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ORIGINAL REPORT

ACTIVITY LIMITATIONS BEFORE AND AFTER SURGICAL CARPAL TUNNEL RELEASE AMONG PATIENTS WITH AND WITHOUT DIABETES

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Objectives: **To evaluate activity limitations before and after carpal tunnel release among patients with and without diabetes, to explore differences between genders and the influence of grip strength on activity limitations.**
Design: **Prospective case-control study.**
Patients: **Thirty-three patients with diabetes and carpal tunnel syndrome (CTS) were age and gender matched with 30 patients without diabetes having idiopathic CTS.**
Methods: **Activity limitations were assessed pre-operatively, 3 and 12 months after surgery, with the self-administered Evaluation of Daily Activities Questionnaire (EDAQ) containing 102 activity items in 11 dimensions and 3 additional male-activity-oriented dimensions including 22 items.**
Results: **For all dimensions the mean score was higher for patients with diabetes compared with patients without diabetes. This indicates a more pronounced activity limitation for patients with diabetes. However, no statistical differences between the two groups could be demonstrated. In general, females have significantly higher activity limitation scores than males.**
Conclusion: **CTS creates a broad variety of activity limitations for affected patients. After carpal tunnel release a significant alleviation of these limitations occurs within the first 3 months. Activity limitations seem not to be related to diabetes, but were more pronounced in women than in men, probably due to reduced grip strength.**

Key words: carpal tunnel syndrome; diabetes mellitus; activities of daily living; gender; grip strength.

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INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy in the upper extremity. In patients with diabetes mellitus, the reported prevalence of CTS is as high as 15% and increases up to 30% in the presence of diabetic peripheral neuropathy (1, 2). In addition to CTS, diabetes mellitus is associated with a series of pathological hand manifestations, known together as "diabetic hand syndrome". These abnormalities, which are strongly associated with duration of diabetes, include: Dupuytren's disease, limited joint mobility, flexor tenosynovitis and CTS (3–5).

The primary symptoms of CTS involve numbness and paresthesias, with or without pain, in the part of the hand innervated by the median nerve. These symptoms are often aggravated during sleep and triggered in the daytime by static or repetitive action of the hand. As functional disturbances, patients typically describe muscle weakness and/or clumsiness of the hand.

Only a few studies on diabetic hand disorders and its impact on activities of daily living have been published. Duration of diabetes was found to be associated with more severe neuropathy and increased activity limitations in a comparison of patients with type 2 diabetes, impaired glucose tolerance and normal glucose tolerance (6). Decreased hand grip strength was shown to correlate with functional disability of the hands in patients with type 2 diabetes compared with controls (7). Finally, a cohort study on patients with type 1 and type 2 diabetes, demonstrated that functional hand disturbances were related to impaired muscle function as well as the presence of CTS (8).

We have demonstrated previously that patients with type 1 and type 2 diabetes having CTS obtain the same beneficial clinical outcome (perception of touch, grip strength, patient satisfaction) after carpal tunnel release as patients without diabetes (9). However, the physical scores of the generic health-related quality of life measure, Medical Outcome Short-Form-36 (SF-36), were decreased before as well as after carpal tunnel release in the patient with diabetes (10). Such differences may be due to mobility impairment and dysfunction in daily activities as a consequence of diabetes complications and comorbidities (11).

It has been recommended that outcome measures after carpal tunnel release should not only reveal resolution of symptoms, but also assess activity limitations (12). The Boston Carpal Tunnel Questionnaire is a frequently used disease-specific measure of symptom severity and functional status designed explicitly for patients with CTS (13, 14). In general, however, a total score, and not the results for the individual functional items, have been reported (15, 16). As a consequence, specified assessment of activity limitations before and after carpal tunnel release is limited. Such information is valuable, as it mirrors the severity of the disease as viewed from the patients'

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perspective. In addition, it provides the basis for possible interventions in order to improve patient independence and satisfaction in daily activities. Furthermore, it would enable the development of more accurate patient information and sets rational expectations for outcomes after surgery.

The objectives of this study were: (*i*) to describe and compare activity limitations before and after surgical carpal tunnel release, between a consecutive series of patients with diabetes and CTS and an age- and gender-matched series of patients without diabetes having idiopathic CTS; (*ii*) to investigate differences in activity limitations between male and female patients; and (*iii*) to assess the impact of grip strength on activity limitations.

