Erciyes Med J 2020; 42(4): 400–4 • DOI: 10.14744/etd.2020.76702
ORIGINAL ARTICLE – OPEN ACCESS

Treatment Outcomes and Clinical Evaluation of Upper Extremity Infections Related to Diabetes

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ABSTRACT

Objective: The most important and common complication encountered in diabetic patients is diabetic infections, which may result in amputation. Herein, we aimed to present the treatment results of rare upper extremity infection related to diabetes at the wound clinic.

Materials and Methods: Forty-two patients who were diagnosed with and treated for upper extremity infection in our diabetic wound clinic between June 2018 and November 2019 were retrospectively screened and the 23 who met the inclusion criteria were included in this study. Drainage, VAC, ray/open amputation, and flap reconstruction were applied either alone or in combination. The preoperative, intraoperative, and postoperative data were recorded.

Results: The mean follow-up time of the 23 patients (4 F/19 M; mean age 55.08±11.83 (28-66) years) was 13.73±4.43 (6–26) months and the mean hospital stay was 18.82±9.31 days. Hypertension was also present in 2/3 of the patients and coronary artery disease in 1/3. The etiological cause was unknown in almost half of the patients. While combined surgical methods were used in some patients, the most common method applied was drainage. Two patients were treated with flap reconstruction.

Conclusion: We think that the treatment of upper extremity infection related to diabetes using a multidisciplinary approach and the dissemination of diabetic wound services will highly likely to make the treatment of complications of this disease more cost-effective.

Keywords: Diabetes mellitus, diabetic hand, wound, infection, multidisciplinary.

Cite this article as:
Ekinci Y, Gürbüz K. Treatment Outcomes and Clinical Evaluation of Upper Extremity Infections Related to Diabetes. Erciyes Med J 2020; 42(4): 400-4.

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Submitted
18.05.2020

Accepted
14.07.2020

Available Online Date
04.09.2020

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INTRODUCTION

Diabetes mellitus (DM) is a chronic systemic disease with high mortality and morbidity (1, 2). As in the rest of the world, the prevalence of DM is increasing daily in Turkey (2, 3). Long before the diagnosis of DM, severe damage to many systems begins, including peripheral atherosclerosis, coronary artery disease, and peripheral neuron degeneration due to hyperglycemic metabolism. Thus, even if blood glucose regulation is achieved, the quality of life of the patients deteriorates and their life span is shortened (3). With the acceptance of diabetes as a public health problem, it is possible to dramatically reduce the complications and the costs incurred through arrangements made in preventive medicine services (4).

The most important and common complication encountered in diabetic patients is diabetic ulcers, which result in high amputation rates (4, 5). Ulcerated lesions, mostly secondary to trauma in diabetic patients, may cause an increase in morbidity and mortality, and so a more careful approach should be used for these patients (5–7). Patients diagnosed with DM have a 12–15% risk of diabetic ulcers throughout their lives after diagnosis (8). Approximately 40–60% of nontraumatic amputations are performed in diabetic patients (9).

Surgical treatment of infection often tends to be more complicated than originally planned (9). One study reported that only 54% of patients recovered without complications, while 20% died (9). In the diabetic patient, if diabetic hand/foot ulcer develops, the length of hospital stay is 50% longer (7). With multidisciplinary evaluation and treatment of diabetic hand ulcers, it is possible to reduce infection-related morbidity, the number of hospitalizations, length of hospital stays, and major extremity amputation rates (10–12).

While there are many studies on diabetic foot infections in the literature, very few studies on upper extremity infection related to diabetes, have been published. An important share of the current publications is African case reports. In these publications, hand infections are defined as 'tropical diabetic hand syndrome' (10). Although its clinical presentation varies from localized cellulite to a potentially fatal ulcerative gangrenous lesion, it is rarely seen outside of tropical regions (13).

