EDITOR'S CHOICE

Quantifying the Effect of Diabetes on Surgical Hand and Forearm Infections

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Purpose Diabetes has long been established as a risk factor for hand and forearm infections. The purpose of this study was to review the effect of glycemic factors on outcomes among diabetic patients with surgical upper-extremity infections. We hypothesized that diabetic inpatients may benefit from stronger peri-infection glycemic control.

Methods A prospective cohort study enrolled diabetic and nondiabetic surgical hand and forearm infections over 3 years. Glycemic factors included baseline glycosylated hemoglobin, blood glucose (BG) at presentation, and inpatient BG. Poor baseline control was defined as glycosylated hemoglobin of 9.0% or greater and poor inpatient control as average BG of 180 mg/dL or greater. The main outcome of interest was the need for repeat therapeutic drainage. Multivariable logistic regression quantified the association between diabetic factors and this outcome.

Results The study involved 322 patients: 76 diabetic and 246 nondiabetic. Diabetic infections were more likely than nondiabetic infections to result from idiopathic mechanisms, occur in the forearm, and present as osteomyelitis, septic arthritis, and necrotizing fasciitis. Diabetic microbiology was more likely polymicrobial and fungal. After first drainage, diabetic patients were more likely to require repeat drainage and undergo eventual amputation. Among diabetic patients, poor inpatient control was associated with need for repeat drainage.

Conclusions Diabetes exacerbates the burden of surgical upper-extremity infections: specifically, more proximal locations, deeper involved anatomy at presentation, broader pathogenic microbiology, increased need for repeat drainage, and higher risk for amputation. Among diabetic patients, poor inpatient glycemic control is associated with increased need for repeat drainage. *(J Hand Surg Am. 2017;■(■):■−■. Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Prognostic I.

Key words Diabetes, infections, glycemic control.

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DIABETES HAS LONG BEEN ESTABLISHED as a risk factor for hand and upper-extremity infections,[1] which produce pain, impaired quality of life, and even death.[2] Diabetes also exacerbates the burden of other infections, including community and nosocomial infections[3,4] and postsurgical infections after total knee replacement,[5] total hip replacement,[6] and posterior lumbar instrumented arthrodesis.[7] Diabetes more than doubles a patient's annual medical expenditure[8] and continues to increase in prevalence in the United States.[9] Given the increasing prevalence, consequent morbidity, and escalation in cost to the health care system, an in-depth understanding of how diabetes shapes pathology becomes increasingly important for all providers, including hand surgeons.

Our current understanding of diabetes and upper-extremity infections is based on retrospective case series. In general, infections in diabetic patients should be approached with more caution[10] because the surgical extent of infection tends to be more extensive than initially suspected[11] and time to resolution of an infection may be increased.[12] Amputation rates have ranged from 14% to 35%.[13–15] In one study, only 54% of patients healed without complications, whereas 20% died.[16] Internationally, the diabetic tropical hand is a well-known and highly morbid entity in the developing world, which shares the characteristics of poor baseline diabetic control, low patient socioeconomic status, relatively minor antecedent trauma, higher rates of necrotizing fasciitis, and higher risk of amputation and death.[17]

Importantly, these studies highlight how diabetes exacerbates the complexity and morbidity of upper-extremity infections. However, they are retrospective in nature, with relatively small sample sizes, and they fail to make comparisons with nondiabetic patients, which limits our understanding of how diabetes worsens disease. Therefore, the goals of this study were (1) specifically to delineate how diabetes alters the burden of distal upper-extremity infections with regard to infection mechanism, location, type, pathogenic microbiology, and clinical outcomes; and (2) to quantify whether diabetes-related glycemic factors correlate with clinical outcomes.

MATERIALS AND METHODS

This study was a prospective cohort of all surgical distal upper-extremity infections evaluated by our division at a single institution from April, 2014 to December, 2016. Inclusion criteria included infections located in the digits, thumb, hand/wrist, and forearm, and infections requiring initial procedural drainage (either at the bedside or in the operating room) with subsequent antibiotics. Exclusion criteria included nonsurgical infections (lymphangitis, herpetic whitlow, and cellulitis) and postoperative infections after elective procedures. We obtained institutional research board approval.

Patients were divided into 2 groups: diabetic and nondiabetic individuals, based on reported history and a documented glycosylated hemoglobin (HbA1c). Patient demographic characteristics, clinical presentation, microbiology results, surgical evaluation, and clinical outcomes variables were tabulated. Obesity was defined as body mass index of 30 kg/m^2 or greater. For diabetic patients, we measured baseline HbA1c, with HbA1c of 9.0% or greater defined as poor baseline control, which was consistent with US Department of Health and Human Services recommendations.[18] Clinical presentation variables included blood glucose (BG) at time of presentation, laterality of infection (dominant side or not), white blood cell count (with leukocytosis defined as a white blood cell count of 9.8×10^3 cells/mL^3 or greater), and infection mechanism, location, and type. Mechanism was categorized as burn, human or animal bite, intravenous drug use, other trauma, foreign body, dermatologic lesion, bacteremia/sepsis, or idiopathic. Bacteremia/sepsis indicated that the patient had sepsis with bacteremia, as evidenced by positive blood cultures at the time of consultation. Location was defined as the thumb, digit, hand/wrist, or forearm. Type was classified as paronychia, felon, superficial abscess, deep abscess, osteomyelitis, tenosynovitis, joint, or necrotizing fasciitis. A deep space abscess was defined as occurring within the thenar, hypothenar, midpalmar, dorsal subaponeurotic, or Parona space. Because patients can present with multiple locations and/or types simultaneously, the prevalence of each specific location and type for which patients presented was recorded for analysis; hence, percentages can total more than 100%.

Microbiology data included the number and type of different organisms on final cultures and Gram stain morphology. Cultures were categorized as methicillin-sensitive *Staphylococcus aureus*, methicillin-resistant *S aureus*, non-*S aureus* Gram-positive cultures, Gram-negative cultures, *Mycoplasma*, and fungus. Surgical evaluation variables included setting of first drainage and subsequent level of care. The setting for the drainage procedure could be either at the bedside or in the operating room, whereas the level of care could be either outpatient oral antibiotics or inpatient intravenous antibiotics. For inpatients, the average BG during hospitalization course was calculated. Average inpatient BG of 180 mg/dL or more was defined as poor inpatient glycemic control, which was consistent with American Diabetes Association recommendations.[19] Latency was defined as the time from consultation to first treatment, in minutes.

The main clinical outcome was the need for repeat drainage during treatment. Criteria for repeat drainage included any of the following: ascending erythema, residual or recurrent purulence, worsening