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# BMJ Open

## Long-term results after one-stop carpal tunnel surgery

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Long-term results after one-stop carpal tunnel surgery

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39 Abstract

40 Objectives:

41 The aim of this study was to evaluate one-stop surgery (OSS) for carpal tunnel  
42 syndrome (CTS) regarding outcome, patient satisfaction and waiting time from referral  
43 to discharge with or without surgery. We hypothesized that OSS has an outcome  
44 equivalent to conventional patient management.

45 Design

46 This is a long-term retrospective follow-up study [56.5 months] of 1003 patients  
47 referred for CTS and discharged with or without surgery from an OSS clinic. Of the  
48 original cohort, 671 patients completed the long-term follow-up interview.

49 Results

50 The outcome and patient satisfaction in this study were equally good compared to  
51 conventional patient management of CTS surgery. Pre-selection by a nurse-conducted  
52 telephone interview reduced the number of cancellations and postponements on the day  
53 of surgery and increased the amount of operated patients actually having surgery  
54 completed in a single visit from 68% to 86%. Furthermore, patients referred for surgery  
55 were more likely to decline surgery during conversation in the telephone with a nurse  
56 than to the doctor in the out-patient clinic.

57 Conclusion

58 The implementation of a multidisciplinary clinical pathway and OSS for the  
59 management of CTS was safe with positive long-term clinical outcome and high patient  
60 satisfaction. However, inclusion of the neurophysiological evaluation in the one-stop  
61 visit and the use of resolvable sutures would lead to a more genuine one-stop  
62 experience. OSS with pre-selection by a nurse-conducted telephone interview can be

recommended as the standard procedure for patient management in patients with CTS referred for surgery.

**Keywords:** Carpal tunnel syndrome; Follow-up study; Long-term; Outcome; One-stop surgery; Patient satisfaction.

### Strengths and limitations of this study

- The study include a large number of patients.
- The follow-up also include patients discharged without surgery from the OSS clinic.
- All data was collected retrospectively.
- Data was not collected according to the Boston questionnaire used in many studies.
- Interviews produce better outcomes compared to self-administered questionnaires.

### Background

Increasing demands on the health care system calls for exploration of new approaches to patient management. Carpal tunnel syndrome (CTS), which is the most frequent entrapment neuropathy with an incidence of operative treatment is 0.6-1.7 per 1000 population with geographical variation,[1] leads to a considerable symptom burden and substantial direct and indirect medical and socioeconomic costs.[2] Compared to conventional surgical patient management, one-stop surgery (OSS) reduces three

83 hospital visits for surgical pre-assessment, surgery and follow-up into a single visit,  
84 which could contribute to improve patient satisfaction and apply a more efficient use of  
85 health care resources.[3,4]

86 Potential challenges with OSS, however, include insufficient information and wasted  
87 theatre time in case of same day cancellation.[3] Other concerns are that OSS might be  
88 associated with a substandard pre-assessment due to the face-to-face consultation is  
89 replaced by a telephone interview.

90 The aim of the present study is to evaluate the outcome, challenges and potentials in a  
91 large population of patients referred for operative treatment of CTS and pre-selected by  
92 a nurse-conducted semi-structured telephone interview. We hypothesize that OSS in  
93 CTS has an equivalent outcome and patient satisfaction to conventional CTS patient  
94 management reported in the literature.

95 Previous studies of OSS in CTS in highly pre-selected patients reported a high quality  
96 outcome and patient satisfaction.[3–5] One study also included a same day nerve  
97 conduction study in the OSS patient management.[4]

98 This study presents a long-term follow-up of outcome and patient satisfaction in a large  
99 population of patients referred for surgery and pre-selected by a nurse-conducted  
100 structured telephone interview before discharge with or without surgery from an OSS  
101 clinic.

102

## 103 Material and methods

104 The aim of this study was to evaluate OSS for CTS regarding outcome, patient  
105 satisfaction and waiting time from referral to discharge with or without surgery.

### 106 Study design

107 This is a retrospective long-term follow-up study of 1003 patients discharged with or  
108 without CTS surgery from the OSS clinic from 2003-2009.

