Impact of Diabetes on Outcomes in Hand Surgery

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Diabetes mellitus is associated with the development of several pathologic conditions of the hand, including carpal tunnel syndrome, Dupuytren disease, trigger digits, and limited joint mobility or cheiroarthropathy. In recent years, across a variety of surgical disciplines, increased emphasis has been placed on the impact of diabetes on treatment outcomes. This review provides an overview of the current literature regarding the effect of diabetes on outcomes of hand surgery for these common diabetes-related conditions. Taken as a whole, the best current evidence supports the efficacy of surgical interventions for the management of these conditions in diabetic individuals; however, additional research is required to determine whether the treatment outcomes are equivalent to those of nondiabetic patients, and whether diabetes is associated with an increased risk of complications. *(J Hand Surg 2011;36A:2067–2072. Copyright © 2011 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Diabetes mellitus, carpal tunnel syndrome, Dupuytren disease, limited joint mobility, stenosing tenosynovitis.

Diabetes mellitus is a metabolic disease resulting in the development of microvascular and macrovascular complications throughout the body. In the hand, diabetes has been associated with the development of carpal tunnel syndrome (CTS), Dupuytren disease, stenosing flexor tenosynovitis or trigger digits, and limited joint mobility (LJM).[1] Whereas these conditions affect nondiabetic individuals, they occur so frequently in diabetic patients that they have collectively been labeled "the diabetic hand."[2] Despite the strong linkage between diabetes and specific hand pathology, the exact pathophysiologic mechanism of the diabetic hand remains unknown.[1] In addition to the increased frequency of hand pathology, diabetic patients often present to the hand surgeon with multiple conditions or at an advanced stage of disease.[2,3]

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Received for publication July 2, 2011; accepted in revised form October 4, 2011.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

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0363-5023/11/36A12-0036$36.00/0
doi:10.1016/j.jhsa.2011.10.002

Across several surgical disciplines, increased emphasis has been directed toward investigating outcomes following operative management of diabetic patients. Previous studies have demonstrated that perioperative hyperglycemia is associated with increased rates of postoperative complications, particularly wound infections.[4,5] The presence of this hyperglycemic state results in impaired immune function,[4,5] change in vascular permeability,[4] and alteration of metabolic redox reactions.[4] This constellation of changes is thought to result in the creation of impaired host defenses leading to inferior surgical outcomes.[4,5]

Given that diabetic patients represent a large proportion of patients with typical hand pathology, such as CTS and trigger digits, it is essential to assess the treatment outcomes and potential complications in this patient population. The current review focuses on the outcomes of hand surgery in diabetic patients.

MATERIALS AND METHODS

We undertook a thorough review of recent English language literature focusing on the treatment outcomes of diabetic patients with carpal tunnel syndrome, Dupuytren disease, flexor tenosynovitis, and LJM. Based on this review, we present an overview of the operative outcomes and complications of hand surgery in diabetic patients.

CARPAL TUNNEL SYNDROME

There is a well-recognized association between diabetes mellitus and CTS with respect to both electrophysiologic parameters and patient symptoms. In the diabetic population, the incidence of CTS has been reported to be between 15% and 33%.[6] This represents a relative 10-fold increase compared with its incidence in the general population. Whereas the exact mechanism of CTS in the diabetic patient remains unknown, diabetics often present with more advanced nerve impairment than their nondiabetic counterparts.[3] Given the increased prevalence of CTS in diabetic patients, it is noteworthy that the clinical practice guidelines endorsed by the American Academy of Orthopedic Surgeons in 2009 failed to provide specific treatment recommendations for diabetic patients with CTS owing to a lack of sufficient evidence.[7]

Electrophysiological impairment occurs early in the course of diabetes. Up to 82% of newly diagnosed type 2 diabetics are reported to have nerve conduction abnormalities at the time of diagnosis.[8] In a longitudinal observational study of 1,284 type 2 diabetic individuals, one-third of all participants showed electrophysiologic evidence of CTS, although only one-sixth reported symptoms.[9]