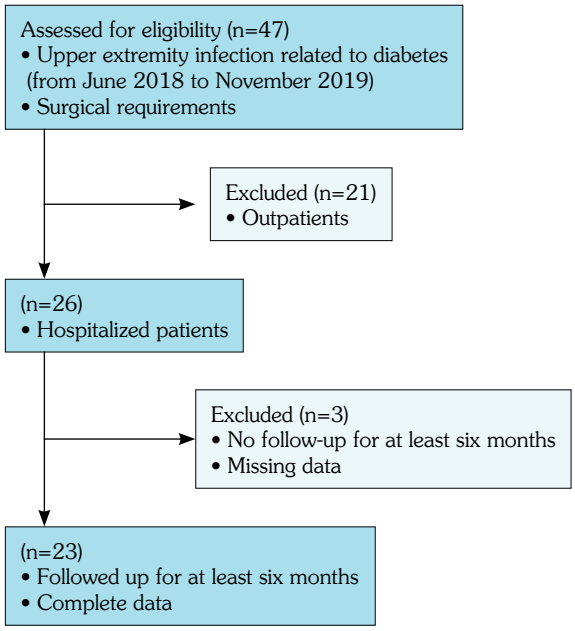

Figure 1. Flow diagram of study inclusion and exclusion criteria

In our study, we aimed to present the clinical results of upper extremity infection related to diabetes cases, which are rarely encountered in the literature in a tertiary hospital.

MATERIALS and METHODS

The study protocol was approved by the Kayseri City Training and Research Hospital Clinical Research Ethics Committee (numbered 2020/65). A retrospective review of prospectively collected data was performed of all surgically treated upper extremity infection related to diabetes in our diabetic foot and chronic wound clinic from June 2018 to November 2019. All patients provided informed consent before study entry and this study was conducted in accordance with the principles of the Declaration of Helsinki.

The inclusion criteria for this study were as follows: the patient had a diagnosis of DM and presented with finger, thumb, hand, wrist, or forearm infection; for the infection, the patient was hospitalized and treated with surgical intervention, and a culture was taken at the time of diagnosis; antibiotic treatment was initiated after surgery, and the data were not deficient.

The exclusion criteria were as follows: having lower extremity and other site infections, and having nonsurgical soft tissue infection (e.g., cellulitis and lymphangitis) or nosocomial infection after any surgical procedure.

Out of the 47 patients who were followed up with a diagnosis of upper extremity infection related to diabetes in our clinic, 24 were excluded from this study, and patients who did not meet the criteria were not followed up for at least six months, were treated and followed up at the outpatient clinic, and data were missing (Fig. 1).

All patients included in this study were given a tracking number and their age, sex, medical anamnesis, blood glucose level, white blood cell count, and infection biomarkers (sedimentation rate, C-reactive protein, and ferritin) were recorded.

Table 1. Characteristics of the cases

Variable	n=23 median (min.–max.) or mean±SD or n (%)
Age (years)	59 (28–66)
Sex	
Male	19 (82.6)
Female	4 (17.4)
Blood glucose (mg/dL)	339.91±79.74
HbA1c (%)	8.73±1.64
Sedim (mm/h)	32.87±11.44
CRP (mg/L)	49.30±16.01
WBC (mm^3)	11096.08±3543.96
Follow-up (month)[¥]	13.73±4.43
Length of stay (day)	18.82±9.31
Diabetes type	
Type 1	5 (21.7)
Type 2	18 (78.3)
Hand Dominance	
Right	21 (91.3)
Left	2 (8.7)
Infected Side	
Right	20 (87)
Left	3 (13)
Morbidity	
Hypertension	16 (69.6)
CAD	7 (30.4)
CRF	3 (13)
Asthma	1 (4.3)
History of infection	
Trauma	5 (21.7)
Burn	2 (8.7)
Nasocomial	1 (2.4)
Animal bite	5 (12.2)

[¥]: Normal distribution data are given as mean±SD; SD: Standard deviation; CAD: Coronary artery disease; CRF: Chronic renal failure; HbA1c: Glicolized haemoglobin; Sedim: Sedimentation; CRP: C-reactive protein

Each patient was evaluated throughout the period of follow-up and treatment by the Departments of Infectious Diseases & Clinical Microbiology, Internal Medicine, Ophthalmology, and Orthopedics and Traumatology. Etiological factors were classified as idiopathic, trauma, burns, and animal bites.

