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Original Article

Evaluation of Surgical Interventions in Patients with Diabetic Foot Ulcer and Infection Assessed in the Chronic Wound Council Between 2016-2017

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ABSTRACT

Objective: Diabetes mellitus is a common health issue with an increasingly rampant incidence all over the world. Diabetic foot ulcers raise morbidity, reduce the quality of life, prolong hospital stay, and cause a high rate of lower extremity amputation. Our aim in this study is to evaluate the patients presented to the hospital with the diabetic foot diagnosis.

Methods: 147 diabetic foot patients were evaluated retrospectively in the chronic wound council between 2016–2017 at our hospital. Wagner was used for wound classification, whereas Infectious Diseases Society of America (IDSA) was for infection classification.

Results: Evaluating the cases according to the Wagner classification, 1 patient was observed to be on stage 1, 19 were on stage 2, 58 were on stage 3, 58 were on stage 4, 11 were on stage 5. Patients on stage 3 and above accounted for 86.4% of all cases. 66 patients (45%) underwent minor amputation, whereas 18 (21%) were below-knee amputation and 2 (1%) were above-knee amputation. 44 patients recovered with debridement and wound care.

Conclusion: Lower extremity ulcers and infections in diabetic patients are one of the most common causes of hospitalization and non-traumatic amputation in diabetic patients. The amputation rate, which was determined as 58.5% in our study, is higher compared to similar studies. We consider that this is due to patients who presented late, who had higher grades of Wagner wound stages, who had osteomyelitis, who had vascular problems and were referred to our center for decision of amputation.

INTRODUCTION

Diabetes mellitus is a common health problem with an increasing incidence all over the world.[1,2] Parallel to the rise in the prevalence of diabetes, the incidence of diabetic foot ulcers and infections is also upsurging. There is a risk of developing a diabetic foot ulcer in one out of every four diabetic patients during their lifetime. Diabetic foot ulcers increase morbidity, decrease quality of life, prolong hospital stay, and cause a high rate of lower extremity amputation.[2,3]

The diabetic wound is becoming an increasingly significant health problem in the world. With the holistic and interdisciplinary approach of the diabetic foot and chronic wound councils and different clinics functioning under the roof of tertiary healthcare institutions, joint strategies that accelerate wound healing can be determined.

This study aims to evaluate the patients admitted to the hospital with diabetic foot diagnoses.

MATERIALS AND METHODS

Between 2016 and 2017, 147 diabetic foot patients were examined in the chronic wound council in our hospital. Patient information was obtained retrospectively from the hospital computer system (Octomed) and the council protocol book. Wagner was used for wound classification and Infectious Diseases Society of America (IDSA) was for infection classification.

RESULTS

Of the 147 cases evaluated by the committee, 40 (17.2%) were female and 107 (72.8%) were male. The mean age of the cases, whose age range was between 29 and 86, was 59.5. Neuropathy was found in 84 (57.14%) cases, 65 (44.2%) nephropathy, and 12 (8.2%) peripheral arterial disease. Evaluating the cases according to the Wagner classification, 1 patient was in stage 1, 19 patients were in stage 2, 58 patients were in stage 3, 58 patients were in stage 4 and 11 patients were in stage 5. Patients with stage 3 and above constituted 86.4%. of all cases. Osteomyelitis was diagnosed in 50 cases by direct radiography and MRI.

Evaluating the laboratory characteristics of the cases, WBC was between 4000–41000/mm^3. WBC was found to be >10.000/mm^3 in 67 (45.5%) of these. CRP values were between 3-289 mg/dL, sedimentation were 8–208 mm/h, while 70 of them had sedimentation >70 mm/h, and the mean HBA1C value were 7.8 (6.5–14.2). Minor amputation was performed on 66 patients (45%), below-knee amputation on 18 patients (21%), and above-knee amputation on 2 (1%) patients. The surgical procedures of the patients reviewed in the council are presented in Table 1. All patients who underwent amputation were evaluated by cardiovascular surgery with Doppler USG and/or angiography for preoperative vascular evaluation. Hip disarticulation was performed after stump healing problems seen in 2 patients who underwent above-knee amputation. Three of the patients were operated on for Charcot's foot, but 2 of them underwent below-knee amputation in the 2-year follow-up after the operation. These 3 patients were not included in our study.