109 A doctor obtained data from patient files and a team of two pre-trained medical students  
110 and three medical doctors conducted the long-term follow-up telephone interviews. If  
111 the patient was unreachable on phone, a request to contact the clinic was sent by letter at  
112 two occasions.

113 Patients were excluded from the telephone interview follow-up if they were not able to  
114 understand Danish or English, were severely cognitive and/or hearing impaired or had  
115 emigrated from Denmark.

### 116 Participants

117 A large majority (67%, n=671) of the 1003 patients in the original cohort (2003-2009)  
118 completed the follow-up interview and constituted the study population. Of the 671  
119 included patients, 507 (78%) patients were discharged from the OSS clinic with surgery  
120 in one or both hands representing overall 683 carpal tunnel releases. An overview of the  
121 original cohort, the study population and the non-participants of both operated and non-  
122 operated patients can be seen in the supplementary material. Time from referral to  
123 follow-up was 56.5 months [15.3-103.6]. The average age was 55 years [21-97] for the



operated patients with 77% being female and 53 years [26-89] for the non-operated patients with 73% being female.

The majority (93%) of the operated patients had a neurophysiological evaluation. Patients referred without a neurophysiological evaluation were redirected for an EMG prior to the OSS appointment with the exception of distinct cases with a classical clinical picture and history of a successful operation on the opposite hand.

Relevant co-morbidities for all patients in the follow-up study were polyneuropathy (5%), metabolic disorder (5%) primary myxedema; connective tissue disease (9%); diabetes (14%); arthrosis and rheumatism (21%); obesity (14%); excessive use of alcohol exceeding 14/21 units per week for women/men (7%). Other co-variables were age above 70 years (16%), poor communication skills (1%), atrophy of the thenar (7%) and duration of symptoms >3 years (22 %). Of the operated patients, 53% were on medication, which were true for 26% of the non-operated patients.

**The patient flow from referral to discharge from the OSS clinic**

The neurosurgical department received referrals from general practitioners and neurologists. During the initial study period (2003-2007) all patients were offered an OSS appointment, as there was no pre-selection of patients for OSS. Later (2007-2009), we introduced pre-selection by a nurse-conducted telephone interview prior to the OSS appointment with the aim to screen out those patients unlikely to undergo surgery in case of very minor symptoms or if the patients decline surgery whatsoever, and those patients were discharged directly from the telephone interview. In case of; pregnancy, history of relevant fractures or severe comorbidities, patients were offered a separate outpatient assessment instead of an OSS appointment before decision for surgery.

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4 147 Alternatively they received a late day OSS appointment to interfere the least with the  
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6 148 flow of the day in case of cancellation. Patient selected for OSS received information  
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8 149 about the procedure and an appointment. A diagram of the patient flow can be seen in  
9  
10 150 the supplementary material.

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13 151 At the day of the OSS appointment, the surgeon performed a regular pre-assessment of  
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15 152 the patient and – if indicated - performed surgery immediately afterwards. Patients were  
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17 153 first operated on the side, which they expressed were most affected. Patients with CTS  
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19 154 on both hands who had previously been operated with effect, were offered a new  
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21 155 appointment for OSS a minimum of three months later on the opposite hand. During the  
22  
23 156 study period (2003-2009), there was initially (2003-2005) no routine postoperative  
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25 157 follow-up. Later (2006-2009), the outpatient nurse conducted postoperative follow-up  
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27 158 by a telephone interview on day 1 and day 14 with the aim to identify postoperative  
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29 159 complications requiring medical attention or guidance.

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34 160 The outpatient clinic houses the OSS clinic 1-4 days per month. The clinic  
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36 161 accommodates 5-6 procedures per day. The patients are scheduled for their OSS  
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38 162 appointment with a time interval of 45-60 minutes depending on the surgeon. Two  
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40 163 nurses assist the surgical procedure in: a) getting the patient ready for surgery, b)  
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42 164 surgery, c) attending the patient during surgery d) cleaning and preparation for the next  
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44 165 procedure and e) providing post-operative information and support to the patient. In  
45  
46 166 routine cases, the patient leaves the outpatient clinic when comfortable after surgery.