METHODS

Over a 3-year period (2004–2007) consecutive patients referred to our outpatient clinic with type 1 or type 2 diabetes and duration of CTS of at least 6 months, were invited to participate in the study (9). Patients with diabetes were age and gender matched with patients without diabetes having idiopathic CTS. The Regional Ethical Review Board at Lund University approved the study (LU 508-03). All patients gave written informed consent to participate.

Eligibility criteria

The diagnosis of CTS was based on clinical history and symptoms that included paraesthesia and/or pain in at least two of the fingers innervated by the median nerve. Night symptoms often occurred and were usually relieved by changing posture and/or shaking the hand. Daytime symptoms were often caused by static or repetitive hand function. Other symptoms included weakness and loss of dexterity of the hand. Physical examination for sensory loss, thenar muscle weakness, Tinel's sign and Phalen's test were used to reinforce the diagnosis. The diagnosis of CTS was confirmed by nerve conduction study demonstrating reduced antidromic sensory conduction velocity in the carpal tunnel segment (< 44 m/s) (17). Exclusion criteria were: previous carpal tunnel release in the hand under study, clinical signs of focal nerve entrapments other than CTS, cervical radiculopathy, inflammatory joint disease, renal failure, thyroid disorders, previous wrist fracture on the affected side, daily long-term exposure to vibrating tools, pregnancy, and inability to complete a self-questionnaire due to cognitive disorder or language problems.

In addition, all non-diabetic patients had performed an oral glucose tolerance test to exclude un-diagnosed diabetes (18).

Surgical procedure

The same surgeon performed the operations, consisting of a palm-only, slightly curved, 3-cm long incision between the distal wrist crease and Kaplan's cardinal line. The transverse carpal ligament and the distal 1 cm of the deep antebrachial fascia were divided. No additional procedures were performed. Patients were advised to carry out range of motion exercises following a written programme and were encouraged to use the hand for lighter daily activities. No additional rehabilitation was offered. Dressings and sutures were removed 12–14 days after the operation.

Study procedure

Patients were examined preoperatively, and 3 and 12 months after surgery. All clinical examinations were performed independently by the same occupational therapist. At the same time, the Evaluation of Daily Activities Questionnaire (EDAQ) was presented for the patient, which afterwards was completed at home and returned using a stamped addressed envelope.

Evaluation of Daily Activities Questionnaire

The EDAQ is a self-administered questionnaire that was initially developed to evaluate performance of daily activities in patients with rheumatoid arthritis (19, 20). The instrument consists of 102 daily activity items distributed into 11 activity dimensions: eating/drinking, toileting, dressing, bathing, cooking, mobility indoors, cleaning, washing/clothes care, transferring, communication, mobility outdoors/shopping, with answers rated from 0 to 3 (0 = without any difficulty, 1 = with some difficulty, 2 = with much difficulty, and 3 = unable to perform). Accordingly, a higher score indicates more severe activity limitation.

As the EDAQ questionnaire was designed primarily for patients with rheumatoid arthritis and a majority of patients with rheumatoid arthritis are women, the items predominantly reflect domestic activities. Therefore, 22 additional activity items considered important and difficult to perform for men with hand injury were included. These additional items have been used previously in the evaluation of daily activities among vibration-exposed male workers (21, 22). The items are distributed into 3 additional dimensions; home maintenance (change light bulb, use hammer and nail, use screwdriver, work with vibrating machine, lifting and carrying, work outdoors in cold weather, light gardening, heavy gardening, use motor lawnmower and use pruning shears), mobility with car (open car door, turn car key, use steering wheel, change gear, wash car, car maintenance) and miscellaneous (use manual and electric razor, writing, turn a page in book/paper, use computer and computer mouse). The rating score for the additional items was the same as for the EDAQ.

For each dimension, the mean score was calculated by adding patient ratings and dividing by the number of items. For each item, the mean score was calculated by adding patient ratings and dividing by the number of patients.

Study population

A total of 36 patients with diabetes and CTS entered the study. Preoperatively, 1 female patient was excluded due to diagnosed thyroid dysfunction. One patient missed the 12-week examination due to hospitalization. The patients with diabetes were matched with 36 patients without diabetes having idiopathic CTS. From this group, 3 male patients were excluded due to diagnosed diabetes and an additional 2 male patients were excluded due to signs of peripheral neuropathy.

