The Presence of Limited Joint Mobility Is Significantly Associated with Multiple Digit Involvement by Stenosing Flexor Tenosynovitis in Diabetics

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ABSTRACT. ***Objective.*** Diabetes is associated with several disorders of the hand, including stenosing flexor tenosynovitis (SFTS). The feature of SFTS in diabetics is a higher prevalence of multiple digit involvement. We examined the magnitude of the tendency for involvement of more digits by SFTS in diabetic patients than in nondiabetic patients, and attempted to clarify the factors influencing multiple digit involvement by SFTS in diabetics.

Methods. The study comprised 302 diabetic patients with SFTS and 235 nondiabetic patients with SFTS. The total number of digits exhibiting SFTS within the 1-year period following the initial visit to the Department of Orthopaedic Surgery was investigated in a prospective manner. We compared the difference in the frequency of multiple digit involvement by SFTS between diabetic and nondiabetic patients using the chi-squared test. Multiple regression analysis was performed to examine the contribution of independent variables [defined as 12 factors including age, sex, type of diabetes, estimated duration of diabetes, HbA_{1c} values, carpal tunnel syndrome, Dupuytren contracture, limited joint mobility (LJM), de Quervain's disease, diabetic retinopathy, diabetic nephropathy, and dyslipidemia] to the total number of digits affected by SFTS in diabetic patients.

Results. Diabetic patients showed a significantly higher prevalence of multiple digit involvement than nondiabetic patients ($p < 0.0001$). Multiple regression analysis in diabetic patients revealed that the presence of LJM was positively associated with the prevalence of multiple digit involvement ($r = 0.626$, $p < 0.0001$).

Conclusion. LJM in diabetics is closely associated with SFTS involving multiple digits. (J Rheumatol First Release June 15 2009; doi:10.3899/jrheum.081024)

Key Indexing Terms:
DIABETES MELLITUS FLEXOR TENOSYNOVITIS LIMITED JOINT MOBILITY
STENOSING TENOSYNOVITIS TRIGGER FINGER

Microangiopathy has generally been confirmed to cause major serious complications in a diabetic condition, such as retinopathy, nephropathy, and neuropathy, that increase morbidity and mortality. In addition, there is increasing awareness that diabetes mellitus is also associated with a wide variety of rheumatic disorders of the hands, including stenosing flexor tenosynovitis (SFTS), carpal tunnel syndrome (CTS), Dupuytren contracture (DC), and limited joint mobility (LJM), some of which are often combined and can be potentially disabling. Although these hand disorders are also observed in nondiabetic patients, the prevalence is thought to be much higher in diabetic patients[1-3].

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SFTS, also known as trigger finger, is a fairly common hand disorder. The association between diabetes mellitus and SFTS was first suggested by Strom[4]. The initial symptoms of SFTS are characterized by the inability to flex and extend the fingers smoothly, followed by a triggering or snapping phenomenon with/without pain when the fingers are actively flexed or extended. The most severe symptom is locking of the fingers in flexion or extension. These consecutive phenomena are caused by disproportion between the flexor tendon and its surrounding ligamentous tendon sheath, in which smooth gliding of the flexor tendon within its sheath is restricted. The first annular (A1) pulley is the most responsible lesion in SFTS. Although the exact mechanisms of this phenomenon in diabetic patients remain uncertain, alterations in collagen metabolism in the tendon sheath under a hyperglycemic condition have been suggested[1-3,5-9]. Microangiopathy in diabetics is also suggested to be another underlying pathology[7]. SFTS has a reported prevalence ranging from 1.7% to 2.6% in the general population; however, the prevalence of SFTS in diabetic patients is reported to be between 10% and 20%[1-4]. We previously examined the response to intrasheath injection of triamci-

nolone for SFTS in diabetic patients, and analyzed diabetes-related factors including lipid metabolism, and found that HbA_{1c} values determine the outcome of this treatment. This is clear evidence that SFTS is a hyperglycemia-induced complication, because its clinical manifestation was closely related to HbA_{1c} values[10].

Another feature of SFTS in diabetic patients is the higher prevalence of multiple digit involvement than in nondiabetic patients[2,5,8]. To our knowledge, the predisposing factors have not been clearly elucidated. Surgical release of the A1 pulley is currently an accepted treatment for severe SFTS. However, postoperative complications, such as persistent pain or flexion contracture of the operated digits, are more common in diabetic than in nondiabetic patients[8]. These problems suggest that lesions associated with SFTS are more extensive in diabetics than in nondiabetics. Although de Quervain's disease is another common type of stenosing tenosynovitis that has not been related to a diabetic condition, the coexistence of SFTS, CTS, and de Quervain's disease is often encountered in clinical practice[11].