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51 167 The standard surgical procedure was the endoscopic procedure with the single portal  
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53 168 Wolf system.[6] The surgery was performed in local anesthesia with up to 10 mL of  
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55 169 Marcain-Adrenalin (5 mg/mL + 5 ug/mL) placed in the wrist and palm region without  
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170 the use of a tourniquet. Conversion to open surgery was done in cases of anatomical  
171 variations, insufficient space or pain during dissection or at the attempt to introduce the  
172 endoscopic tube. Open surgery was used in all re-operations and at the surgeon's  
173 individual choice, mostly in the case of severe neurological deficits. The surgeons were  
174 all board certified neurosurgeons with the exception of a few supervised procedures  
175 performed by residents.

176 **Outcome measures**

177 We evaluated the long-term outcome of the 671 referred patients to the OSS clinic  
178 regarding both primary outcomes of residual symptoms as well as secondary outcomes  
179 of surgical complications, patient satisfaction scores and waiting time.

180 *Primary outcome; Residual symptoms*

181 Residual symptoms were uncovered by questioning the patient: *Do you have any*  
182 *symptoms from your hand?* If so, this was specified as 1) Wake-ups at nights due to pain  
183 or numbness in the hand, 2) Constant symptoms from the hand, 3) Weakness in the  
184 hand, 4) Worsening of symptoms with activity such as using the telephone, using  
185 computer, biking, etc., 5) Pain from the wrist, and 6) Pain from the palm.

186 *Secondary outcomes: Patient satisfaction scores and surgical complications*

187 Patients were asked to assess the following on a 10-point scale (1= very unsatisfied, 10  
188 = very satisfied) related to the effect of the surgery, the information level and the overall  
189 impression of the patient care and management.

190 The numbers and types of complications including suspected surgical site infections  
191 (SSI) treated with antibiotics, was collected as well from the patient files and the long-  
192 term follow-up interview.

193 The outcome measures were analyzed in subgroups of A) surgical technique  
194 (endoscopic, converted or a planned open procedure), B) +/- EMG, C) the surgeon, D)  
195 patient characteristics as described in the demographic section. Six surgeons performed  
196 between 53 and 167 of the total 683 procedures. We pooled surgeons and supervised  
197 residents with less than twenty procedures in one group of total 52 procedures.

## 198 **Statistical analyses**

199 Data was organized in a relational database. The statistical analyses were performed  
200 with the multivariate logistic regression analysis for co-variants described in the  
201 demographic section. The patient satisfaction scores (1-10) were analyzed with the t-test  
202 of each group.

## 204 **Results**

### 205 **Primary outcome**

#### 206 *Good long-term outcome at follow-up*

207 The overall average self-reported satisfaction score of the effect of surgery was 9.0 on a  
208 1-10 scale. At time of follow-up, a vast majority of the operated patients had relief of  
209 symptoms to a various degree, and 66% of the operated patients (Table 1) became  
210 completely free of even minor symptoms compared to 37% of patients discharged  
211 without surgery (Table 2). The outcomes were equally good in operated patients with

co-morbidities, except in patients who had arthrosis, polyneuropathy or atrophy (Tables 1 and 2).

Table 1. Long-term residual symptoms and patient satisfaction scores after one-stop carpal tunnel surgery.

Co-morbidities and/or risk factors of poor outcome												
	No risk factors	Polyneuropathy	Diabetes	Connective tissue disease	Metabolic disorder	Arthrosis	Symptoms > 3 year	Atrophy	Excessive use of alcohol	Age > 70	Obesity	Use of translator
Number of operated hands (n)	153	35	107	63	40	164	198	57	51	117	125	9
Number of operated patients (n)	120	25	75	44	27	117	148	48	36	86	85	7
Hands (%) free of any symptom	66	43 **	62	62	65	60 *	62	65	61	65	69	78
Hands (%) with symptoms	34	57 **	38	38	35	40 *	38	35	39	35	31	22
Wake-up at nights (%)	8	14	6	14	3	10	5	11	12	9	7	0
Constant symptoms (%)	12	26 *	14	11	15	11	10	19 *	16	16	10	11
Weakness (%)	22	29	25	27	15	23	18	23	20	20	15	11
Worsening (%)	18	34 **	15	19	18	20	21	18	25	9 *	20	22
Paresthesies (%)	19	49 **	31	32	28	31 *	24	32	27	26	26	11
Pain (wrist) (%)	14	17	10	16	10	13	11	7	12	9	12	0
Pain (palm) (%)	7	11	9	13	10	11 *	7	7	8	7	6	0
Self-reported score on a scale of 1-10 (mean)												
Effect of surgery in the hand	9.0	8.9	8.9	8.6	9.0	8.8	9.1	8.9	9.1	9.1	8.9	9.8 **
Level of information	8.9	8.9	8.6	9.1	8.9	8.9	9.0	9.1	8.7	9.5 **	9.0	9.2
Overall impression	8.9	8.9	8.8	8.5	8.5	8.8	9.0	8.9	9.2	9.1	8.8	9.8

