Quantification of Early Subclinical Limited Joint Mobility in Diabetes Mellitus

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Limited joint mobility (LJM) has been described in juvenile diabetic patients by Rosenbloom et al.; similar abnormalities are also present in adult diabetes. This modification may be associated with a high risk of microvascular complications. We tested the use of a goniometer in measuring subclinical joint limitation in 50 adult diabetic patients without overt, i.e., clinically evident, LJM as described by these authors. This diabetic population was compared with 118 nondiabetic adult controls. We found significant changes in hand mobility between the two groups for wrist flexion and extension of the 3rd and 5th fingers ($P < 0.001$). Age was correlated to wrist flexion, wrist extension, and proximal interphalangeal flexion of the little finger. Wrist extension correlated with duration of diabetes ($r = -0.37$, $P < 0.01$). Heavy manual activities significantly limited all motions except wrist and 5th finger metacarpophalangeal flexion. Early systematic examination by goniometry may prove to be a sensitive, quantitative, and inexpensive way of detecting joint stiffness at an early stage. DIABETES CARE 1985; 8:329–32.

Limited joint mobility (LJM) associated with diabetes has been clinically appraised on a subjective yes/no basis by many authors since Rosenbloom et al.[1–6] In its caricatural aspect the syndrome combines flexion contractures of the distal and proximal interphalangeal joints, resulting in the inability to approximate the palmar surfaces of the hands,[2,3] a passive resistance to finger extension,[4] and, in approximately one-third of the cases studied, thick, tight, waxy skin. In some studies, the joint limitations were present in about 30% of insulin-dependent diabetic subjects as against 1% of nondiabetic control subjects.[2,3,5] We assumed that a more discrete subclinical joint limitation, accessible only to objective measurement, precedes this constituted syndrome. If this assumption is correct, we might have an objective method for quantifying this complication, thus facilitating epidemiologic studies.

METHODS AND PATIENTS

Methods. We measured by goniometer (Figure 1) the six following joints on the predominant hand: maximal wrist flexion, maximal wrist extension, maximal flexion of the metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joints of the 5th finger, and maximal passive extension of the MCP joints of the 3rd and 5th fingers. We considered that maximal extension and flexion were reached when pain occurred. This approach is based on the hypothesis that both diabetic and nondiabetic subjects have the same threshold for pain when joints are "forced."

Reproducibility of the method was estimated in the first seven control subjects examined, measurements being taken twice at 4–5-day intervals by two operators. Intraobserver coefficient of variation was at worst 8% and interobserver coefficient of variation 7%. All measurements for the study were thereafter carried out by one operator only (M.L.).

Patients. Joint mobility was studied in 50 diabetic patients (32 type I and 18 type II). Patient characteristics are shown in Table 1. Type I diabetes was defined on the basis of clinical characteristics (age < 30 yr, history of ketosis or ketoacidosis, major weight loss or low weight at onset of diabetes). Type II diabetes was defined on the basis of absence of the above criteria.

Type I diabetic subjects were treated by conventional subcutaneous insulin injections (one injection per day in 2 cases, two injections per day in 27 cases, and three injections per day in 3 cases).

Diabetic complications were present as follows: (1) retinopathy—60% of patients were without retinopathy (32 cases),

