

The effect of age and gender on the improvement of the strength and function of the hand of patients following surgery for carpal tunnel syndrome

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ABSTRACT

Introduction: Carpal tunnel syndrome is the most common compressive neuropathy in the upper limb. Morbidity is approx. 4 times higher in women than in men. Clinical observations suggest that the sex and age of patients influence a preoperative reduction of grip and pinch strengths as well the range of improvement in these variables postoperatively.

The objective of the study was to investigate this issue.

Materials and methods: The study group consisted of 1,117 patients, 909 women (81%) and 208 men (19%) at a mean age of 63 years. Each patient had been tested for total grip strength, pinch strength and completed the functional part of the Levine questionnaire which evaluates the severity of dysfunction caused by the disease.

Results: Preoperatively, men had almost a double-fold total grip and pinch strength compared to women, whereas women had greater, but clinically irrelevant, hand dysfunction. The total grip

and pinch strengths were statistically and clinically significantly lower in patients >80 years old. Postoperative improvement of the power and function of the hand was similar in women and men. Patients in different age groups achieved similar improvement of the power and function of the hand postoperatively, except in the oldest group (>80 years old) in which the improvement was smallest.

Conclusion: In the course of carpal tunnel syndrome, reduction of the power and function of the hand are similar in women and in men, as well as in different age ranges, except for the oldest patients in which dysfunction is the greatest. Surgery results in similar improvement of power and function of the hand in both sexes and in different age groups, except for the oldest patients, who show the least improvement.

Keywords: carpal tunnel syndrome; sex and age; outcome measure.

INTRODUCTION

Carpal tunnel syndrome (CTS) is caused by a compression on the median nerve in the carpal tunnel. It is the most common peripheral neuropathy, affecting approx. 6% of women over 40 [1, 2, 3]. Although several risk factors predisposing to CTS were identified (diabetes, hypothyroidism, rheumatoid arthritis), the idiopathic form is the most common [1, 2]. Typical symptoms of the condition include paraesthesiae (numbness, tingling and “pins and needles” phenomenon) felt in fingers I–IV which are innervated by the median nerve and pain in the hand occurring predominantly at night (nocturnal symptoms). Apart from complaints, a proportion of patients experienced impaired function of the hand in terms of weaker and unsafe grip, faster hand fatigue and problems with the performance of some daily living tasks, including buttoning, sewing or taking coins out of a purse. In long-term CTS, atrophy of the thenar muscles and reduction of the sensation in the fingertips develops.

Carpal tunnel syndrome predominantly affects women in their middle-ages, while instances in men are 4 times lower [1, 2, 4]. Although this difference is significant, the number of men suffering from CTS is also great, due to the commonness of the condition. It is noticeable in clinical practice that the course of the disease, including its effect on the power and function

of the hand in the performance of daily living activities, differs with respect to the age and gender of the patients. Observations from the authors’ institution show that, for example, women suffer from weaker and unsafe grip, as well as have problems with the performance of household tasks more frequently than men. Likewise, older patients complain more commonly from weaker grip strength and overall hand function in the affected hand than younger patients. In contrast, post-operative evaluation shows a similar range of improvement of these variables among men and women and in various age groups. These observations prompted the authors to investigate the problem.

The objective of the study was to investigate if there are differences in power and function of the hand between men and women and between older and younger CTS patients before surgery. Secondly, an investigation of whether the operation had the same effect on the improvement of these variables in men and women as well as in older and younger patients was conducted.

MATERIALS AND METHODS

The study was conducted in the authors’ institution using the Carpal Tunnel Syndrome Register, henceforth referred to as

“the Register”. The Register is the institutional database established in 2009 for the assessment the outcomes of surgical treatment of CTS. The present report focuses on the cohort of patients who were operated on over a period of 4 years (2012–2015). The records of 1,117 patients were analysed. This group comprised 909 women (81%) and 208 men (19%) with a mean age of 63 (range 20–91) years. Eight hundred and sixty-nine patients (78%) had bilateral CTS, whereas 248 (22%) had unilateral CTS. For the purpose of the study, the group was divided into 2 sub-cohorts with regard to sex and into 4 sub-cohorts according to age (Tab. 1).