The road map to be applied was determined according to the examination conducted at the first presentation of the patients, whether at the Emergency Department or Diabetic Wound Care Outpatient Clinic. Sterile material taken from the focus of the abscess was sent for Gram staining and culture testing. Appropriate antibiotherapy was initiated for each patient after consultation

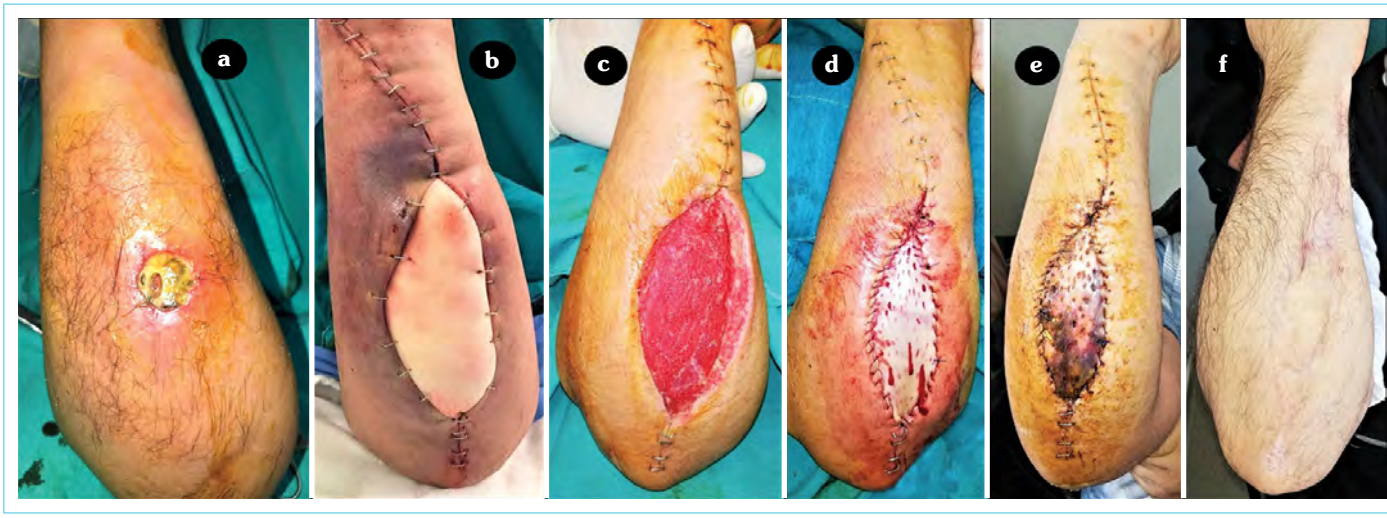

Figure 2. Clinical presentation of an upper extremity infection related to diabetes. (a) Preoperative view of the fistulized apse at the forearm. (b) Intraoperative view of the VAC application after debridement (first day). (c) Intraoperative view of the well-granulated area of the wound after consecutive radical and wide debridements assisted with VAC application (second week). (d) Intraoperative view of full-thickness skin graft surgery (second week). (e) Early postoperative view of the clinical case (fourth week). (f) Late postoperative view of the clinical case (sixth month)

with the Infectious Disease Department, inpatient treatment was planned in the event of clinical necessity, and outpatient treatment was not required. According to the culture results, the antibiotics of the patients were changed if necessary.