Taking these points into account, we examined the magnitude of the tendency for diabetic patients to have more digits involved by SFTS than do nondiabetic patients, and attempted to clarify the factors influencing multiple digit involvement by SFTS in diabetics, using statistical analysis.

MATERIALS AND METHODS

From July 1999, 702 patients with SFTS in the Department of Orthopaedic Surgery, Saiseikai Central Hospital, were candidates for the study. The following were excluded: (1) patients with rheumatoid arthritis, hemodialysis, gout, thyroid disease, osteoarthritis of the digits, or pyogenic tenosynovitis; (2) patients under 20 years of age at onset of SFTS; (3) patients taking steroids or hormone therapy on a regular basis; and (4) patients who were lost to followup during observation, or during followup, in whom it could not be determined whether SFTS symptoms occurred. The remaining 302 diabetic patients with SFTS and 235 nondiabetic patients with SFTS were the subjects of our study.

Diabetic patients with SFTS comprised 148 men and 154 women with a mean age of 62.3 years (range 26–83 yrs). Nondiabetic patients with SFTS comprised 92 men and 143 women with a mean age of 58.3 years (range 20–87 years). There was no significant difference in age between diabetic and nondiabetic patients. In diabetic patients, the estimated duration of diabetes was 16.4 ± 9.1 years, and HbA_{1c} was 7.6% ± 1.3%. Four patients in the diabetic group and 3 in the nondiabetic group had undergone carpal tunnel release because of symptoms of CTS before the onset of SFTS.

The diagnosis of SFTS was made by the presence of each of the following criteria: (1) triggering or snapping on motion, (2) tenderness over the A1 pulley, or (3) pain on extending or flexing the fingers passively. Although thickening of the A1 pulley in SFTS can be confirmed by palpating, this finding is sometimes mimicked by nodules or cords in DC. Exact differentiation between SFTS and DC is sometimes impossible. Therefore we excluded cases with painless thickening of the A1 pulleys without triggering or snapping from the diagnosis of SFTS. The diagnosis of diabetes mellitus was made by the second, third, and fourth authors, who are specialized in the treatment of diabetes according to the criteria published by the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus in 1997[12]. The total number of digits exhibiting SFTS within the 1-year period following the initial visit to the Department of Orthopaedic Surgery was investigated in each patient in a prospective fashion.

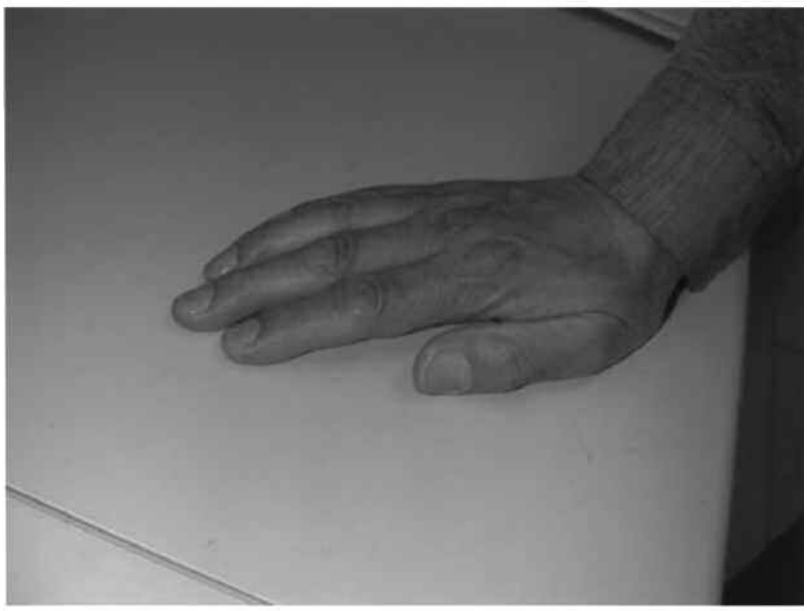
At the end of this study, we compared the difference in the frequency of multiple digit involvement by SFTS between diabetic and nondiabetic patients using the chi-squared test. Next, in the diabetic group, multiple regression analysis was used to examine the contribution of independent variables to the total number of digits affected by SFTS. Independent variables were defined as the 12 factors listed in Table 1. CTS was defined by the presence of paresthesia or hypesthesia in the palmar aspect of the thumb, index, and middle fingers, and/or positive Tinel's sign and/or Phalen test. When the diagnosis of CTS was uncertain, delayed median nerve conduction velocity in the palm-wrist tract was confirmed by an electrophysiological study. DC was defined by the presence of visible and/or palpable nodules, cords, dimpling, and/or tethering of the skin of the palms and digits. LJM was defined by the presence of a positive prayer sign (having patient hold the palmar surfaces of the digits together) and/or table sign (having the patient place the palms on a flat surface; Figure 1)[13]. Cases of DC showing a positive prayer sign or table sign were not defined as LJM. De Quervain's disease was defined by the presence of tenderness over the common sheath of the abductor pollicis longus tendon and the extensor pollicis brevis tendon at the radial styloid process and/or positive Finkelstein provocative test[11]. Diabetic retinopathy was assessed by experienced ophthalmologists using funduscopy. Diabetic nephropathy was assessed by the presence of microalbuminuria (albumin excretion rate ≥ 20 μg/min) or clinical proteinuria. Dyslipidemia was defined by the presence of high serum