After inclusion, refusal to complete, or only partial completion of the EDAQ questionnaire resulted in the exclusion of 3 additional patients. Thus, the study population comprised 33 patients with diabetes and CTS, and 30 patients without diabetes having idiopathic CTS.

Statistical analysis

Comparison of variables between and within groups was carried out using a non-parametric Mann-Whitney *U* test and Wilcoxon signed-rank test, respectively. Friedman test was used to detect any differences over time within the specific dimensions. Spearman's rank correlation test was used to detect any correlation between activity limitations and grip strength. Statistical analysis was performed using SPSS 17.0 for Windows (SPSS Inc., Chicago, IL, USA). $p < 0.05$ was considered statistically significant.

RESULTS

Patient characteristics

Patient characteristics are shown in Table I. They are representative of patients with CTS being middle-aged, having female predominance and the majority reporting bilateral symptoms. The patients with diabetes (14 with type 1 and 19 with type 2) had median duration of diabetes as long as 15 years (range 1–41) years.

Table I. *Characteristics of patients with diabetes mellitus (DM) and without DM (non-DM) who have carpal tunnel syndrome (CTS)*

	DM ($n=33$)	Non-DM ($n=30$)
Age, years, median (range)	54 (31–73)	51 (35–77)
Female/male, *n*	21/12	19/11
Dominant hand operated, *n*	24	23
Bilateral CTS, *n*	21	19
Duration of CTS, months, median (range)	24 (8–96)	36 (12–180)
Duration of DM, years, median (range)	15 (1–41)	–
BMI, median (range)	28 (19–35)	26 (20–36)

BMI: body mass index.

Activity limitations comparing patients with and without diabetes

For all dimensions (EDAQ and additional) the mean score was higher for patients with diabetes and CTS compared with patients without diabetes having CTS (Table II). This indicates a more pronounced activity limitation for patients with diabetes, but no statistical differences between the two groups could be demonstrated at any follow-up time. In general, the same pattern of results was demonstrated for most specific activity items (data not shown). However, before the operation patients with diabetes reported that a few activities were significantly more difficult; making the bed, sweeping the floor, cleaning the kitchen floor, opening/folding an ironing board, and heavy gardening, and after 3 months; lifting and carrying, and light and heavy gardening. At the 12-month follow-up, no significant differences were reported.

For both patient groups, the dimensions that cause the most pronounced activity limitations were home maintenance, eating/drinking and cooking. Dimensions that mainly involve lower extremity activity, such as mobility indoors and transferring, were reported to cause only minor difficulty (Table II).

Both patients with and without diabetes demonstrated a significant (Friedman test) improvement over time in all dimensions except for mobility indoors and transferring. We therefore performed a Wilcoxon signed-rank test to detect improvements from pre-operative data to 3-month follow-up and from 3- to 12-month follow-ups. Both patient groups demonstrated significant improvements at the 3-month follow-up, which continued to progress until 12 months after surgery (Table II).

Activity limitations over time for all patients

As the number of items with significant differences between patients with and without diabetes was very limited, results from the two groups were pooled for a detailed description of activity limitation before and after carpal tunnel release. Pre-operatively, 95% of all patients experienced some kind of difficulty when performing daily activities (EDAQ and additional dimensions), 84% after 3 months and 68% 12 months after surgery. The majority of patients reported minor difficulties performing these activities, while only a few stated inabilities.

Table II. *Mean EDAQ total score, and mean score for each dimension before and after carpal tunnel release in patients with diabetes mellitus (DM) and without DM (non-DM)*