The numbers of operated hands and patients are listed according to co-morbidity and other co-variants such as duration of symptoms, atrophy of the thenar, age and communication difficulties. The percentages of operated hands with none or residual symptoms are listed accordingly. Statistical analysis of none or residual symptoms were performed with multivariate logistic regression analysis and the level of statistical significance level was chosen at p < 0.05 (\*), p < 0.01 (\*\*) and p < 0.001 (\*\*\*). The patient satisfaction scores (1-10) are listed as the mean and the statistical analysis was performed with t-test within each group.

Table 2. Long-term residual symptoms and patient satisfaction scores in non-operated patients discharged from the OSS clinic.

Co-morbidities and/or risk factors of poor outcome

	No risk factors	Polynuropathy	Diabetes	Connective tissue disease	Metabolic disorder	Arthrosis	Excessive use of alcohol	Age > 70	Obesity	Use of translator	> 1 risk factor
Number of patients [hands]	82	7	18	12	3	18	8	20	8	3	26
Hands (%) free of any symptom	37	29	39	39	33	11 *	38	50	38	0	35
Hands (%) with symptoms	63	71	71	61	67	89 *	63	50	63	100	65
Wake-up at nights (%)	21	43	43	28	67	33	38	10	25	100	31
Constant symptoms (%)	18	43	43	33	67	28	25	15	13	67	27
Weakness (%)	38	43	43	33	33	44	50	25	50	67	42
Worsening (%)	43	71	71	61	67	61	50	35	50	100	50
Paresthesias (%)	54	71	71	56	67	67	63	45	38	100	50
Pain (wrist) (%)	21	43	43	33	33	17	13	20	25	33	23
Pain (palm) (%)	11	29	29	17	0	0	13	10	13	33	8
Self-reported score of 1-10 (mean)											
Effect of surgery in the hand											
Level of information	7.8	6.6	7.8	7.7	7.7	7.0	6.3	7.7	7.3	1.0	6.6
Overall impression	7.8	7.0	8.4	7.4	7.3	6.9	6.9	6.7	7.8	1.0	6.2

The numbers of patients discharged without surgery from the OSS clinic and did not have surgery later on in another facility (n=145). An additional 19 patients reported at follow-up that they have had surgery later on in another facility, but their symptoms at follow-up did not differ significantly from the 145 never operated patients. The patients are listed according to co-morbidity and other co-variants such as duration of symptoms, atrophy of the thenar, age and communication difficulties. The percentages of patients with none or residual symptoms are listed accordingly. Statistical analysis was performed with multivariate logistic regression analysis and the level of statistical significance level was chosen at  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*). The patient satisfaction scores (1-10) are listed as the mean and the statistical analysis was performed with t-test within each group.

We observed an equally good outcome in patients operated by the endoscopic and converted procedure. With the planned open procedure, however, which was conducted only in selected cases with severe neurological deficits and in reoperations, the outcome was worse (Table 3).

