figure of amputation could be explained by the seriousness of the hospitalized patients, and the delay in consultation due to socio-economic conditions.

On the clinical-biological level: the occurrence of amputation in hospitalized diabetic patients was not associated with age, which was in contradiction with the data in the literature which showed a significant correlation of amputations with age [23]-[25]. Indeed, the majority of studies reported an explanation for the decrease in angiogenesis, local synthesis of growth factor [26] and the high frequency of arteriopathy in the elderly. However, other authors reported that age had no influence on the evolution of lesions [15] [27]-[29].

Male gender was a factor that doubled the risk of amputation compared to female gender [23] [25], with the explanation being the generally recognized poor therapeutic compliance in men [20]. Even though there was a good correlation between the risk of amputation and gender in the literature data, our study did not highlight this proven risk factor as found in other countries of the world [26]-[29].

Concerning cardiovascular risk factors such as hypertension and smoking, no significant difference was found compared to amputation. The data in the literature remain unclear and contradictory [3] [23] [25] [28] [29]. History of amputation was not statistically linked to amputation according to our results. This result was superimposable to that of Boyko in the United States [23] and Quilici in Brazil [29].

Among the chronic complications of diabetes: Obliterative arteriopathy of the lower limbs in diabetics was a factor associated with amputation with a risk multiplied by 4.96 according to our results. This was in line with the data in the literature [23] [25] [26] [32] [33] where a strong correlation was found between amputation and arteriopathy. Indeed, arteriopathy, common in diabetic patients (30% of patients), constitutes a determining factor in the evolution of lesions [26]. These findings allowed the authors to conclude that vascular management (revascularization) should be an integral part of the prevention strategy to reduce the risk of lower limb amputation.

Neuropathy was found in 78.3% of diabetics, which was consistent with published data indicating a high prevalence of neuropathy in diabetic patients hospitalized for foot lesions [29]. However, our study did not allow us to take neuropathy into account as a risk factor for amputation.

Contrary to what was found in the literature, there was no association between chronic kidney disease (CKD) and the risk of amputation. Indeed, chronic kidney disease (CKD) was a pejorative factor in the case of foot lesions [26] [31]. The risk

of amputation was multiplied by 4 to 10 in the case of terminal CKD compared to a diabetic population with normal renal function. In our series, the low number of patients with terminal CKD (4.9%) could explain this result.

The presence of diabetic imbalance was not correlated with the risk of amputation according to our results, which was contradictory to the data in the literature which found an obvious risk of amputation, if we consider its effect on the occurrence of complications [30] [31] [33].

Regarding the diabetic foot, foot gangrene was statistically linked to the occurrence of amputation. Indeed, diabetics with foot gangrene had a 3.16 times greater risk of undergoing amputation. These results were similar to data from the literature where the lesions most often associated with amputation were gangrene and foot ulcers [9] [31]. Indeed, ignorance, poor practice, and lack of resources meant that it was at the gangrene stage that patients were seen and hospitalized with the ultimate solution being foot amputation [26].

In the USA and the UK, delayed healing and amputation were correlated with the grades and high stages of the lesions [34]. This corroborated our results where stage D and grades 2 and 3 were linked to amputation with a risk multiplied by 17.49. This relationship was understandable since patients consulted late with serious lesions and this could be linked to difficulties in accessing care, to the low socio-economic level, the lack of knowledge of diabetes and its complications.

The presence of infection and osteitis had long been considered risk factors for amputation in patients with diabetic foot. These two associations have been found in several studies [26] [31]. Although they were found in bivariate, adjustment for other variables did not allow these relationships to be preserved in multivariate in our study.

Regarding treatment, insulin was not associated with the occurrence of amputation in our study. In the United States and Australia, the same results were found [23] [28]. While in other studies, insulin was considered a risk factor for amputation [22] [30] [36] [37], and this could be related to the fact that the most severe cases would be treated with insulin. But also, it was necessary to recognize that after 10 years of diabetes evolution, most patients would need insulin treatment [36].

5. Conclusions

Diabetic foot is a major public health problem both because of its personal and social implications for the patient and those around him and because of its economic impact on society. The major issue of this problem is the amputation that it can lead to.

In our study, the risk factors for foot amputation in hospitalized patients were peripheral arterial disease, gangrene of the foot, and high grade and stage, according to the University of Texas, which were risk factors for amputation in diabetic patients. Consideration of these factors by healthcare providers and increased prevention and education in diabetic patients will help combat these amputations.

Research work through a prospective study could contribute to refining the analysis of factors associated with amputation in patients hospitalized for a diabetic foot, but also to the implementation of solid recommendations to improve strategies to combat diabetic foot.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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