	Preoperative		3 months		12 months	
	DM ($n=33$) Mean (95% CI)	Non-DM ($n=30$) Mean (95% CI)	DM ($n=30$) Mean (95% CI)	Non-DM ($n=30$) Mean (95% CI)	DM ($n=31$) Mean (95% CI)	Non-DM ($n=29$) Mean (95% CI)
EDAQ, total score	31.00 (19.20 to 42.79)	19.70 (13.51 to 25.89)	15.36 (6.85 to 23.88)*	10.28 (3.45 to 17.10)*	9.94 (3.33 to 16.54)	4.52 (1.39 to 7.65)**
Eating/drinking (12 items)	6.36 (3.85 to 8.87)	4.83 (3.26 to 6.41)	2.77 (1.20 to 4.34)*	2.50 (0.85 to 4.15)*	1.90 (0.74 to 3.06)	1.24 (0.40 to 2.08)
Toileting (13 items)	1.88 (0.86 to 2.90)	1.53 (0.86 to 2.21)	0.70 (0.23 to 1.17)*	0.70 (–0.02 to1.42)*	0.48 (–0.04 to 1.01)	0.28 (0.03 to 0.52)
Dressing (11 items)	3.03 (1.55 to 4.51)	1.63 (0.88 to 2.38)	1.50 (0.26 to 2.74)*	0.57 (0.09 to 1.04)*	1.03 (0.15 to 1.91)	0.41 (–0.11 to 0.94)
Bathing/shower (12 items)	2.61 (1.19 to 4.02)	1.50 (0.75 to 2.25)	1.37 (0.40 to 2.33)*	1.10 (0.30 to 1.90)	0.97 (0.12 to 1.82)	0.41 (0.10 to 0.73)**
Cooking (12 items)	4.73 (2.73 to 6.72)	2.80 (1.70 to 3.90)	2.23 (0.85 to 3.62)*	1.67 (0.58 to 2.76)*	1.52 (0.45 to 2.59)	0.38 (0.05 to 0.71)**
Mobility indoors (7 items)	0.36 (0.12 to 0.61)	0.17 (0.03 to 0.31)	0.33 (0.00 to 0.66)	0.13 (–0.14 to 0.41)	0.35 (0.01 to 0.70)	0.07 (–0.07 to 0.21)
Cleaning (7 items)	3.27 (1.83 to 4.71)	1.17 (0.43 to 1.91)	1.47 (0.45 to 2.48)*	1.10 (0.13 to 2.08)	0.81 (0.11 to 1.51)	0.21 (0.02 to 0.39)**
Washing clothes care (9 items)	3.73 (2.15 to 5.31)	2.27 (1.26 to 3.27)	1.50 (0.72 to 2.28)*	1.03 (0.19 to 1.87)*	1.13 (0.35 to 1.91)	0.38 (–0.02 to 0.78)**
Transferring (4 items)	0.39 (0.04 to 0.75)	0.20 (–0.03 to 0.43)	0.40 (0.08 to 0.72)	0.13 (–0.08 to 0.35)	0.16 (–0.05 to 0.38)	0.10 (–0.11 to 0.32)
Communication (4 items)	1.76 (1.01 to 2.51)	1.50 (0.92 to 2.08)	0.50 (0.11 to 0.89)*	0.50 (0.21 to 0.79)*	0.23 (0.02 to 0.43)	0.21 (0.02 to 0.39)
Mobility outdoors/shopping (11 items)	2.88 (1.82 to 3.94)	2.10 (1.29 to 2.91)	2.60 (1.32 to 3.88)	1.27 (0.47 to 2.06)*	1.35 (0.36 to 2.35)**	0.83 (0.83 to 1.31)
Additional dimensions						
Home maintenance (11 items)	6.70 (4.71 to 8.68)	5.20 (3.73 to 6.67)	4.77 (2.60 to 6.93)	2.83 (1.06 to 4.60)*	2.74 (1.13 to 4.35)**	1.38 (0.23 to 2.53)**
Mobility with car (6 items)	1.21 (0.50 to 1.93)	0.70 (0.37 to 1.03)	1.11 (0.32 to 1.89)	0.48 (0.01 to 0.96)	0.61 (0.11 to 1.12)	0.21 (–0.03 to 0.46)
Miscellaneous (5 items)	1.36 (0.83 to 1.90)	1.83 (1.19 to 2.48)	0.93 (0.19 to 1.67)	0.69 (0.13 to 1.25)*	0.43 (0.08 to 0.78)	0.14 (–0.09 to 0.37)**

*Significant improvement from preoperative evaluation to 3-month follow-up.
**Significant improvement from 3-month to 12-month follow-up.
CI: confidence interval; EDAQ: Evaluation of Daily Activities Questionnaire.