Table 1. Association of various independent variables and total number of digits affected by stenosing flexor tenosynovitis within the 1-year period following the initial visit to the Department of Orthopaedic Surgery in the diabetic group, using multiple regression analysis.

	n (%)*	Regression Coefficient	p
Age, yrs		–0.005	0.4899
Sex		0.127	0.3432
Male	148 (51)		
Female	154 (53)		
Type of diabetes		–0.181	0.4685
Type 1	26 (69)		
Type 2	276 (51)		
Estimated duration of diabetes, yrs		0.012	0.1483
HbA_{1c}, %		0.025	0.6229
Carpal tunnel syndrome		0.384	0.1111
No	279 (52)		
Yes	23 (61)		
Dupuytren contracture		0.227	0.2947
No	271 (51)		
Yes	31 (68)		
Limited joint mobility		0.626	< 0.0001
No	162 (37)		
Yes	140 (70)		
de Quervain's disease		0.263	0.3872
No	288 (51)		
Yes	14 (71)		
Diabetic retinopathy		0.013	0.9255
No	153 (46)		
Yes	149 (59)		
Diabetic nephropathy		–0.166	0.2435
No	213 (54)		
Yes	89 (49)		
Dyslipidemia		0.081	0.518
No	161 (50)		
Yes	141 (55)		

* Percentage of multiple digit (2 or more) involvement in each subgroup.

A



B

Figure 1. A. Prayer sign (inability to hold the palmar surfaces of the digits together). B. Table sign (inability to place the palmar surfaces of the digits on a flat surface).

triglyceride concentration (≥ 150 mg/dl) during a fasting state, high serum total cholesterol concentration (≥ 220 mg/dl), high serum low-density lipoprotein cholesterol concentration (≥ 140 mg/dl), low serum high-density lipoprotein cholesterol concentration (≤ 40 mg/dl), or use of statin medication on a regular basis. Each of the defined variables was based on information collected at the patient's first visit (or as close as possible to the first visit) to the Department of Orthopaedic Surgery. All data were analyzed with the statistical software StatView 5.0 (SAS Institute, Japan). A p value < 0.05 was regarded as statistically significant.

This study was conducted in compliance with the Declaration of Helsinki. We obtained approval from the Ethics Committee of Saiseikai Central Hospital and informed consent from every patient.

RESULTS

Frequency-distribution diagrams for the total number of digits affected by SFTS in diabetic and nondiabetic groups within the 1-year period following the initial visit to the

Department of Orthopaedic Surgery are shown in Figure 2. One hundred forty-four patients (48%) in the diabetic group had one digit involved and 158 patients (52%) had 2 or more digits involved. In contrast, in the nondiabetic group, 189 patients (80%) had one digit involved and 46 patients (20%) had 2 or more digits involved. The diabetic group had a significantly higher prevalence of multiple digit involvement ($p < 0.0001$).

Multiple regression analysis of the 302 patients in the diabetic group revealed that only the presence of LJM was positively associated with the prevalence of multiple digit involvement with strong significance ($r = 0.626$, $p < 0.0001$), as shown in Table 1.

Although the association was not significant, the presence of CTS in diabetic patients tended to be positively associated with the prevalence of multiple digit involvement ($r = 0.384$, $p = 0.1111$).

DISCUSSION

We confirmed that the diabetic group had a significantly higher prevalence of multiple digit involvement in comparison to the nondiabetic group, as suggested previously[5,9]. Although we excluded cases with systemic illness including rheumatoid arthritis, gout, thyroid disease, and renal failure, which are thought to be associated with multiple digit involvement by SFTS, we did not assess work-related disorders in each case. It is generally believed that repetitive or forceful activities are the leading cause of SFTS. However, Trezies, *et al* investigated the occupational history in 178 patients with SFTS and concluded that occupation is not an etiologic factor[14]. On the other hand, in some cases, no possible etiologic factor that could cause SFTS with multiple digit involvement can be identified.