TABLE 1. Division of the study group in age sub-groups

Age ranges	Number of patients	%
<40 years	89	8
40–60 years	603	54
61–80 years	394	35
>80 years	31	3
Total	1117	100

The diagnosis of CTS was made on the basis of clinical findings including the typical signs and symptoms mentioned earlier. The following measurements from the database were analysed:

- total grip strength which was measured with a Jamar dynamometer,
- key-pinch strength which was measured with a pinch-meter,
- the Levine questionnaire scores.

All measurements were performed 1 day before the operation and repeated at 1 and 6 months post-operatively. The results at the 6-month assessment were analysed in the study. Operations were performed in standard way, using a small incision in the distal metacarpus (Fig. 1, 2).



FIGURE 1. Skin incision for the carpal tunnel release

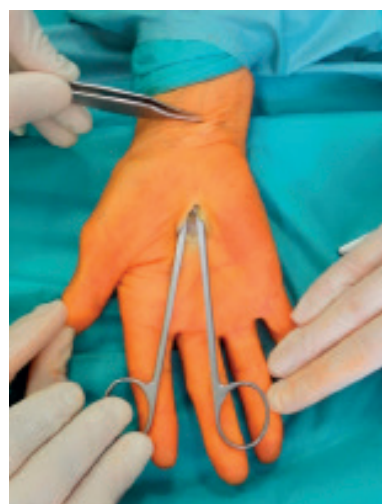


FIGURE 2. End of the operation: flexor retinaculum divided, scissors introduced through opened carpal tunnel up to the proximal forearm

The Levine questionnaire (also named the Carpal Tunnel Questionnaire or Boston Questionnaire) is a standardized instrument for the assessment of the clinical severity of CTS [5]. It consists of 2 parts: the symptom severity score (SSS) for the assessment of the subjective perception of pain and pain-related phenomena and the function severity score (FSS) evaluating dexterity of the hand in the performance of daily living tasks. For the purpose of this study, only the FSSs were considered.

Minimal important (meaningful) difference

Minimal important changes and differences describe the smallest changes and differences between individuals that are relevant to them. This is the smallest change in an outcome measure that is clinically meaningful, and not simply statistically significant. The following values were considered minimal important differences: 2–4 kG for total grip strength, 0.5 kG for key-pinch strength and 0.7 for the Levine FSS [6].

STATISTICAL ANALYSIS

For the comparison of variables between the sex subgroups, the Student t-test was used. For the comparison of variables between age groups with a non-normal distribution, an ANOVA Kruskal–Wallis test was used, and in the *post-hoc* analysis the Mann–Whitney U test with Bonferroni correction was used. A confidence level of 0.05 was assumed as indicating statistical significance.

RESULTS

The effect of sex on considered variables (Tab. 2).

Baseline (pre-operative) total grip strength was almost 2 times greater in men than in women. At the 6-month post-operative assessment, a statistically significant improvement of grip strength was noted in both gender groups (t-Student test,

TABLE 2. A comparison of total grip, key-pinch strength and function severity scores of the Levine form in women vs. men at baseline and at 6 months following surgery

	Baseline		At 6 months		Range of improvement (mean)		p
	women	men	women	men	women	men	
Number of of patients	909	208	909	208	909	208	
Total grip strength in kG							
Mean	14.9	26.9	18.7	31.6	3.8	4.7	<0.001
SD	7.5	12.9	7.1	11.0			
Key-pinch strength in kG							
Mean	3.3	5.5	4.5	7.4	1.2	2.9	<0.001
SD	1.6	2.4	1.5	2.1			
The Levine function severity scores							
Mean	3.0	2.6	1.7	1.5	1.3	1.1	0.001
SD	0.7	0.9	0.6	0.7			

SD – standard deviation

$p < 0.001$), compared to baseline. The range of this improvement was statistically significantly greater in men than in women (of 0.9 kG), but the difference did not reach minimal clinical significance.

Baseline (pre-operative) key-pinch strength was almost 2 times greater in men than in women. At the 6-month follow-up, a statistically significant improvement of key-pinch strength was noted in both gender groups (t-Student test, $p < 0.001$), comparing to baseline. The range of this improvement was statistically and clinically significantly greater (of 1.7 kG) in men than in women.

Baseline mean FSS of the Levine questionnaire were statistically significantly greater in women than in men (by 0.4 points; Tab. 2), but the difference did not reach minimal clinical significance. At the 6-month follow-up, a statistically significant improvement of FSS was noted in both gender groups (of 1.3 and 1.1 points, t-Student test, $p < 0.001$), comparing to baseline. The range of this improvement was statistically significantly greater in women than in men, but the difference was minimal (of 0.2 point) and did not reach minimal clinical significance.