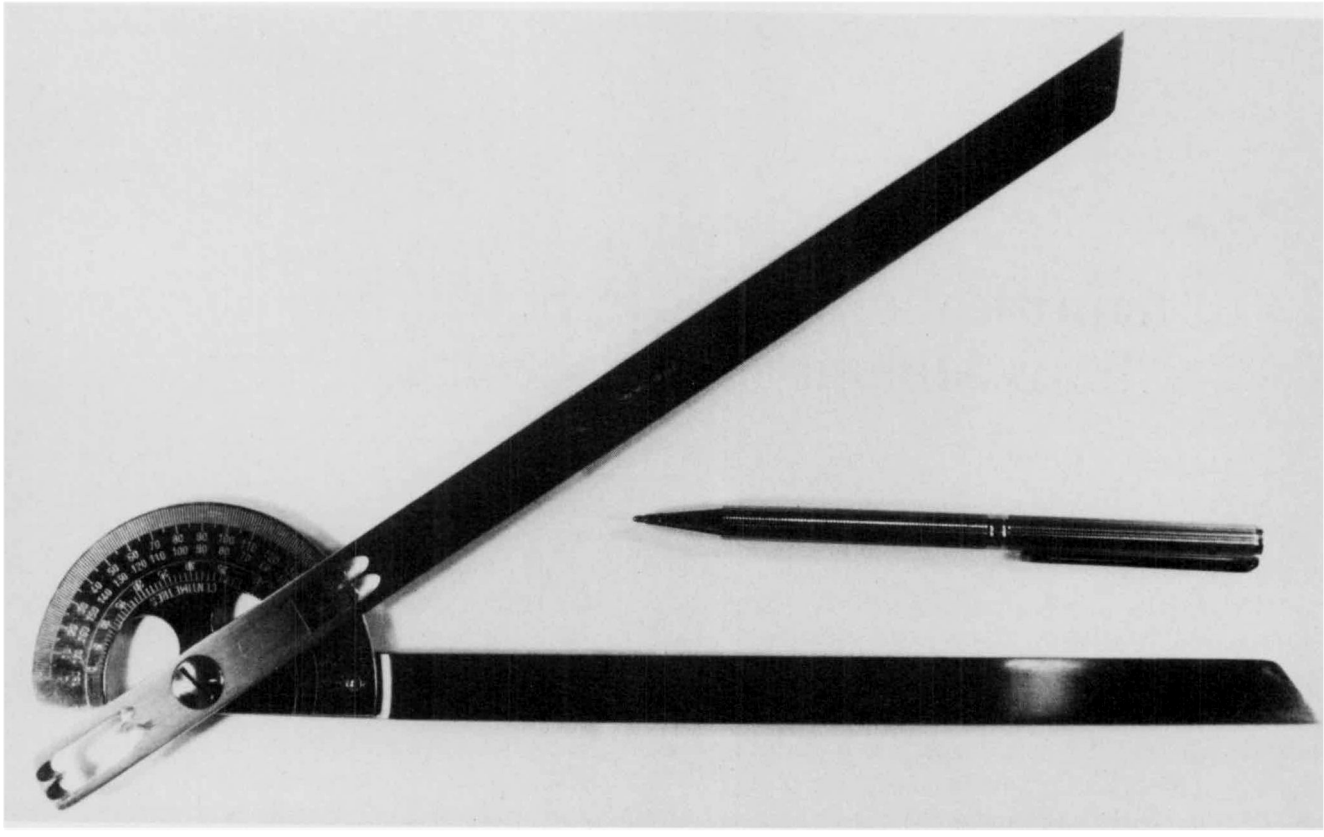

FIG. 1. Houdre's metallic goniometer.

24% with microaneurysms and/or microhemorrhages (12 cases), 16% with new vessels (8 cases); (2) neuropathy—50% without (25 cases), 20% with abolished reflexes of the lower limbs (10 cases), 30% presenting symptoms (pain or paresthesia) of the lower limbs (15 cases); (3) cardiovascular disease—76% without clinical evidence of CVD (38 cases), 10% with angina pectoris and/or myocardial infarction (5 cases), 12% with obstructive vascular disease of the lower limbs (6 cases), 2% with obstructive vascular disease and angina pectoris (1 case); (4) nephropathy—none (mean plasma creatinine was 72 ± 21 μmol/L). The degree of glycemic control was not studied since we considered that control at the time of experiment was irrelevant to the study of a long-term complication. We excluded from our study subjects who were clinically affected by overt LJM (i.e., those who were visibly unable to approximate the palmar surface of both hands). We included subjects presenting Dupuytren's contractures defined by visible and/or palpable nodules on the palm, whether or not associated with visible contractures of the MCP and PIP joints of the 5th, 4th, or 3rd fingers.

Results were compared with those obtained in 118 nondiabetic controls carefully matched for age and sex and taken among staff and inpatients (43 ± 16 yr in both groups).