Additional comorbidities such as neuropathy and nephropathy were observed in 92 (62.6%) of the patients. The distribution of comorbidities by groups is presented in Table 2.

Deep tissue cultures were obtained from 109 patients and bacterial growth was detected in 84 (77%) patients. Single bacteria were isolated in 68 and more than one bacteria in 12 cases. The distribution of causative agents was found to be as follows: 15 *Pseudomonas aeruginosa*, 14 *Staphylococcus aureus*, 12 *Escherichia coli*, 11 E*nterococcus faecalis*, 7 *Morganella morgagnii*, 4 *Acinobacter baumannii*, 7 *Proteus spp*, 4 *Serratia marcassens*, 4 *Klebsiella spp*, 1 *Streptococcus pyoyenes*, 1 *Citrobacter freundii*, 1 *Streptococcus anginosus*. The patients were treated for the causative agents empirically according to their infection stage, agent isolation and their antibiotic susceptibility during their hospitalization. Antibiotic treatment was administered for at least 2 weeks in cases with soft tissue infections and at least 6 weeks in cases with osteomyelitis.

Table 2. Comorbidities by groups

	Amputation	Debridement
Number of cases	86	61
Peripheral artery disease	9	3
Diabetic neuropathy	47	37
Diabetic nephropathy	35	30
Infection presence	88	21
Culture positivity	65	17

Hyperbaric oxygen therapy (HBOT) was applied to 54 of 98 patients with signs of ischemia and circulatory problems. All patients receiving HBOT underwent debridement, local wound care and/or minor amputation.

A delay in postoperative wound healing occurred in 20 of 66 patients who underwent below-ankle amputation, of which 4 were recovered with local wound care alone, 11 with HBOT in addition to local wound care, and 3 with negative pressure wound closure system in addition to HBOT. In addition to wound care in two patients, the operation was performed while the amputation stump was still below the ankle, and wound healing was achieved in the follow-up.

Wound healing problem developed in 15 of 18 patients who underwent amputation at the above-ankle level. Of these, 11 were recovered with debridement and dressing, while 2 had a further negative pressure wound closure process and the other 5 had a further HBOT treatment. The remaining 3 below-knee amputations were progressed to above-knee amputation, and 1 above-knee amputation was processed to hip disarticulation. (In 1 case, disarticulation was performed first above the knee and then at the hip). The 6 patients who were operated on the upper level were those with HBA1C level >8, who had vascular problems and whose blood sugar regulation could not be achieved.

DISCUSSION

Lower extremity ulcers and infections are one of the most common causes of hospitalization and non-traumatic am-

Table 1. Distribution of amputated patients

	Minor	Below-knee	Above-knee	Debridement	Total
Council	66 (45%)	18 (21%)	2 (1%)	49 (33%)	147

putation in diabetic patients. Diabetic foot ulcers comprise 60% of non-traumatic foot amputations.[4] Especially in patients with foot ulcers, late admission to the hospital is associated with the development of infection, and serious infections are associated with poor prognosis.[5] Therefore, the prevention and early treatment of diabetic foot ulcers are important for prognosis.

Although the causative agents of diabetic foot infection vary according to the characteristics of the patient, the stage of the wound, whether there exists a patient's history of antibiotic use, surgery and/or hospitalization beforehand, the first 3 causative agents found in studies conducted in our country are *P. aeruginosa, S. aureus* and Gram (-) enteric bacilli.[6,7] Similarly, *P. aeruginosa* (18%), *S. aureus* (17%), *E. coli* (14%) and *E. faecalis* (14%) were found to be the most common agents in our study.