Table III. *Activity limitations reported from EDAQ and additional dimensions before and after carpal tunnel release*

	Pre-operative (n=63) n (%)	3 months (n=60) n (%)	12 months (n=60) n (%)
EDAQ			
Opening glass jar	44 (70)	31 (52)	25 (42)
Opening juice bottle	40 (64)	23 (38)	
Bringing home groceries	39 (62)	24 (40)	
Holding a book	36 (57)		
Lifting frying pan by its handle	35 (56)	23 (38)	
Reaching for sugar	34 (54)	22 (37)	
Wringing out cloth	32 (51)	24 (40)	
Picking up needles	30 (48)		
Emptying potato water	30 (48)		
Peeling potatoes	29 (46)		
Opening can	28 (46)		
Buttoning and unbuttoning	26 (41)		
Opening bottle	24 (37)		
Opening milk carton	24 (37)		
Turning up hem of a skirt	21 (33)		
Additional dimensions			
Heavy gardening	40 (64)	26 (43)	
Lifting and carrying	39 (62)	28 (47)	
Writing	37 (59)		
Using pruning shears	37 (59)		
Working with vibrating machine	33 (52)		
Using hammer and nail	32 (51)		
Using screwdriver	32 (51)		
Working outdoors in cold weather	27 (43)	20 (33)	
Shopping on a large scale	25 (40)		
Using motor lawn mover	25 (40)		

Listed are activities difficult to perform reported by more than one-third of the patients.
EDAQ: Evaluation of Daily Activities Questionnaire.

Activity limitations reported by more than one-third of the patients are presented in Table III. Pre-operatively, a considerable number of activity limitations related to motor function (e.g. opening a glass jar, heavy gardening, lifting and carrying), sensory function (e.g. writing, picking up pins, buttoning and unbuttoning) as well as cold intolerance was reported. Substantial reductions in the number of difficult items are noted after 3 months. At 12 months follow-up, only "opening a glass jar" is reported as an activity limitation by more than one-third of the patients.

Activity limitations and gender

In general, women had a significantly higher EDAQ and additional dimension score than men (Table IV). In order of severity, women reported distinct activity limitation for the dimensions eating/drinking, home maintenance and cooking, while men reported most problems for the dimensions home maintenance, eating/drinking and dressing. There was a tendency toward equalization of activity limitations between women and men over time. However, despite a reduced number of dimensions with significant differences, women still reported higher EDAQ and additional dimension scores at the 12-month follow-up.

Table IV. *Mean EDAQ total score, and mean score for each dimension before and after carpal tunnel release in female and male patients*