Professional activities and hobbies that could conceivably modify hand mobility were roughly classified as either heavy manual work (i.e., gardening, bricklaying) or as skilled and nonmanual occupations (white-collar workers, pianists, students).

Statistical analysis used the chi-square test with Yates' correction when necessary and analysis of variance. Results are given as mean ± SD.

TABLE 1
Characteristics of diabetic subjects

	Type I	Type II
N	32	18
Male/female ratio (M/F)	16/16	7/11
Age (yr)	35 ± 14	55 ± 13
Weight (kg)	68 ± 5	78 ± 9
Height (cm)	169 ± 6	165 ± 5
Diabetes duration (yr)	12 ± 8	10 ± 7
Treatment (number of cases)	Insulin Once = 2 Twice = 27 Three times = 3	Diet alone = 4 Diet + B* = 12 Diet + B + S† = 2

Results are given as mean ± SD.
*B, biguanides.
†S, sulfonylureas.

TABLE 2
Maximal joint motion angles in diabetic and nondiabetic subjects

	Wrist		5th finger			3rd finger MCP extension (degrees)
	Flexion (degrees)*	Extension (degrees)	MCP† flexion (degrees)	PIP‡ flexion (degrees)	MCP extension (degrees)	
Nondiabetic (N = 118)	80 ± 10	58 ± 12	94 ± 7	99 ± 7	56 ± 19	33 ± 14
Diabetic (N = 50)	74 ± 10	58 ± 19	92 ± 6	98 ± 8	43 ± 19	25 ± 12
P§	<0.001	NS	NS	NS	<0.001	<0.001

*Mean ± SD.
†MCP: metacarpophalangeal joint.
‡PIP: proximal interphalangeal joint.
§Significance levels are indicated only for P value < 0.05; NS = nonsignificant.

RESULTS

Results on joint motions in diabetic and control subjects are shown in Table 2. We found no statistical difference between type I and type II diabetic subjects even when age was taken into account; both were therefore grouped together for further study.

Significant differences appear between diabetic and control subjects for three joint motions: wrist flexion and extension of the 5th and 3rd fingers ($P < 0.001$). The conventional level of statistical significance was almost reached for the metacarpophalangeal flexion of the 5th finger ($P < 0.06$).

Aging correlated significantly and negatively with hand motions in the diabetic population as well as in controls. The following correlations were found, respectively, in diabetic and in control subjects: for wrist flexion $r = -0.46$, $P < 0.001$ versus $r = -0.60$, $P < 0.001$; for wrist extension $r = -0.32$, $P < 0.03$ versus $r = -0.34$, $P < 0.001$; and for PIP flexion of the 5th finger $r = -0.04$, NS versus $r = -0.34$, $P < 0.001$.

Duration of diabetes correlated only with wrist extension ($r = -0.37$, $P < 0.01$).

No systematic correlation was found concerning joint limitation and sex or BMI. Sex correlated, in the population as a whole, only to wrist extension (54 ± 11 in men versus 62 ± 10 degrees in women; $P < 0.0001$), to 5th finger MCP extension (49 ± 20 versus 55 ± 20 degrees; $P < 0.05$), and to 3rd finger MCP extension (28 ± 13 versus 33 ± 15 degrees; $P < 0.03$). This was not found in the diabetic subgroup where differences between men and women for the six hand

TABLE 3
Relationship between diabetic and control subjects when professional activity is taken into account

	Wrist		5th finger			3rd finger MCP extension (degrees)
	Flexion (degrees)*	Extension (degrees)	MCP flexion (degrees)	PIP flexion (degrees)	MCP extension (degrees)	
Nonmanual profession (skilled and no professional activity)						
Controls (N = 105)	81 ± 9	60 ± 12	94 ± 8	100 ± 7	56 ± 20	33 ± 15
Diabetic subjects (N = 37)	75 ± 10	60 ± 10	92 ± 5	99 ± 8	47 ± 18	27 ± 11
Heavy manual work						
Controls (N = 13)	71 ± 7	48 ± 9	94 ± 6	94 ± 8	53 ± 15	30 ± 10
Diabetic subjects (N = 13)	72 ± 10	52 ± 8	91 ± 6	95 ± 8	31 ± 20	17 ± 11
Significance level† between controls and diabetic subjects adjusted on the presence or not of heavy work	NS	NS	NS	NS	P < 0.001	P < 0.001
Significance level† between heavy work or not adjusted on the presence or not of diabetes	P < 0.01	P < 0.001		P < 0.01	P < 0.05	P < 0.03