Diabetic foot councils are operative in healing foot ulcers and infections and reducing surgeries for lower extremity amputations.[8] Depending on the conditions of the hospitals; cardiology, cardiovascular surgery, orthopedics, endocrinology, internal medicine, infectious diseases, plastic surgery, hyperbaric oxygen therapy, podology specialists and wound care nurses take part in these councils. With this multidisciplinary approach, the treatment and procedures for patients are carried out faster. Amputation rates in diabetic foot ulcers and infections vary according to wound stage, vascular circulation and patient characteristics.

Yesil et al.[9] reported the amputation rate of 37% in 510 patients with 670 foot ulcers between 1998 and 2008, and ischemia, presence of gangrene, ulcer size, Wagner stage (especially ≥4) were found to be independent risk factors for major amputation.

The amputation rate was found to be 28.6%, and the absence of glycemic control and concomitant cardiovascular and renal diseases were found to be risk factors for amputation in the study on 98 cases between 2007–2010 by Forde H et al.[10]

The amputation rate was 58.5% in our study, 52% of which were minor, 14% were below the knee and 1% were above the knee operations. The reason for this high rate, we consider, maybe that 86% of the patients who applied to the council had a wound classification above Wagner 2 and that the patients were referred for amputation decisions from other hospitals to ours where a wound council was available. Another reason may be the patients thought of going to a grand hospital when the amputation is recommended.

Diabetic foot ulcers and infections are among the important causes of lower extremity amputations, as revealed in our study. We believe that in order to reduce the amputa-

Figure 1. (a, b) Pre-debridement of the patient. (c, d) Post-debridement of the patient. (e, f) After the 3rd VAC dressing change of the patient.

tion rate, all diabetic patients should first be received foot care training, early treatment should provide for patients with foot ulcers, and if possible, a podologist should follow the patients and refer them to higher centers where diabetic foot or chronic wound councils are available.

Treatment management for diabetic foot ulcers and infections includes blood sugar regulation, offloading the foot, infection control, peripheral vascular interventional procedures, and surgery. Moreover, it is recommended to apply different wound care products such as hyperbaric oxygen therapy and negative pressure wound closure to support wound healing.[11] Blood sugar regulation, antibiotic therapy, surgical interventions and hyperbaric oxygen therapy were administered as supplementary treatment in our patients.

Hyperbaric oxygen therapy is a treatment method based on inhalation of 100% oxygen in a high-pressure environment. In HBOT applied studies, better results were obtained, especially in cases with small-scale vascular uptakes.[12] The first randomized controlled clinical study on HBOT was carried out by Doctor et al.[13] In this study, it was shown that minor amputations took the place of major amputations in diabetic foot cases. Thus, HBOT has been evaluated as an effective and reliable treatment method. We consider that minor amputations provide rapid recovery in our patients and prevent the amputation level from increasing to the proximal amputation. 20 of the 60 patients who underwent minor amputation had wound healing problems, 11 patients received HBOT and no recurrence was observed in the 1-year follow-up of amputation levels.

The most important results of the peripheral effects of diabetes are wounds wounds occuring due to decreased bloodflow to the foot, delayed wound healing, susceptibility to infection, ulcers, and loss of lower extremities. The combination of ischemia, neuropathy, and sepsis causes osteomyelitis and gangrene, leading to amputation. It has been shown that amputation rates increase with delay in treatment.[14,15] In our hospital, the first surgical treatment was performed within 2–7 days after the surgical decision was taken by the wound council. An amputation suggested patient can be clinically recovered after early debridement and can be relieved from amputation (Fig. 1a-f).

The prevalence of amputation was found to be increased as the depth and stage of the ulcer increased, and the probability of amputation increased 11 times in ulcers reaching the bone, and 90 times in patients with concomitant infection. Moreover, low transcutaneous oxygen pressure, increased leukocyte count, and estimated glomerular filtration rate (eGFR) of the Wagner stage are independent risk factors.[16,17] Studies have shown that approximately half of amputations are preventable.[16] In our study, it is revealed that the patient is protected from a major amputation with appropriate follow-up, in which bone debridement is performed if necessary in ulcerated wounds distal to the Wagner 2 metatarsal region. Furthermore, in our study, the presence of infection in diabetic wounds undergoing amputation and the rate of growth in culture were found to be high. We believe that the amputation rate will decrease with early debridement, wound care, appropriate and early antibiotic treatment.