	Pre-operative		3 months		12 months	
	Female (n=40) Mean (95% CI)	Male (n=23) Mean (95% CI)	Female (n=37) Mean (95% CI)	Male (n=23) Mean (95% CI)	Female (n=38) Mean (95% CI)	Male (n=22) Mean (95% CI)
EDAQ, total score	33.15 (23.57 to 42.73)	12.52 (6.56 to 18.48)*	18.42 (10.09 to 26.74)	4.17 (2.23 to 6.12)*	10.02 (4.37 to 15.68)	2.64 (0.82 to 4.45)*
Eating/drinking (12 items)	7.05 (5.04 to 9.06)	3.17 (1.35 to 4.99)*	3.95 (2.28 to 5.61)	0.52 (0.16 to 0.89)*	2.32 (1.27 to 3.36)	0.32 (–0.03 to 0.66)*
Toileting (13 items)	2.35 (1.46 to 3.24)	0.61 (0.22 to 0.99)*	1.08 (0.43 to 1.73)	0.09 (–0.09 to 0.27)*	0.58 (0.13 to 1.03)	0.05 (–0.5 to 0.14)*
Dressing (11 items)	2.63 (1.38 to 2.08)	1.91 (0.97 to 2.85)	1.41 (0.36 to 2.45)	0.43 (0.12 to 0.75)	1.00 (0.21 to 1.79)	0.27 (–0.01 to 0.55)
Bathing/shower (12 items)	2.90 (1.70 to 4.10)	0.65 (0.18 to 1.12)*	1.84 (0.90 to 2.78)	0.26 (–0.01 to 0.53)*	1.00 (0.30 to 1.70)	0.18 (–0.04 to 0.40)
Cooking (12 items)	5.30 (3.67 to 6.93)	1.22 (0.46 to 1.98)*	2.97 (1.68 to 4.27)	0.30 (0.03 to 0.58)*	1.45 (0.56 to 2.33)	0.14 (–0.02 to 0.29)*
Mobility indoors (7 items)	0.33 (0.12 to 0.53)	0.17 (0.01 to 0.34)	0.35 (0.02 to 0.69)	0.04 (–0.05 to 0.13)	0.34 (0.04 to 0.64)	0.00 (0.00 to 0.00)
Cleaning (7 items)	3.08 (1.84 to 4.31)	0.87 (0.15 to 1.59)	1.92 (0.84 to 3.00)	0.30 (0.06 to 0.55)*	0.71 (0.13 to 1.29)	0.18 (0.01 to 0.36)
Washing clothes care (9 items)	4.05 (2.71 to 5.39)	1.26 (0.43 to 2.09)*	1.68 (0.82 to 2.53)	0.61 (0.16 to 1.06)	1.02 (0.35 to 1.70)	0.32 (0.00 to 0.64)
Transferring (4 items)	0.33 (0.03 to 0.62)	0.26 (–0.04 to 0.56)	0.22 (0.01 to 0.43)	0.35 (–0.03 to 0.73)	0.10 (–0.06 to 0.27)	0.18 (–0.11 to 0.48)
Communication (4 items)	2.15 (1.55 to 2.75)	0.74 (0.08 to 1.39)*	0.70 (0.35 to 1.05)	0.17 (–0.04 to 0.39)*	0.26 (0.08 to 0.45)	0.14 (–0.07 to 0.34)
Mobility outdoors/shopping (11 items)	3.00 (2.14 to 3.86)	1.65 (0.62 to 2.68)*	2.46 (1.37 to 3.54)	1.09 (0.19 to 1.98)*	1.24 (0.45 to 2.02)	0.86 (0.15 to 1.58)
Additional dimensions						
Home maintenance (11 items)	7.00 (5.29 to 8.71)	4.22 (2.73 to 5.70)*	5.05 (2.99 to 7.12)	1.78 (0.66 to 2.90)*	2.82 (1.32 to 4.31)	0.82 (0.20 to 1.44)
Mobility with car (6 items)	1.13 (0.57 to 1.68)	0.70 (0.15 to 1.24)	1.18 (0.46 to 1.90)	0.22 (–0.01 to 0.44)	0.62 (0.18 to 1.06)	0.09 (–0.10 to 0.28)
Miscellaneous (5 items)	2.05 (1.52 to 2.58)	0.78 (0.25 to 1.32)	1.22 (0.51 to 1.93)	0.17 (–0.04 to 0.39)*	0.44 (0.12 to 0.77)	0.05 (–0.5 to 0.14)

*Significant difference between female and male patients.
CI: confidence interval; EDAQ: Evaluation of Daily Activities Questionnaire.

Relationship between activity limitations and grip strength

In order to evaluate the impact of grip strength on activity limitations, we used previously published results on grip strength for the patients participating in the present study (9, 23). Before the operation median grip strengths for female and male patients were 14 kg (range 1–34.5) and 31 kg (range 9.5–50.5), respectively. At 52 weeks follow-up it had increased to 18.5 kg (range 5–28.5) for female and 34 kg (range 5.5–48.5) for male patients. For female patients, significant inverse correlations were found throughout the observation period between grip strength and several of the EDAQ dimensions (eating/drinking ($r_s = -0.60$ to -0.47, $p < 0.003$), cooking ($r_s = -0.43$ to -0.35, $p < 0.03$), cleaning ($r_s = -0.43$ to -0.42, $p < 0.006$), mobility outdoor/shopping ($r_s = -0.41$ to -0.49, $p < 0.009$) and the additional dimension home maintenance ($r_s = -0.41$ to -0.42, $p < 0.013$)). In other words, higher grip strength associates with lower EDAQ or additional dimension score, and thereby less activity limitations. In contrast, male patients did not demonstrate any significant relationships, either pre-operatively, or at the 12-month follow-up, between grip strength and any of the EDAQ or additional dimension scores.

DISCUSSION

Of the 102 activity items included in the EDAQ, 77 are related to upper extremity activity. In spite of this, the EDAQ, together with the additional items, has been useful in the assessment of activity limitations in workers exposed to hand-arm vibration (21, 22). In the present study on patients with CTS, we were not able to demonstrate any significant difference in activity limitations before and after carpal tunnel release, between patients with and without diabetes. A substantial alleviation of activity limitations occurred by 3 months after surgery and continued to improve until the 12-month follow-up. Women reported more severe activity limitations than men, which, for many activities, were related to reduced grip strength in the former.