*Mean ± SD.
†Significance levels are indicated only for P values < 0.05.

motions were as follows: wrist flexion = 76 ± 10 versus 73 ± 11°, NS; wrist extension = 54 ± 10° versus 60 ± 9°, $P < 0.05$; 5th finger MCP flexion = 93 ± 5° versus 91 ± 6°, NS; 5th finger PIP flexion = 100 ± 10° versus 96 ± 7°, NS; 5th finger MCP extension = 39 ± 21° versus 46 ± 17°, NS; and 3rd finger MCP extension = 23 ± 12° versus 26 ±11°, NS.

Body mass index was not correlated to the three most significant joint motions: wrist flexion ($r = -0.13$, NS in all subjects and $r = -0.17$, NS in diabetic subjects); 5th finger MCP extension ($r = -0.04$, NS in all subjects and $r = 0.08$, NS in diabetic subjects); and 3rd finger MCP extension ($r = -0.10$, NS in all subjects and $r = 0.05$, NS in diabetic subjects). For the other motions results are as follows: wrist extension ($r = 0.03$, NS in all subjects versus $r = 0.08$, NS in diabetic subjects); 5th finger MCP flexion ($r = -0.24$, $P < 0.002$ in all subjects and $r = -0.34$, $P < 0.02$ in diabetic subjects); and 5th finger PIP flexion ($r = -0.27$, $P < 0.001$ in all subjects and $r = -0.21$, NS in diabetic subjects).

A significantly ($P < 0.02$) uneven distribution of professional activity was found between diabetic and nondiabetic subjects since only 11% of controls were heavy manual workers versus 26% in diabetic subjects. As shown in Table 3, wrist flexion, wrist extension, 5th finger PIP flexion and MCP extension, and 3rd finger MCP extension were significantly more limited in heavy manual workers than in others, regardless of the presence of diabetes. However, the difference between diabetic and control subjects remains valid and at a high degree of significance ($P < 0.001$) for 5th and 3rd finger MCP extension when the relationship with professional activity is taken into account.

We found a similar percentage of clinically evident Dupuytren's contractures in both groups (9% in controls and 12% in diabetic subjects). Though these contractures did, of course, influence joint mobility, particularly for 5th and 3rd finger extension, when subjects with Dupuytren's contractures were removed from the study, the difference between diabetic and control subjects remained the same.

DISCUSSION AND CONCLUSION

We found a significant decrease in joint mobility (LJM) in diabetic patients compared with controls in subjects without obvious LJM on direct clinical appreciation. This subclinical limitation probably corresponds to an early phase of LJM, which can be quantitatively appraised by means of a goniometer.

Various factors other than the presence of diabetes play a part in hand stiffness: aging, sex, BMI, heavy manual professional work or hobby, and the presence of Dupuytren's contractures. When these interfering factors were taken into account, differences between diabetic and nondiabetic subjects remain unchanged for 5th and 3rd finger MCP extension. However, they may partially explain the dispersion of the results and the overlap between diabetic and control values. This overlap means that only an extreme value can distinguish between the normal and the pathologic. Nevertheless, it is probable that, for each individual, repeated measurements at regular intervals will reveal at an early stage the onset of some degree of hand stiffening, thereby making this sign a marker of evolving lesions rather than a diagnostic tool.

The prevalence of Dupuytren's contractures in the normal population is consistent with the survey of Heathcote et al.,[7] who found a prevalence of 13% in nondiabetic versus 19–42% in diabetic subjects. Our study was not designed to establish a relationship between joint angles and late complications of diabetes. Further studies along these lines are now presently being undertaken. However, since it has been suggested by Rosenbloom that LJM is predictive of a high risk of microvascular complications, this method might prove to be an early, quantitative way of conducting epidemiologic studies on a larger group of subjects in order to confirm this hypothesis.

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