As a result of the orthopedic evaluation, in addition to drainage in patients with an abscess focus, it was also decided to perform VAC, emergency amputation in patients with lack of circulation and necrosis in their fingers, and open amputation in those with lack of circulation and necrosis in their fingers and skin defects during the treatment process. While reconstruction was applied to the patients using flaps, these applications were also combined with each other when clinically necessary. Recurrent surgical drainage and debridement were performed in patients with no improvement in skin erythema, continuing purulent discharge, and pain (Fig. 2). Inpatients were discharged if the signs of infection had regressed according to their laboratory and clinical results if blood glucose could be regulated and maintained at normo-glycemic levels if wound care and dressing could be done outside the hospital, if the treatment could be continued with oral antibiotics, and if the pain could be tolerated with nonsteroidal analgesics.

Statistical analyses were performed using SPSS 22.0 for Mac (SPSS Inc., Chicago, IL, USA). The data were analyzed for normal distribution by the Shapiro–Wilk test. Mean±standard deviation was used for normally distributed data, while the median (min–max) was used for nonnormally distributed data.

RESULTS

The mean age of the 23 patients (4 women, median age 64 years, age range 63–64 years; 19 males, median age 58 years, age range (28–66) years) in our study was 55.08±11.83 years and mean follow-up time was 13.73±4.43 (range 6–26) months. The majority of the patients had type 2 DM. The dominant hand was the right in 21 patients (91.3%); in 20 patients (87%), the right hand was infected (Table 1).

It was determined that six patients with diabetic hand infections were operated on due to CTS, 9 patients were operated on due to trigger finger, and three patients were previously diagnosed with Dupuytren's disease, while one patient was noticed during the examination. In addition, peripheral polyneuropathy was detected by the monofilament test in six patients.

Hypertension (69.6%) was also present in 2/3 of the patients and it was the most concomitant morbidity, while coronary artery disease, asthma, and chronic kidney failure were other causes. The source of infection was idiopathic in approximately half of the patients (47.8%), whereas trauma and farm-related infections were common.

The treatment process started with the diagnosis of soft-tissue disorder (STD) and cellulitis (43.4%) in almost half of the patients (Fig. 3a). Although the range of surgical treatments is quite wide, many methods were used from simple drainage to flap reconstruction. Of these, the most common was drainage, followed by VAC, ray amputation, open amputation, fasciotomy, and flap reconstruction (Fig. 3b).

While polymicrobial organisms (34.8%) and Staphylococcus aureus (34.8%) were the most common pathogens, Candida was detected in one patient.

DISCUSSION

Although DM is supposedly treated and strictly followed up, micro- and/or macrovascular complications occur, leading to loss of function in the musculoskeletal system. In these patients, generally, foot examinations are common, while less attention is paid to hand examinations. The most common factor in this is that the first onset of neuropathy is in the feet. Thus, this is the first symptom causing patients to present to the Orthopedics outpatient clinic. In addition to affecting the tendons and muscles, the presence of neuropathies will also disrupt the functional use of the hand. Although the complications that occur are painless, they may cause loss of hand function in the future.