In general, results after carpal tunnel release have been rewarding, with reported success rates above 80% (13). In contrast, it has often been stated that patients with diabetes and CTS achieve less predictable results with uncertain sensory and motor recovery (24). In support of such a statement, nerve conduction velocity and vibrotactile sense, reflecting large nerve fibre function, has been demonstrated to be significantly impaired in patients with diabetes before and after carpal tunnel release compared with patients without diabetes (25, 26). However, in previously published results on the patient participating in the present study we have demonstrated that the patient with diabetes obtained the same clinical improvement after carpal tunnel release as the patients without diabetes (9). Likewise, using the Boston Carpal Tunnel Questionnaire, no differences in functional status score were demonstrated at any follow-up time (10). Several studies on patients with diabetic hand disorders have demonstrated functional impairment to be associated with decreased grip strength (7, 8). In our previous report, no significant difference in grip strength was encountered between the patients with and without diabetes (9). This may, in part, explain why we were not able to demonstrate significant differences in EDAQ and additional dimension scores between patients with and without diabetes.

Before carpal tunnel release our patients reported a substantial number of activity limitations. The value of the additional 3 dimensions is evident, as many of the activities causing difficulty emanate from these items. Even though many difficulties were reported as minor it clearly demonstrates that CTS has a substantial impact on daily activities. The operative treatment caused a marked improvement in performing daily activities after 3 months and continued to improve until 12 months after surgery. These results follow the pattern found in other studies on carpal tunnel release, reporting on either sensory and motor recovery or functional status using the Boston Carpal Tunnel Questionnaire (15, 16). It is notable that, before surgery, 43% of the patients reported difficulties in working/staying outdoors in cold weather, indicating signs of cold intolerance. Cold intolerance after upper extremity trauma is well recognized, while its importance in nerve entrapment neuropathy has been only sparsely investigated (9, 27).

Gender differences exist in CTS, with men presenting symptoms later and, at that stage, having more pronounced neurophysiological impairment than women (28). As in our study, women generally report more discomfort and functional disturbances than men (29). This could be attributed to a general difference in response to health symptoms, or differences in aetiology, such as strenuous manual work, repetitive wrist trauma, or long-term exposure to vibrating tools (28, 30). However, when matched for pre-operative status, results after carpal tunnel release have been found to be similar between women and men (29, 30). Furthermore, in a study to predict outcome after carpal tunnel release, worse pre-operative functional disability of the hand, poorer physical and mental health status, but not gender, were recognized as the most important factors on outcome (31).

Evaluating normative data for grip strength in healthy adults, 50–59-year-old women reached 60–65% of the mean grip strength for men (32). In rheumatoid arthritis, grip strength, irrespective of gender, was found to be closely related to activity limitations, as reported by the EDAQ (33). In other words, men may have less activity limitations simply because they are stronger than women. This has also been hypothesized as an explanation for the difference in hand performance between men and women with CTS (28), and parallels the finding in our present study. To establish a critical cut-off value for necessary grip strength to achieve a satisfactory activity level requires a large number of participants, as multiple factors, such as, age, gender, body mass index, occupation, leisure activities, temperature and time of day, are considered to influence the result (32). Such estimation is beyond the scope of our study. After distal radius fracture, satisfactory results are reported when patients recover 65% of their grip strength (34). In rheumatoid arthritis, severe activity limitations are found for those with grip strength below 114 N (12 kg), while those with grip strength above 214 N (22 kg) reported very few limitations (33).

The findings of our study should be interpreted with awareness of its limitations. The EDAQ was designed primarily for patients with rheumatoid arthritis and predominantly reflects domestic activities. It would be of value to develop a modification of the EDAQ, encompassing home-maintenance activities that are more often performed by men. EDAQ was originally analysed with Rasch methodology, which transforms the ordinal score into a linear measure (20). We used mean values and non-parametric statistics, even though median values would theoretically be more correct. However, mean values have been used previously in other EDAQ studies (19). The strength of our study is the well-defined, consecutive patient series matched for age and gender.

In conclusion, our results provide the first thorough description of activity limitations before and after carpal tunnel release. As greater limitations in daily activities were found for women with reduced grip strength they may benefit from strategies to improve their grip and muscle function. A formal postoperative occupational therapy programme for all patients has not been justified (35). Instead, intervention in relation to CTS should be individualized to include treatment of symptoms, activity modifications and advice about environmental modifications to facilitate and improve daily activity performance.

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