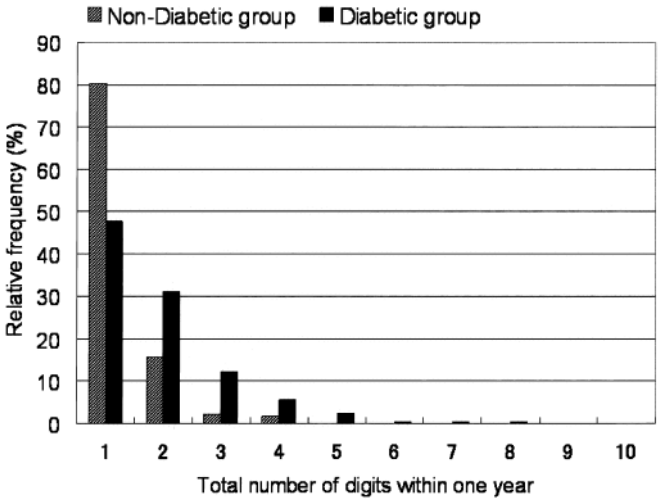


Figure 2. Frequency distribution of total number of digits affected by stenosing flexor tenosynovitis in diabetic and nondiabetic groups within the 1-year period following the initial visit to the Department of Orthopaedic Surgery, Saiseikai Central Hospital.

LJM was originally defined as joint contractures in juvenile diabetics with short stature[15]. Later, LJM was widely recognized as a common early complication in diabetics, which is simply characterized by flexion deformity of the digits with thick, tight, waxy skin[13]. The pathogenesis of LJM has previously been assumed to be disturbance of glucose metabolism, including nonenzymatic glycosylation of collagen, increased crosslinking of collagen and resistance to collagenase, or increased hydration of collagen mediated by the aldose reductase pathway[8,13]. These mechanisms could lead to capsular thickening, dermal fibrosis, and decreased elasticity of connective tissue, which may all be responsible for the development of joint contractures. However, no conclusive evidence has yet been elucidated. There is some opinion that SFTS and LJM frequently occur in the same patient, and that the symptoms of SFTS and LJM are markedly improved by intrasheath injection of steroid, suggesting that SFTS is an important etiologic component of LJM[8]. Ismail, *et al*[6] showed using ultrasound scans that the A1 pulleys were significantly thicker in diabetic patients with LJM than in those without LJM and nondiabetic patients, suggesting that thickening of the A1 pulleys is an integral part of LJM. Interestingly, all patients with LJM had evidence of microvascular complications[6]. Although they did not correlate the thickening of A1 pulleys with SFTS, we consider that thickening of the A1 pulleys is a manifestation of SFTS. We showed in this report that the presence of LJM in diabetic patients was significantly associated with greater multiple digit involvement by SFTS. As LJM has been correlated with diabetic microangiopathy[6,13,15], ischemia, edema, or fibrosis in a wide variety of connective tissues could be induced under a diabetic condition, resulting in thickening of the A1 pulleys in multiple digits. The flexor tendon itself may also be thickened in diabetics. However, this possibility has not been investigated because resection of flexor tendons for research is ethically unrealistic. The condition of the flexor tendons may be investigated using ultrasound scans in the future.

We also found that the presence of CTS in diabetic patients may be associated with multiple digit involvement by SFTS; however, the association was not significant. This was probably because only 23 of 302 patients (8%) had CTS in this study. Although some researchers have related carpal tunnel release to the occurrence of SFTS[16,17], only 4 of 23 patients had a history of operation for CTS in this study. CTS is sometimes characterized by multiple finger stiffness with no evidence of abnormal electrophysiological findings[18,19]. In addition, multiple finger stiffness with CTS is sometimes present only in the morning. Thus, it is possible that we failed to detect cases of CTS in which finger stiffness in the morning was the only symptom. Recently, the main pathology of CTS has been suggested to be thickening of the flexor tenosynovium within the confined space of the carpal tunnel rather than the median nerve itself. Neal, *et al*

investigated the pathology of CTS and reported a variety of vascular lesions, including thickening of vessels walls, intimal hyperplasia, and thrombosis, in the thickened tenosynovium at the level of flexor retinaculum, suggesting ischemia, edema, and fibrosis[20].

Although vascular pathology seems to be responsible in patients with SFTS involving multiple digits, diabetes-related factors, including lipid metabolism, did not show a significant relation in our study. Moreover, we did not assess the presence of diabetic neuropathy or the association between the severity of LJM[15] and the presence of multiple digit involvement by SFTS in diabetics. It is possible that the proteinous component of synovial fluid may be exposed to glycation or oxidative stress, causing changes of mechanical structures of tendon sheaths. Further research is necessary to determine the underlying mechanism of SFTS with multiple digit involvement in diabetic patients.

Our study provides evidence that diabetic patients with limited joint mobility have significantly higher risk of stenosing flexor tenosynovitis involving multiple digits.

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