CONCLUSION

Foot problems are vital in diabetic patients. In the absence of blood sugar regulation and in case of vascular insufficiency, wound healing becomes difficult even if surgical intervention is performed.

Diabetic foot infection causative agents vary from center to center and between countries. In our series, similar to the studies carried out in our country, *P. aeruginosa* 18%, *S. aureus* 17%, *E. coli* 14% and *E. faecalis* 14% are the most common infectious causative agents.

The amputation rate was found to be 58.5% in our study, which is higher than in similar studies. We consider that this is due to patients who presented late, who were at the high levels in the Wagner wound stages, who had osteomyelitis, who had vascular problems and were referred to our center for amputation decision. To reduce the amputation rate, the evaluation and follow-up of patients with a diabetic ulcer should be carried out with a single diabetic foot center and with a multidisciplinary approach, the factors causing ulcers should be determined separately for each patient and measures should be taken, and most importantly, the patients and their relatives should be educated for foot care and blood sugar regulation.

Ethics Committee Approval

This study approved by the Kartal Dr. Lutfi Kirdar Training and Research Hospital Clinical Research Ethics Committee (Date: 26.06.2019, Decision No: 2019/514/156/5).

Informed Consent

Retrospective study.

Peer-review

Internally peer-reviewed.

Authorship Contributions

Concept: Z.T.; Design: O.A.; Supervision: G.F.; Fundings: T.G.; Materials: Z.T.; Data: Z.T.; Analysis: S.G.S.; Literature search: N.A.; Writing: Z.T.; Critical revision: O.A.

Conflict of Interest

None declared.

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2016-2017 Yılları Arasında Kronik Yara Konseyinde Değerlendirilen Diyabetik Ayak Ülser ve Enfeksiyonlu Hastalardaki Cerrahi Girişimlerin Değerlendirilmesi

Amaç: Diyabetes mellitus tüm dünyada görülme sıklığı artan yaygın bir sağlık sorunudur. Diyabetik ayak ülseri morbidite artışına, yaşam kalitesinde azalmaya, uzun hastane kalış sürelerine ve yüksek oranda alt ekstremite amputasyonuna yol açmaktadır. Bizim bu çalışmada amacımız diyabetik ayak tanısı ile hastaneye başvuran hastaları değerlendirmektir.

Gereç ve Yöntem: Hastanemizde 2016–2017 yılları arasında kronik yara konseyinde 147 diyabetik ayak hastası geriye dönük olarak değerlendirildi. Olguların yara sınıflamasında Wagner, enfeksiyon sınıflamasında IDSA kullanıldı.

Bulgular: Olgular Wagner sınıflaması ile değerlendirildiğinde bir hasta evre 1, 19 evre 2, 58 hasta evre 3, 58 hasta evre 4, 11 hasta evre 5 idi. Evre 3 ve üzeri olan hastalar olguların %86.4'ünü oluşturmaktaydı. Altmış altı hastaya (%45) minör, 18'ine (%21) diz altı, ikisine (%1) diz üstü amputasyon uygulandı. Kırkdört hasta debritman ve yara bakımı ile iyileşme sağlandı.

Sonuç: Diyabetik hastalarda alt ekstremite ülser ve enfeksiyonları hastaneye yatış ve travmatik olmayan amputasyonların en sık sebeplerinden biridir. Çalışmamızda amputasyon oranı %58.5 bulunmuş ve benzer çalışmlara göre daha yüksektir. Bunun sebebi olarak da hastaların geç evrede başvurması, Wagner yara evrelerinin yüksek oluşu, osteomyelit varlığı, vasküler problemlerin olması ve amputasyon kararı için bu hastaların merkezimize yönlendirildiğini düşünmekteyiz.

Anahtar Sözcükler: Alt ekstremite; amputasyon; diyabetik ayak.