The effect of age on considered variables (Tab. 3, 4, 5).

Baseline total hand grip was statistically and clinically significantly weaker in the oldest (>80 years) group, compared to other age groups (differences 5.9–9.5 kG, $p < 0.001$) – Table 3. The differences between other age groups were statistically insignificant. At the 6-month follow-up, a statistically and clinically significant improvement of grip strength was noted in all age groups (4.0–5.1 kG; t-Student test, $p < 0.001$), compared to baseline, except for the oldest (>80 years) group of patients, in which this improvement (of 2 kG) was clinically insignificant. Thus, an older age (>80 years) had a statistically significantly negative effect on preoperative power of the hand and on the grade of its improvement following surgery.

Baseline key-pinch strength was statistically and clinically significantly weaker in the oldest (>80 years) group, compared to other age groups (differences 1.1–1.4 kG, $p < 0.001$) – Table 4.

The differences between other age groups were statistically insignificant. At the 6-month follow-up, a statistically and clinically significant improvement of grip strength was

TABLE 3. A comparison of total grip strength in various age groups at baseline and at 6-months following surgery

Variables		Total grip strength in kG				improvement (mean)
age ranges	n	baseline		at 6 months		
		mean	SD	mean	SD	
<40 years	89	19.9	13.0	25.0	12.2	5.1
40–60 years	603	17.6	9.5	21.5	8.7	3.9
61–80 years	394	16.3	9.8	20.3	9.4	4.0
>80 years	31	10.4	6.1	12.4	6.9	2.0

SD – standard deviation

TABLE 4. A comparison of key-pinch strength in various age groups at baseline and at 6-months following surgery

Variables		Key-pinch strength in kG				improvement (mean)
age ranges	n	baseline		at 6 months		
		mean	SD	mean	SD	
<40 years	89	3.8	1.9	5.3	1.9	1.5
40–60 years	603	3.6	1.8	5.0	1.9	1.4
61–80 years	394	3.9	2.1	5.1	2.2	1.2
>80 years	31	2.5	1.7	3.9	1.7	1.4

SD – standard deviation

TABLE 5. A comparison of the Levine function severity scores in various age groups at baseline and at 6-months following surgery

Variables age ranges	n	The Levine function severity scores				
		baseline		at 6 months		improvement (mean)
		mean	SD	mean	SD	
<40 years	89	2.7	0.8	1.4	0.4	1.3
40–60 years	603	3.0	0.7	1.6	0.6	1.4
61–80 years	394	3.0	0.7	1.7	0.7	1.3
>80 years	31	3.3	0.7	2.0	0.8	1.3

SD – standard deviation

noted in all age groups (1.2–1.5 kG; t-Student test, $p < 0.001$), compared to baseline.

The range of post-operative improvement was similar in all 4 age groups (1.2–1.5 kG). In spite of this, the key--pinch was statistically and clinically significantly weaker in the oldest patient group than in the other age groups. Thus, old age (>80 years) had a statistically significant negative effect on preoperative key-pinch strength, but not on its improvement following surgery.

The baseline mean FSS of the Levine questionnaire was statistically significantly lower in the age group <40 years, compared to the group >61 years ($p < 0.001$) – Table 5. However, as the difference was small (0.3–0.6 points), it did not reach clinical significance. An improvement of hand function as an effect of surgery, expressed in decreasing FSS, was similar in all age groups (1.3–1.4 points). Thus, the age of the patients had a statistically significant effect on preoperative function of the hand, but not on its improvement following surgery.

DISCUSSION

The results obtained in this study indicate that baseline (pre-operative) total grip and key-pinch strengths were almost 2 times greater in men than in women. A stronger grip in men is natural and differences between sexes in CTS patients are natural too, being irrelevant to the median nerve compression. The follow-up measurements showed that improvement of total grip and key-pinch strengths following surgery is greater in men than in women, but it is clinically significant (detectable by patients) only for key-pinch strength. Instead, the gender of the patients had no significant impact on post-operative improvement of the function of the hand, as assessed with the Levine questionnaire. Thus, the beneficial effect of the operation was similar for women and for men.

The analysis of the results showed that the oldest (>80 years) patients suffering from CTS had significantly weaker power in the involved hands, compared to others. This also seems normal. Outcomes of this study showed that surgery resulted in significant improvement of the strength and function of the

hand in all age groups, except for total grip strength in the oldest patients. Thus, the beneficial effect of the operation was detectable for younger and for older patients.