Table 3. Residual symptoms, effect score and SSI according to surgical technique

	Endoscopic n	Converted n	Primary open n
Number of operated hands [patients]	487 [366]	140 [108]	56 [33]

Hands (%) free of any symptom	67	66	43 ***
Hands (%) with symptoms	33	34	57 ***
Wake-up at nights (%)	6	8	29 ***
Constant symptoms (%)	11	7	23 **
Weakness (%)	18	20	30 *
Worsening (%)	16	22	30 **
Paresthesias (%)	21	26	38 **
Pain (wrist) (%)	11	9	29 ***
Pain (palm) (%)	7	7	13
Self-reported VRNS score of 1-10 (mean)			
Effect of surgery in the hand	8.9 *	8.9	7.4 ***
Level of information	9.1	8.9	9.3
Overall impression	9.1	8.9	8.9

The numbers and percentages (%) of operated hands with residual symptoms and self-reported scores (1-10) on a 10-point scale (1 = very unsatisfied, 10 = very satisfied) are listed according to surgical technique of the endoscopic, converted and planned open procedures. Statistical analysis was performed with multivariate logistic regression analysis and the level of statistical significance level was chosen at  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*). The patient satisfaction scores (1-10) are listed as the mean and the statistical analysis was performed with t-test within each group.

Of the 164 patients discharged from the OSS clinic without surgery, nineteen (12%) were operated in another facility at a later stage. This group of patients, however, had residual symptoms equivalent to patients discharged without surgery that had not been operated at time of follow-up.

## Secondary outcome

### *Low complication rate*

None of the 683 mainly endoscopic procedures resulted in severe complications. Of the 212 operated patients who did not participate in the follow-up interview, however, one developed reflex sympathetic dystrophy and another patient had damage to the recurrent muscular branch of the median nerve.

The follow-up interviews did not reveal any complications unknown to the specialists except for a few patients treated with antibiotics for suspected surgical site infections (SSI) (Table 4).



261 **Table 4. Complications and reoperations.**

	No	%
<b>Procedures</b>	<b>683</b>	
<b>Complications other than SSI</b>	<b>16</b>	<b>2.3</b>
Excessive bleeding during surgery	1	0.1
Severe spasms (reschedule for generalized anesthesia)	1	0.1
Severe pain (admitted 24 hours)	1	0.1
<b>Re-operations</b>		
Postoperative hematoma	1	0.1
Deep infection	3	0.4
No effect or recurrence	5	1.0
Worsening	2	0.3
Tenosynovitis	1	0.1
Granuloma	1	0.1
<b>Antibiotic use (suspected superficial SSI).</b>	<b>34</b>	<b>5.0</b>

263 The complications, reoperations and suspected superficial surgical site infection (SSI) are listed in all 683 procedures conducted in  
 264 patients referred to the OSS clinic in the seven year period 2003-2009 and included in the long-term follow-up interview. The  
 265 follow-up interview did not reveal any un-documented complications in the journals with the exception of a few patient reports on  
 266 antibiotic use.  
 267

268 The use of antibiotics for suspected SSI was 5% and significantly higher for the  
 269 converted procedure. The rate of suspected SSI did not differ significantly between  
 270 patient gender and age, but differed between surgeons (1.3% to 11.8%) and was  
 271 significantly higher for two surgeons. Other complications did not relate to the surgical  
 272 technique or a specific surgeon. Patients with suspected SSI had a significantly worse  
 273 outcome except from the presence of constant symptoms and weakness, but the self-  
 274 reported satisfaction score of the effect of surgery (8.7) was not significantly reduced.  
 275 Patients with complications other than SSI had significantly lower self-reported  
 276 satisfaction score of the effect of surgery (6.3) and more had residual symptoms other  
 277 than weakness.

278

279 *Reduced waiting time and improved patient management*



280 An increased number of patients with *no interest* in surgery were identified after  
281 introduction of the telephone interview (21%) compared to no pre-selection (7%). The  
282 nurse discharged 12% of the referred patients after the telephone interview (figure 1).  
283 Moreover, the telephone interviews reduced the number of cancellations and  
284 postponements on the day of surgery and increased the amount of operated patients  
285 actually having surgery completed in a single visit from 68% to 86%.  
286 Pre-screening by telephone interview also reduced the waiting time from *referral* to  
287 *surgery* from 93 days to 81 days, and the *waiting time* from referral to the patients' first  
288 evaluation (telephone interview) from 93 to 31 days, although patient numbers rose with  
289 an annual rate of 3.6%. The average waiting time of 31 days for the telephone interview  
290 includes waiting time for the group of patients redirected for an EMG. Usually the  
291 patients were interviewed within a week of referral or the neurophysiological  
292 evaluation.

