High Wagner's grade, poor glycemic control, and anemia as risk factors for diabetic foot amputation (a cross-sectional study in Basrah city)

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Abstract

Background: Foot ulcers represent a major problem for diabetic patients and the managing doctors as well. Patients may need a major or minor lower limb amputation due to severe gangrene. Diabetic foot is regarded as the major cause of lower limb amputation in the world. The study aimed to identify the effects of high Wagner's grade, poor glycemic control, and anemia as risk factors for amputation in diabetic foot patients.

Materials and methods: A cross-sectional study was undertaken on 65 patients with diabetic foot ulcers at Al-Sader Teaching Hospital in Basrah. Ulcer grading was determined using Wagner's classification system. The surgical outcome of the patients was studied in correlation with Hb level, HbA1C level, and Wagner's grade to demonstrate the effect of these three variables on the outcome.

Results: Of the 65 studied patients, 28(43.1%) required debridement, 32(49.2 %) had amputations and 5 (7.٧%) patients had disarticulations. Thirty-eight patients (58.5%) had HbA1C levels of 8 and above, and 26 of them (68.4%) ended with amputation or disarticulation. Hemoglobin levels below 10 gm/dl were reported in 36 patients (55.4%), and 22 of them (61.1%) ended with amputation or disarticulation. There are Forty-five patients (69.2% of all) presented with Wagner 3,4, and 5 ulcers, and 31 (68.9%) of them ended with amputation or disarticulation, this indicates a statistically significant association between the high Wagner's grade and the need for major limb amputation.

Conclusion: the study showed that low hemoglobin level, poor blood sugar control, and high Wagner's grade are all predictors of poor outcomes and an increased risk of amputation in our studied patients.

Keywords: Wagner's grade, diabetic foot, glycemic control, anemia.

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Introduction

Diabetic foot syndrome (DFS), as defined by the World Health Organization, is an "ulceration of the foot (distally from the ankle and including the ankle) associated with neuropathy and different grades of ischemia and infection" (1). Diabetic foot disease is an earnest complication of diabetes mellitus. diabetes mellitus patients have a 25% lifetime risk of developing a foot ulcer, and between (14 -24%)of patients may need a major or minor lower limb amputation due to severe gangrene (2). Diabetic foot is regarded as the major cause of lower limb amputation in the world, it was estimated that 40-60 % of amputations for the lower limb are done for diabetics, and 85% of these started as foot ulcers and deteriorate as massive gangrene (3). Amputation in diabetics is regarded as

a poor outcome predictor, with a perioperative 30-day mortality of 8-23%. New findings suggest that the higher the level of amputation is, the higher the risk of perioperative mortality (4), in addition to the risk factors of developing diabetic foot ulcers such as neuropathy, angiopathy, previous foot ulcer, nephropathy, and cardiovascular diseases, the jeopardy of diabetic foot ulcer development is increased with the duration of diabetes if it was more than 10 years (5). There are also considerable connections between diabetes duration, high neutrophil-lymphocyte ratio, poor ankle-brachial index, and smoking with the grade of diabetic foot ulcers according to Wagner's classification (6). A recent literature review revealed a strong association between diabetic foot amputation and poor glycemic control as well as smoking (7). Diabetic foot amputation has a major socioeconomic influence on the patient and his family, on the other hand, low socioeconomic status strongly increases amputation risk and mortality in patients with diabetes (8).

Ethnic and racial differences were found in the rate of amputation in diabetic foot. Individuals from minority groups of some races and ethnicities have higher rates of diabetes and are also more likely to develop diabetic foot ulcers and receive amputations compared to Caucasian individuals (9). Amputees in diabetics have a great psychological impact on patients. A WHO study found that 14.1% of amputees go through depression. Another study found an increase in depression and anxiety in amputees when compared to the general population. There are also other mental health effects of amputation, including "psychological morbidity, increased dependency, decreased self-esteem, distorted body image and certain levels of social isolation" (according to studies on short- and long-term follow-up) (10).

In our locality, where the accessibility of prosthesis is not guaranteed all the time and where the financial restriction is a major issue, especially with low or medium economic status the situation will be more difficult and will exacerbate the condition to a large extent. In this study, we will try to find the correlation between some risk factors on the rate of amputations in diabetics and correlate them with the level of these amputations.