Several attempts have been made to modify the natural history of CTS in diabetic patients, including the use of rehabilitation and glycemic control strategies. The use of rehabilitation to alleviate symptoms and improve hand function in diabetic patients has been demonstrated to be ineffective,[10] although that study was limited by its small sample size. Nonetheless, there does appear to be a potential role for improved glycemic control in modifying factors that predispose to CTS. A short-term improvement in glycemic control and serum triglycerides in mild to moderate diabetic sensorimotor polyneuropathy has been shown to result in a sustainable restoration of nerve function.[11] This evidence suggests that early recognition and control of diabetes could have a significant role in ameliorating peripheral neuropathy. It is unknown whether improved glycemic control in diabetic patients will affect the development of compression neuropathies such as CTS.

Diabetic patients undergo carpal tunnel release (CTR) 4 to 14 times more than the general population,[9] which is consistent with the increased incidence in this population. In diabetic patients, as with the general population, obesity is strongly associated with surgical intervention.[9] Diabetes has been suggested to be associated with poorer outcomes after CTR.[6] Given the high incidence of sensorimotor polyneuropathy in diabetic patients, it is reasonable to suggest that these patients may not obtain outcomes equivalent to those of nondiabetic patients. However, the evidence to support worse outcomes in diabetic patients after CTR is limited, and recent evidence has failed to consistently support this assumption.

There are a limited number of outcome-based studies investigating the efficacy of CTR in the diabetic population. These studies commonly identify 2 end points: symptomatic improvement and electrophysiological recovery postoperatively. A retrospective review of subjective outcomes after 20 CTR in 15 diabetic patients demonstrated that patients with little or no electrophysiologic evidence of median nerve compression, despite reporting numbness preoperatively, experienced poorer outcomes than patients with evidence of nerve compression.[12] The implication of this finding is unclear, given the lack of a nondiabetic control group and inclusion of patients without clear evidence of CTS. No significant difference in outcomes was identified in a long-term study following CTR in 10 diabetic patients compared with 50 nondiabetic patients. The authors did, however, report a trend of less pain relief in the diabetic patients.[13] Although that study provided a thorough preoperative and postoperative assessment of all included subjects, the value of the results is unclear owing to the inclusion of patients without clear evidence of CTS and the small sample size. Finally, a large retrospective study demonstrated similar self-reported outcomes after division of the carpal tunnel with a retinaculotome in 149 diabetic patients (213 hands) compared with 200 age-matched controls.[14] Unfortunately, the outcome measures are nonspecific and no analysis of the results was performed.

Four recent publications have specifically addressed the outcomes of diabetic patients after CTR compared with nondiabetic controls. Ozkul et al[15] demonstrated that 22 diabetic patients did not experience the same degree of improvement in either global symptom scores or electrophysiological measures as 25 nondiabetic subjects after open CTR. Nevertheless, both groups did exhibit significant improvements over the 1-year study. It is noteworthy that this study excluded insulin-dependent diabetics and grouped results based on number of hands, not number of patients. This finding is in partial distinction to a subsequent report of equivalent clinical and electrophysiological improvements in 24 diabetic patients, compared with 72 nondiabetic patients.[16] Two publications by Thomsen et al[3,17] provide additional evidence of the benefit of CTR in diabetic patients. In both studies, the 35 diabetic patients were documented to have greater median nerve dysfunction preoperatively, compared with the 31 nondiabetic pa-

tients, using nerve conduction studies and Semmes-Weinstein monofilament testing. After CTR, significant improvement in median nerve function was documented for both groups; however, the diabetic patients did not achieve the same outcome as the nondiabetic patients. Nevertheless, both groups exhibited a similar degree of relative improvement, but the worse preoperative status of the diabetic patients adversely influenced their ultimate outcome. Interestingly, the results from Thomsen and colleagues suggest that CTS in conjunction with peripheral neuropathy in diabetic patients does not preclude improvement after CTR. It is noteworthy that these 2 publications are based on the evaluation of the same patient population. Taken as a whole, these 4 studies suggest that CTR is an effective treatment for CTS in diabetic patients; however, it is not possible to estimate the magnitude of the effect, compared with nondiabetic patients, based on the outcome of 81 diabetic patients.