Literature review

Previous studies report that outcomes of carpal tunnel surgery do not vary by sex [2, 3], but more recent literature shows a slightly better prognosis for women than men [6, 7, 8]. Hobby et al. analysed impairment of the function of the hand using the Levine questionnaire in 97 CTS patients and showed that at baseline, women had statistically significantly greater hand dysfunction than men (FSS 2.7 vs. 2.0), but this difference was not clinically meaningful. In our study, at the 6-month post-operative assessments, no differences were found between men and women in terms of FSS scores. Thus, the operation afforded similar benefits for men and for women, although the range of functional improvement was greater for women [7].

Ibrahim et al. analysed impairment of function of the hand using the Levine questionnaire in 479 CTS patients and showed that at baseline, women had slightly greater hand dysfunction than men (FSS 3.0 vs. 2.8). This difference is insignificant and clinically not meaningful [8].

Other authors present similar conclusions in their studies [9, 10, 11]. The results of the present study are generally consistent with the literature.

The evidence of the impact of age on the results of carpal tunnel release shows that only elderly patients (>70 years) may have slightly less favourable outcomes [1, 2, 5, 11, 12]. In our study, only the oldest patients (over the age of 80) presented somewhat worse outcomes. It is noticeable that in all cited studies, the reported differences in outcomes between age groups were small and clinically not meaningful. This is important as it suggests that surgery for CTS is sufficiently satisfactory at any age.

Porter et al. compared outcomes of surgery for CTS in 2 age groups: <60 ($n = 46$) vs. >60 ($n = 41$) years old. At the 6-month follow-up assessment, a statistically significant improvement was noted in both groups in terms of a decrease of FSS of the Levine questionnaire. However, this improvement was slightly lower in older patients; likewise, more younger than older patients (86% vs. 66%) declared full satisfaction from the operation [11]. The authors of 2 other studies found that in older (>60 years) patients, the outcome of surgery was related to the preoperative severity of the disease: the more severe the syndrome, the weaker the improvement. The authors attribute this finding to a greater baseline impairment of the median nerve and its lower potential of regeneration following decompression [7, 12]. In another study, the authors noticed worse outcomes of treatment in patients older than 60 years, in terms of greater post-operative FSS and lower rates of satisfaction [13].

In the earlier mentioned article by Hobby et al., the authors failed to find differences in outcomes of surgery in patients in various age groups, except for patients >70 years old, in whom FSS and SSS scores were significantly higher comparing to younger patients (indicating poorer improvement), although this difference was not clinically meaningful. This also did not translate to patient satisfaction from the operation [7].

In an earlier study from the authors' institution, results of carpal tunnel release in 386 CTS patients, 322 women (83%) and 64 men (17%), at a mean age of 57 years were analysed. The study group was split into 3 age sub-groups: <40 years ($n = 28$), 41–65 years ($n = 248$) and >65 years ($n = 73$). No statistically significant differences were noticed between the groups in respect of grip strengths, but a mean FSS score was statistically significantly higher in the youngest group (3.2 vs. 3.0 vs. 3.0 points, $p < 0.05$), indicating greater functional impairment; however, this difference did not reach clinical importance. At the 6-month follow-up, a statistically and clinically significant improvement of grip strength was noted in all age groups. The greatest improvement was observed in the youngest patients <40 years (baseline power 85% of the healthy hand vs. 138% at 6 months; $p < 0.001$). The least improvement was noted in older patients >65 years (baseline power 82% of the healthy hand vs. 87% at 6 months; $p = 0.05$). Functional severity scores decreased statistically and clinically significantly and uniformly in all 3 age groups (3.0 vs. 1.8; 3.0 vs. 1.8 and 3.2 vs. 1.8), indicating improvement of function of the hand as a result of surgery [14].

Fung et al. in their review article extracted information on the outcomes of surgery for CTS in elderly patients. They found that in most of the studies these results were satisfactory and beneficial for patients. However, it was also noticeable that in the oldest patients, results of the operation are less predictable and, with respect to particular variables, worse than in younger ones [15].

CONCLUSION

In the course of CTS, reduction of the power and function of the hand is similar in women and in men, as well as in different age ranges, except in the oldest patients who showed the greatest dysfunction. Surgery resulted in similar improvement of power and function of the hand in both sexes and in different age groups except in the oldest patients, who showed the least improvement.

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