Patients and method

This is a cross-sectional study carried out between February 2018 to September 2019 at the surgical department of Al-Sader Teaching Hospital in Basrah governorate in Iraq. The criterion for selection of the patient was any patient with a foot ulcer due to diabetes. Patients with foot ulcers due to other causes were excluded from the study. A total number of 65 diabetic patients with foot ulcers were involved in the study**.** The managing team included an orthopaedic surgeon, general surgeon, vascular surgeon, and family medicine doctor. A special questionnaire form was prepared to collect data from patients including the age of the patient, type of diabetes, duration of diabetes, type of treatment, history of previous amputation, duration of occurrence of the ulcer, history of hypertension, evidence of neuropathy, nephropathy, retinopathy or cardiac problems.

The patients were referred to the hospital from outpatient clinics, private clinics, and the emergency department. All patients were subjected to thorough local examination and the ulcers were graded according to Wagner's classification of diabetic foot ulcers (11) as shown in Table 1.

Table 1: Wagner's classification of diabetic foot ulcers

Ulcer grading	Description
Grade 0	Skin intact but bony deformities lead to "foot at risk"
Grade 1	Superficial ulcer
Grade 2	Deeper, full-thickness extension
Grade 3	Deep abscess formation or osteomyelitis
Grade 4	Partial Gangrene of forefoot
Grade 5	Extensive Gangrene

Blood investigations were done in the form of hemoglobin level, WBC count, ESR, glycosylated hemoglobin (HbA1c), and serum albumin level, in addition to ECG, chest x-ray, foot x-ray and swab for culturing and sensitivity testing taken from the ulcer to isolate the infective organism and to choose appropriate antibiotic treatment according to the result. Forty-seven of the patients were admitted to the orthopedic department and followed up by an orthopedic surgeon, general surgeon, vascular surgeon, and family medicine doctor. The other eighteen patients were admitted to the medical ward for the control of blood sugar and found to have foot ulcers. Daily wound dressing together with a cover of antibiotics was started in every patient by best guess and modified by culturing and sensitivity testing. Surgical treatment included wound debridement, minor amputations (foot or toe amputation), major amputation (transtibial or transfemoral), or joint disarticulation were carried out according to the decision of the committee of three orthopedic surgeons in the department after an informed and written consent. The operations were done by different surgeons in the orthopedic department, but Wagner's classification was obtained by the same surgeons in all cases to avoid interobserver variation.

Initially, five patients underwent debridement but later on, their feet condition necessitated amputation, so they were regarded in the amputation group. Early and late postoperative complications were reported through regular follow-up of the patients with special emphasis on common surgical complications such as wound infection, sloughing of the skin, recurrence of the ulcer, need for revision of amputation or systemic cardiovascular, renal complications, and death.

Statistical analysis

The data was analyzed using the social package statistical science (SPSS) version 20. To evaluate the data results, Chi-square tests (X2) with probability (P) values were computed at the 0.05 level of significance.

Results

Sixty-five patients were included in this study; 38 patients were male representing 58.5% of the total patients, and 27 patients were female representing 41.5%. The results are shown in the following tables:

Of the 65 studied patients, 28 required debridement, 32 had amputations and 5 patients had disarticulations as shown in table (2).

Table 2: Surgical outcome of the 65 patients

	Debridement NO (%)	Amputation NO (%)	Disarticulation NO (%)	Total NO (%)
Patients number	28 (43.1)	32 (49.2)	5 (7.7)	65 (100)

The glycemic control of the patients represented by HbA1C level with procedures performed is shown in Table (3), which shows a significant relation between poor glycemic control with the high rate of amputation. Thirty-eight patients (58.5%) had HbA1C levels of 8 and above, and 26 of them (68.4%) ended with amputation or disarticulation. For the remaining 27(41.5%) with HbA1C below 8, amputation or disarticulation was reported in only 11 patients (40.7%). This difference was found statistically significant with a P value of <0.05.

Table 3: Level of HbA1C with surgical outcome

HbA1c	Total NO	Debridement NO (%)	Amputation NO (%)	Disarticulation NO (%)	p-value
6-6.9	8	5 (62.5)	3 (37.5)	0 (0.0)	<0.05
7-7.9	19	11 (57.9)	7 (36.8)	1 (5.3)	
8-8.9	21	8 (38.1)	12 (57.1)	1 (4.8)	
9-10	17	4 (23.5)	10 (58.8)	3 (17.7)	
Total	65	28 (43.1)	32 (49.2)	5 (7.7)	

The relationship between the hemoglobin concentration of the patients with the surgical outcome is shown in Table (4). The table shows an important relation between low Hb level with high amputation rate. Hemoglobin levels below 10 gm/dl were reported in 36 patients (55.4%), and 22 of them (61.1%) ended with amputation or disarticulation. In the remaining 29 patients (44.6%), the hemoglobin level was above 10 gm/dl, and 15 of them (51.7%) ended with amputation or disarticulation. This difference was found statistically insignificant with a P value of > 0.05.