Several studies have compared surgical complications between diabetic and nondiabetic patients undergoing CTR. In 2004, Mondelli et al[16] identified no difference in number of surgical complications between diabetic and nondiabetic patients. Further studies have found no difference in terms of postoperative wound healing and infection rates in diabetic patients.[17,18] Harness et al,[18] investigating the role of antibiotic prophylaxis on CTR in 3,003 patients, demonstrated no differences in the rates of surgical site infections between diabetic (0.55%) or nondiabetic patients (0.33%). Despite the failure to document a difference in complication rates between diabetic and nondiabetic patients undergoing CTR in the aforementioned studies, it is possible that the inadequate sample sizes of these studies resulted in the inability to document a potentially meaningful difference between groups.

Taken as a whole, the best current literature suggests that diabetic patients with CTS can expect symptomatic and electrophysiological improvement after CTR. However, patients with more advanced median nerve dysfunction, as may be the case with diabetic patients, should be informed that their recovery may be incomplete. Moreover, there does not appear to be a notably increased risk of complications, such as wound-healing problems or infection within this patient population. The caveat of this assumption is that the previous studies of complications did not possess adequate power to detect small changes in risk.

DUPUYTREN DISEASE

Dupuytren disease is a benign fibroproliferative condition resulting in thickening and contracture of the palmar fascia.[19] In the diabetic population, the incidence of Dupuytren disease has been reported to be between 11% and 63%.[1,2] This represents a relative 2- to 8-fold increase compared with its incidence in the general population. A review of 821 cases of Dupuytren disease documented that diabetes was a major risk factor for the diagnosis and treatment of Dupuytren disease,[20] particularly for insulin-dependent diabetics. However, a recent review of 2,919 operated hands undergoing treatment for Dupuytren disease noted that 10.3% of patients had diabetes (approximately 7% in the general population), suggesting that diabetes may not be a strong predictive factor for Dupuytren disease requiring surgical intervention.[21]

Although Dupuytren disease is reported to occur more frequently in diabetic patients, the pathophysiology of the condition appears to be different in diabetic and nondiabetic individuals.[1] In the diabetic population, the middle and ring digits are more commonly affected, compared with the small and ring digits in the nondiabetic population.[2] Also, there is some evidence that the disease course in diabetic patients results in fewer symptoms[1] and less operative intervention.[22]

In the general population, the pathophysiology of Dupuytren disease has been well described.[19] In diabetic patients, however, it has been suggested that chronic hyperglycemia results in an increase in collagen crosslinking, leading to an inherent resistance to collagenase breakdown.[2] Risk factors that predispose diabetic patients to Dupuytren disease include increased age and duration of diabetes. Interestingly, it is unclear whether poor glycemic control is associated with an increased risk of developing Dupuytren disease.[1,2,20,23–25]

Despite a well-documented link between diabetes and Dupuytren disease, no studies have focused on operative outcomes in this population. One review suggested that operative outcomes in diabetic patients yield satisfactory results[2]; however, there is no published evidence regarding the outcomes of these patients.

It is also unclear whether the frequency of recurrence of Dupuytren disease after fasciectomy differs between diabetic and nondiabetic patients. In 2003, Arkkila[23] reported that diabetes was a potential risk factor for disease recurrence.[23] However, this statement is based on the finding of clinical recurrence in 5 of 6 diabetic hands (83%) in a total study group of 69 hands that demonstrated 49 recurrences (71%).[26] More recently, however, Degreef and De Smet[27] failed to identify diabetes as a risk factor for disease recurrence.

At present, it is not possible to provide evidence-based recommendations for the management of diabetic patients with Dupuytren disease. It is unknown whether

these patients experience outcomes and complications similar to those of nondiabetic patients, and whether the risk of recurrence is equivalent.

LIMITED JOINT MOBILITY

Limited joint mobility, or *cheiroarthropathy*, is considered a hallmark feature of the diabetic hand. It is characterized by impairment in extension at the metacarpophalangeal, proximal interphalangeal and distal interphalangeal joints.[1,2] Although the skin is frequently described as thick, tight, and waxy, these findings are not required for the diagnosis of this condition. Generally occurring bilaterally, LJM typically develops in the ulnar digits before presenting in the radial digits.[1] Limited joint mobility is a clinical diagnosis based on the inability of the patient to obtain full passive extension of the fingers. The pathophysiology of the condition is unknown and it is unclear whether some of these patients have concomitant Dupuytren disease or trigger digits.