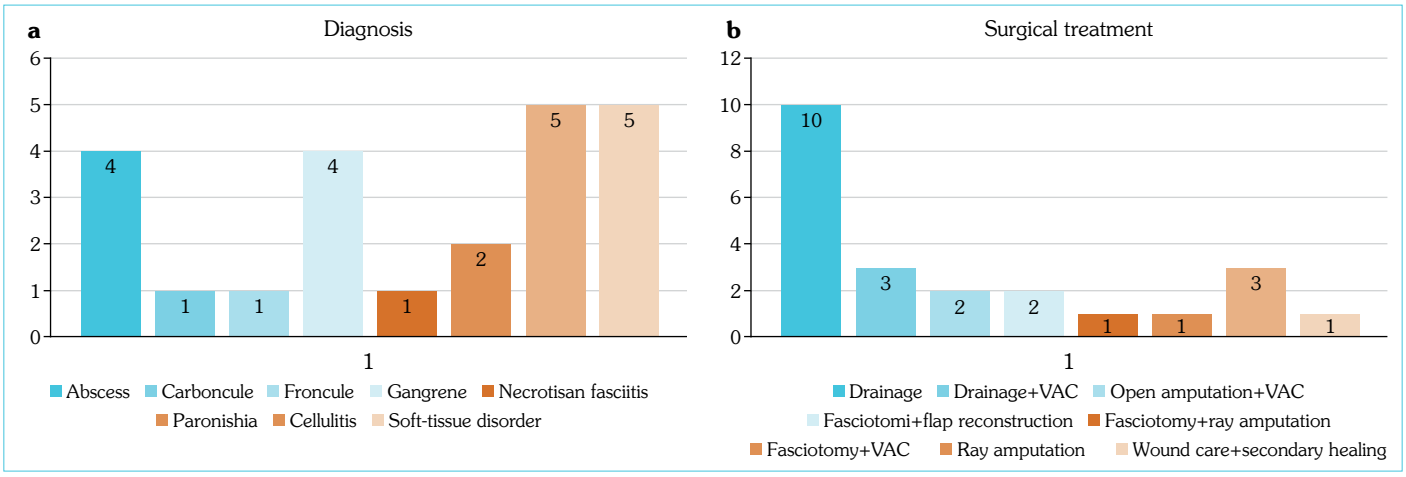

Figure 3. (a) Distribution of the diagnosis of the cases (n). (b) Distribition of the surgical treatments (n)

In diabetic patients, the trio of limited joint movement, Dupuytren's contracture, and trigger finger affecting the upper extremity are defined as "diabetic hand syndrome". While the prevalence of joint motion restriction was 20–54%, that of trigger finger or flexor tenosynovitis was 13–20%, and that of Dupuytren's contracture was 14–26%. These three situations can be seen alone or in combination (14–16).

Carpal tunnel syndrome (CTS) is more common in diabetic patients than in nondiabetic patients, with a prevalence of 14–16% (14–16). Although the direct cause is known in most of these complications, the cause–effect relationship has not been fully revealed in some. Diabetic arthropathy, Dupuytren's contracture, flexor tenosynovitis, and CTS are common complications of both type 1 and type 2 diabetes (15). In our study, six patients with upper extremity infection related to diabetes had CTS, nine patients had trigger finger, and four patients had Dupuytren's disease in accordance with the current literature. In addition, two of the four patients (1 male, 1 female) diagnosed with Dupuytren's disease were also diagnosed with simultaneous Ledderhose's disease (plantar fibromatosis).

Limited joint mobility, Dupuytren's contracture, and trigger finger, which are higher in diabetic patients than in nondiabetics, could be indications in diabetes screening in the general population. Thus, it is significant to carry out diabetes screening in all patients with surgical indications or conservatively, in consultation with Internal Medicine, as performed in our Diabetic Wound Care Outpatients Clinic.

Unfortunately, measurement and apply to the nearest health institution for the regulation of blood glucose levels in healthy individuals in Turkey is very rare. (3). In fact, nine patients in our study were unaware that they had diabetes before the infection developed in their hands. These patients were diagnosed by chance during the long-term treatment of upper extremity infections, insulin treatment was initiated by consulting with the Department of Internal Medicine, and blood glucose level regulation was achieved in all patients. In the literature, late presentation to health institutions is reported as a poor prognostic factor in upper extremity infection related to diabetes (7). It is a great advantage to have a specialized outpatient clinic in our hospital and to have a separate, multidisciplinary diagnosis, treatment, and follow-up for patients with inpatient indication in the health facility where this study was conducted.

Coppini and Best were aware that diabetic neuropathy caused anesthetic hand ulcers (17). In our study, medical treatment was arranged for six patients with peripheral polyneuropathy.