Table 4: The hemoglobin level versus outcome

Hb Gm/dl	Total No.	Debridement NO (%)	Amputation NO (%)	Disarticulation NO (%)	p-value
7-7.9	10	4 (40.0)	5 (50.0)	1 (10.0)	>0.05
8-8.9	12	5 (41.7)	7 (58.3)	0 (0.0)	
9-9.9	14	5 (35.7)	8 (57.1)	1 (7.2)	
10-10.9	12	6 (50.0)	4 (33.3)	2 (16.7)	
≥11	17	8 (47.1)	8 (47.1)	1 (5.9)	
Total	65	28 (43.1)	32 (49.2)	5 (7.7)	

By applying Wagner's classification, grade 1 ulcers needed only debridement, while the major amputations and disarticulations were in grades 4 and 5 Wagner as shown in Table (5). Forty-five patients (69.2% of all) presented with Wagner's grades 3,4 and 5 ulcers of them 31 (68.9%) ended with amputation or disarticulation, while the remaining 20 patients (30.8%) presented with Wagner's grades 1 and 2, the rate of amputation or disarticulation was reported in only 6 of them (30.0%). This indicates high statistically significant association between the high Wagner's grade and the need for major limb amputation.

Table 5: Wagner's classification versus outcome

Wagner Grade	Number	Debridement Number (%)	Amputation Number (%)	Disarticulation Number (%)	p-value
1	3	3 (100.0)	0 (0.0)	0 (0.0)	<0.001
2	17	11 (64.7)	6 (35.3)	0 (0.0)	
3	14	5 (35.7)	9 (64.3)	0 (0.0)	
4	25	9 (36.0)	16 (64.0)	0 (0.0)	
5	6	0(0.0)	1 (16.7)	5 (83.3)	
Total	65	28	32	5	

Discussion

In this cross-sectional study, we try to figure out the clinical criteria for diabetic foot ulcer patients who underwent amputation in Al-Sader Teaching Hospital in Basrah City in the south of Iraq. Our study demonstrated that high blood glucose levels and higher Wagner's grade are statistically significant in contrast with anemia which was found to have an important yet non-significant relation as risk factors for increasing amputation rate in diabetic foot patients. Thirty-eight of our patients (58.5 %) had HbA1C more than 8 which indicates poor glycemic control, 26 of them (68.4%) had amputation or disarticulation, while patients with HbA1C between 6 and 8 which indicate better glycemic control were 27 patients (41.5 %), only 11 (40.7 %) of them had amputation or disarticulation; Care D and Suppl SS in their study regarding the standard targeted blood glucose level in diabetic patients recommended pre-prandial blood glucose between 4.4 mml/L-7.2mml/L and peak postprandial blood glucose less than 10mmol/L (12) twenty-three out of 42 of their patients (54.76%) underwent some form of major amputation. Jiali Xiang et al and Singh SK carried out two different studies on the role of glycemic control on the development of foot ulcers indiabetic patients, their studies showed that poor glycemic control is a causal factor for delayed wound healing and increasing liability for infection, adding to that the development of macro and micro angiopathic changes, not only that but increase blood glucose may increase viscosity of blood enhancing the risk of developing thrombus and limb ischemia (13,14).

Thirty-six of the studied patients (55.4%)had mean hemoglobin levels below 10 gm/dl, and 22 of them (61.1%) had amputation or disarticulation. This figure represents (59.5 %) of patients who underwent amputation or disarticulations (22 out of 37 patients),this result reflects that anemia is an important risk factor for amputation in diabetic foot patients. A study by Gezawa ID et al. showed that amputation, poor wound healing, and the likelihood of death, were all substantially correlated with anemia among diabetic foot ulcer patients (15). Costa RHR et al. study has demonstrated most diabetic patients who developed major amputation were anemic (89.6%) reflecting the increasing risk of amputation in anemic diabetic patients, this may be due to the combined effect of anemia and peripheral vascular disease in the diabetic patient which may exaggerate the hypoperfusion state of tissue leading to impaired wound healing and thrombus formation (16). Wagner's classification was established in 1979 and it is still being used widely as a grading system for diabetic foot ulcers (17). In our study, we have 45 patients with Wagner's grades 3, 4, and 5 (69.2 %), 31 of them had amputation and disarticulation (68.9 %), and for Wagner's grades 1 and 2 we have 20 patients (30.8 %), only 6 of them had amputation (30 %), indicating higher amputation rate with higher Wagner's grade. So our study shows a high statistically significant association between a high Wagner's grade (3 and above) and the risk of major amputation reflecting its useful predictive value in assessing the risk of amputation in diabetic foot ulcers. Since Wagner's classification describes the depth of the ulcer, exposure of the underlying deep structures of the foot, presence of infection, and gangrene, it gives a proper idea about the status of the affected foot and the need for debridement or amputation**.** Our result is consistent with that of