The incidence of LJM in the diabetic population ranges from 8% to 76%.[1,2] The variability in reported rates of LJM in diabetic patients likely reflects differences in diagnostic methodology, as well as study population differences, such as type of diabetes, duration of disease, and glycemic control.[1,2] The pathophysiology of LJM is unknown; however, the development of LJM is believed to be influenced by chronic hyperglycemia, which generates increased crosslinking between collagen fibers.[2,28] In the diabetic population, authors have also postulated that microvascular disease may have an influential role in the development of LJM.[1,2] There is a strong association between the duration of diabetes, patient age, and presence of microvascular complications in LJM.[23] Microvascular complications such as diabetic retinopathy, coronary artery disease, and cerebrovascular disease have also been independently linked to the presence of LJM.[1,2]

Most patients with LJM report limited functional impairment, but patients presenting to hand surgeons may have clinically relevant fixed flexion deformities. Some studies have identified an increased frequency of multiple trigger digits in patients with LJM.[28] This finding is compatible with the previous report of notable improvement in both trigger finger and LJM after intrasheath steroid injections.[29] Ultrasound investigations by Ismail et al[30] demonstrated flexor tendon sheath thickening in patients with LJM independent of the presence of trigger finger, and a previous case report documented the benefit of tenolysis for this condition.[31] Although physiotherapy has been reported to be a potential treatment option for LMJ,[2] there are no data to support the use of splinting or therapy.

At present, there is no meaningful understanding of the pathomechanics of LJM, or how it should be treated. During this literature review, we were unable to identify any studies directly addressing treatment outcomes of LJM in the absence of trigger finger. The best current evidence suggests that patients could receive treatment with an intrasheath steroid injection,[29] with the understanding that it will result in a temporary elevation in serum glucose levels.[32] Anecdotally, the senior author has observed marked improvement in diabetic cheiroarthropathy after steroid injection in patients without evidence of trigger digits; however, there is no reliable evidence to support this practice.

TRIGGER DIGITS

The association between trigger finger and diabetes has been well described, with approximately 10% to 15% of all diabetic patients developing trigger finger during their lifetime.[2,33] In diabetics, triggering is thought to occur as a result of the effects of hyperglycemia on collagen metabolism and degradation.[34] Although the exact pathophysiology is not fully understood, it has been proposed that chronic hyperglycemia results in increased intermolecular linking within peritendinous collagen. This ultimately impairs collagen breakdown, resulting in the accumulation of collagen within tendon sheaths.[34]

There are several unique features regarding the presentation of trigger finger in the diabetic patient. Diabetic patients often present with index finger involvement,[34] multiple finger involvement,[35] and bilateral hand involvement.[34] Stahl et al[35] identified multiple finger involvement in as many as 60% of diabetic patients with trigger finger.[35]

Several treatment options are available for the management of trigger finger: conservative management, steroid injections, and surgical release. Steroid injections, often in combination with lidocaine, have been successfully used in the management of trigger finger. Within the nondiabetic population, steroid injections have resulted in success rates of approximately 60% after a single administration.[36] Within the diabetic population; however, the reported efficacy of steroid injections is variable, with recent literature reporting reduced treatment response rates.[35–38] Griggs et al[38] reported a 50% success rate in non–insulin-dependent diabetic patients and a 44% success rate in insulin-dependent diabetic patients. Nimigan et al[36] produced similar results when they compared nondiabetic patients (57% complete resolution of symptoms) and diabetic patients

(32% complete resolution of symptoms). Others suggested that the decreased efficacy of steroid injections in diabetic patients is related to the stage of the disease, as demonstrated by systemic manifestations such as nephropathy or neuropathy.[37,39] In addition to having lower success rates from steroid injections, diabetic patients also tend to experience a transient impairment in glycemic control after injection.[32] A recent double-blinded, prospective, randomized study demonstrated that after a trial of steroid injection, diabetic patients are 3 times more likely to require operative management for trigger finger compared with nondiabetic patients.[40] Taken together, the results of these previous studies strongly suggest that steroid injections are less efficacious in diabetic patients. Moreover, the results of the Baumgarten et al study[40] suggest that individuals with systemic manifestations of diabetes, such as neuropathy or nephropathy, are more likely to fail treatment with steroid injections.