In Wang et al.'s study (12), the rate of recovery was 76% in diabetic patients with hand ulcers, and no amputation was conducted. Although this rate is very encouraging, the reasons for not using surgical amputation as a treatment option in the patients in their study are not clear. In current patients, necrosis may be the main factor without the problem of circulation or detecting additional comorbidity, because Benotmane et al. (18), in a study using a limited sample, reported 23.1% minor amputations, 53.8% amputation-free recoveries, and 19.2% deaths in their series of 16 cases in which diabetic patients reported the treatment of upper extremity infections. Although the amputation rates in our study were similar, no deaths occurred among our patients. The main factor responsible for this is that our hospital is located in the middle of an area surrounded by smaller provinces and the Diabetic Wound Care Clinic and its specialized outpatient clinic within this hospital can easily and quickly respond if we do not include the medical situations that progress very rapidly like necrotizing fasciitis.

Another advantage of having a specialized Diabetic Wound Outpatient Clinic is that the patient can be easily followed up in a multidisciplinary way. However, this approach should definitely continue while the patient is in the ward while he is being treated and followed up. Another advantage is that the patient with indications for hospitalization undergoes blood glucose level regulation in the Diabetic Wound Care Clinic in the first place, in the safest and shortest time.

This medical treatment can only be performed suboptimally by surgical branches. Therefore, Internal Medicine in the multidisciplinary team is sufficient and competent in this regard. In the first stage of surgical interventions, the infected tissue should be removed from the body with a radical and broad debridement to reduce the microorganism burden because the hand has anatomically low biological barriers and a localized infection can spread rapidly and septicemia may develop in the blink of an

eye. Septicemia was not detected in any of the patients in the present study, and there was no exitus. In addition to reducing the pathogen burden surgically, another important factor is Infectious Diseases and Clinical Microbiology in multidisciplinary diagnosis, follow-up, and treatment. At the time of diagnosis, sterile Gram staining and culture testing samples are taken from the focus of infection immediately, and appropriate antibiotherapy is initiated for each patient by consulting, repeating gram and culture sampling with the appropriate technique in the first debridement operation, arranging antibiotherapy if necessary according to the gram and culture results, which are another advantage.

CONCLUSION

Although it was newly established in this study, we can list the gains and clinical experiences we gained from our Diabetic Wound Care Clinic as follows:

- If upper extremity infection related to diabetes is neglected during diagnosis and treatment is delayed, they can rapidly progress to a life-threatening medical condition.
- Upper extremity infection related to diabetes is a devastating consequence of a metabolic disease that is difficult for a surgeon or other related disciplines to manage alone separately.
- In patients indicated for hospitalization with a diagnosis of upper extremity infection related to diabetes, blood glucose level regulation should be provided as soon as possible.
- Surgical interventions should be provided in the fastest way to reduce the microorganism burden by completely removing the infected tissue from the body with aggressive and capacious serial debridement.
- It is necessary to take sterile Gram staining and Culture testing samples from the focus of infection immediately, and start appropriate antibiotherapy for each patient by consulting with other departments, and arrange antibiotics for patients according to the Gram staining and culture testing results.

Based on these fundamental implications, significant progress can be made towards the acceptance of diabetes as a public health problem and the importance of preventative medicine and reducing complications and costs dramatically by the widespread implementation of the Diabetic Wound Care Services in which a multidisciplinary approach is used for diagnosis and treatment, as in our health facility where the present study was conducted.

Ethics Committee Approval: This research was approved by the ethics board of Kayseri City Training and Research Hospital, Kocasinan/Kayseri, Turkey (date: 14.05.2020, number: 2020/65).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – YE; Design – YE, KG; Supervision – KG; Materials – YE, KG; Data Collection and/or Processing – YE, KG; Analysis and/or Interpretation – KG; Literature Search – YE, KG; Writing – YE; Critical Reviews – KG.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

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