Monterio-Soares M et al. which showed a significant causal association between increasing Wagner's grade and the risk of amputation in diabetic foot ulcer patients (18). Byung-Joon Jeon et al. and Dongkeun Jun et al. also stated that Wagner's classification is a suitable predictor for the outcome of foot ulcers in diabetic patients and for the decision of amputation (19,20).

Conclusion

In this study, the clinical criteria for diabetic foot ulcer patients treated in Al-Sader Teaching Hospital in Basrah, south of Iraq, showed that a high Wagner's grade is highly significant, followed by high blood glucose levels (poor glycemic control) which also found to be significant meanwhile anemia found to have an important yet a non-significant relation as risk factors for high amputation rate in diabetic foot patients.

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درجة واغنر العالية ، ضعف السيطرة على نسبة السكر في الدم وفقر الدم ك عوامل خطورة لبتر القدم السكري (دراسة مقطعية في مدينة البصرة)

الخلفية: تشكل قرح القدم مشكلة كبيرة لمرضى السكري والأطباء المعالجين أيضًا. قد يحتاج المرضى إلى بتر كبير أو صغير في الأطراف السفلية بسبب الغرغرينا الشديدة. يعتبر القدم السكري السبب الرئيسي لبتر الأطراف السفلية في العالم. هدفت الدراسة إلى تحديد تأثيرات درجة واغنر العالية وضعف السيطرة على نسبة السكر في الدم وفقر الدم ك عوامل خطورة للإصابة بالبتر لدى مرضى القدم السكري.

الطرق والمواد: تم إجراء دراسة مقطعية على ٦٥ مريضا يعانون من قرح القدم السكري في مستشفى الصدر التعليمي بالبصرة. تم تحديد درجة القرحة باستخدام نظام تصنيف واغنر. تمت دراسة النتيجة الجراحية للمرضى بالارتباط بمستوى الهيموجلوبين ومستوى الهيموجلوبين A1c ودرجة واغنر لإظهار تأثير هذه المتغيرات الثلاثة على النتيجة.

النتائج: من أصل ٦٥ مريضًا تمت دراستهم ، احتاج ٢٨ مريضًا (٤٣,١٪) إلى استئصال النسيج ، وخضع ٣٢ مريضًا (٤٩,٢٪) للبتر ، وخضع ٥ مرضى (٧,٧٪) إلى بتر تفصيلي. كان لدى ثمانية وثلاثين مريضًا (٥٨,٥٪) مستويات هيموجلوبين A1c تساوي ٨ وما فوق ، وانتهى ٢٦ منهم (٦٨,٤٪) بالبتر أو البتر التفصيلي. تم الإبلاغ عن مستويات الهيموجلوبين أقل من ١٠ جرام / ديسيلتر لدى ٣٦ مريضًا (٥٥,٤٪) ، وانتهى ٢٢ منهم (٦١,١٪) بالبتر أو البتر التفصيلي. وأظهر خمسة وأربعون مريضًا (٦٩,٢٪ من الإجمالي) قرحًا من الدرجة ٣ و ٤ و ٥ في واغنر ، وانتهى ٣١ منهم (٦٨,٩٪) بالبتر أو البتر التفصيلي ، مما يدل على وجود ارتباط مهم إحصائيًا بين درجة واغنر العالية والحاجة إلى بتر كبير للأطراف.

الخاتمة: أظهرت الدراسة أن انخفاض مستوى الهيموجلوبين وضعف السيطرة على نسبة السكر في الدم ودرجة واغنر العالية كلها عوامل مؤثرة على النتائج السيئة وزيادة خطر البتر لدى المرضى الذين تمت دراستهم.