Surgical outcomes from trigger finger release within the diabetic population have also been suggested to be less favorable compared with their nondiabetic counterparts. In a study by Stahl el al,[35] patient-reported treatment response to trigger finger release in diabetic patients was 77%, compared with 94% in nondiabetic patients. The incomplete success of the procedure was related to discomfort at the operative site or incomplete resolution of a flexion contracture at the proximal interphalangeal joint. This reported difference was not significant, and no major complications were noted in either diabetic or nondiabetic patients.

Although trigger digits are a frequent presenting symptom to hand surgeons, we remain limited in our ability to provide evidence-based guidelines for the management of diabetic trigger digits. There is level I evidence that steroid injections are less effective in the management of trigger digits in diabetic patients compared with nondiabetic patients. Nevertheless, it remains unclear whether steroid injections should remain the primary initial treatment for all diabetic patients, owing to the low-risk nature of this intervention. This lack of clarity is partially related to the absence of equivalent quality evidence regarding the outcomes and complications of surgical treatment of trigger digits in diabetic patients. If there was strong evidence that diabetic patients achieved near 100% success after A1 pulley release, without an increase in major complications, it would be reasonable to propose forgoing treatment with steroid injection, particularly in individuals with evidence or systemic complications of longstanding diabetes. However, there is currently inadequate evidence to determine whether diabetic patients achieve similar outcomes as nondiabetic patients after A1 pulley release, and whether the complications in diabetic patients remain primarily minor.

Diabetes is a frequent medical comorbidity in patients seeking care from hand surgeons. The 8% to 10% prevalence of diabetes in industrialized countries makes this a common condition for any patient population. Correspondingly, the increased incidence of CTS, trigger finger, and Dupuytren disease within this group of individuals makes diabetes an important consideration specifically for hand surgeons. Despite the high number of patients presenting with sequelae of the diabetic hand, there are limited data to guide current practice. There is strong evidence that trigger digits in diabetic patients do not obtain an equivalent response to steroid injections as in nondiabetic patients. Unfortunately, it is unknown whether diabetic patients experience equivalent symptomatic relief after A1 pulley release compared with nondiabetic patients, and whether the complications associated with this procedure remain primarily minor in nature. There is also reasonable evidence to suggest that CTR is a valid treatment option for diabetic patients with CTS. However, it is not clear whether the magnitude of the response is equivalent to that experienced by similarly affected nondiabetic patients. The best current evidence does not suggest a difference in the complications experienced by diabetic and nondiabetic patients undergoing CTR; however, the previous studies did not possess adequate sample sizes to detect small but potentially clinically important differences. Finally, there are simply no meaningful data to guide the care of diabetic patients with Dupuytren disease or diabetes-associated LJM/cheiroarthropathy.

Previous literature has demonstrated that poor glycemic control adversely affects surgical outcomes,[4,5] which may ultimately prove to be an important consideration in hand surgery. Several authors have also identified risk factors such as advanced age, increased duration of diabetes, and the presence of diabetes-associated microangiopathies that are predictive of hand complications and poor surgical outcomes in diabetic patients.[2,41] Nevertheless, we require a more fundamental understanding of the role of diabetes in the outcomes of the management of a number of common hand conditions before we can proceed to these more complex questions. The lack of recommendations regarding the management of CTS in the diabetic patient in the clinical practice guidelines endorsed by the American Academy of Orthopedic Surgeons in 2009 reflected the state of evidence regarding the management of these patients.[7] Over the past few years, we have increased

our basic understanding of the impact of diabetes on the outcomes of management of CTS and trigger digits. It is hoped that future studies will expand this basic understanding and will provide evidence regarding the best treatment options for diabetic patients with other hand conditions, such as Dupuytren disease and LJM.

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