293 *Higher patient satisfaction scores*

294 The patient satisfaction scores were significantly higher in operated patients compared  
295 to non-operated patients. Pre-screening by telephone interview, however, increased the  
296 patient satisfaction scores in both groups (table 5).

299 Table 5. Patient satisfaction scores on information level and overall impression of the level of care related to telephone  
300 screening

Information level		Telephone screening		P-value
		No	Yes	
Operated	Yes	8.9 [359]	9.4 [148]	***

		No	7.4 [95]	8.2 [69]	0.07
		p-value	***	***	
<b>Level of care</b>		<b>Telephone screening</b>			
			No	Yes	P-value
Operated	Yes		8.9 [359]	9.2 [148]	*
	No		7.3 [95]	8.0 [69]	n.s
		p-value	***	***	

Average satisfaction scores on the information level and general impression of the level of care [number of patients] on a 1-10 scale according to method of discharge from the OSS clinic (with or without surgery) and pre-assessment with or without telephone screening. Statistical analysis were performed with t-test within each group, and the statistical level of significance was chosen at  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*).

## Discussion

We here show first, that OSS in CTS is safe, has a beneficial long-term outcome and a high self-reported satisfaction scores with OSS in CTS. Secondly, we observed that more patients with no interest in surgery were identified through the telephone interview as compared to a regular outpatient assessment. Lastly, we demonstrate that OSS in CTS reduce waiting time from referral to surgery.

The effectiveness of CTS is usually reported to be very high, although patients might still have some residual symptoms. In consistence with other studies,[7,8] we found that two-thirds of patients were completely free of even minor residual or scar symptoms, and a vaster number benefitted from surgery to a various extent. Non-operated patients had a worse outcome at long-term follow-up, which raises the concern that they could have been discharged in the presence of a carpal tunnel syndrome requiring surgery.

However, the patients in this group who went on to have surgery in a later stage in another facility, had no benefit compared to the patients who never had an operation, which does not support this assumption.

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4 323 The results of CTS are often evaluated by physical findings, while patients might be  
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6 324 more concerned about symptoms and functions. The strongest predictor of satisfaction  
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8 325 of the outcome after CTS symptoms is relief of symptoms, which correlates more with  
9  
10 326 satisfaction than improvement of function.[9,10] We found a good outcome with OSS  
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12 327 for CTS with high self-reported satisfaction scores. Patients with more severe symptoms  
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14 328 and functional impairment assign higher importance to relief of symptoms,[11] which  
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16 329 might explain the higher satisfaction scores in the operated patients. A non-OSS follow-  
17  
18 330 up consultation given to patients discharged without surgery, might increase patient  
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20 331 satisfaction and safety in this subgroup of patients.  
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24  
25 332 Equivalent to others,[3,12] we found a beneficial outcome in the elderly patients. The  
26  
27 333 outcome was not poorer in patients with co-morbidities such as diabetes, excessive use  
28  
29 334 of alcohol and metabolic disorders unless they also had polyneuropathy, arthrosis or  
30  
31 335 atrophy of the thenar. Therefore, in our OSS clinic, we perform surgery in the elderly  
32  
33 336 and in patients with these co-morbidities when otherwise relevant.  
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36  
37 337 SSI was the most frequent complication, and the complication rates in the OSS clinic  
38  
39 338 other than SSI was similar to other studies.[7,8,13–19]  
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41  
42 339 More patients with no interest in surgery were identified through the telephone  
43  
44 340 interview, saving hospital attendance, transport and time off from work for these  
45  
46 341 patients. It may be easier to decline surgery in the telephone than face to face with a  
47  
48 342 surgeon who offers or may even advise surgery. This may particularly be true in one-  
49  
50 343 stop surgery were the whole set-up imply surgery, and the patient may feel a pressure to  
51  
52 344 accept surgery. In the telephone interview the nurse systematically informs the patient  
53  
54  
55 345 and ask the patient for a standpoint regarding surgery and the patient has time to change  
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his/her mind or think it over. We do not believe that the patients are dissuaded from it in the telephone. The patients booked for surgery may feel better prepared for the OSS procedure after the telephone interview. The patients discharged directly from the telephone interview experience a shorter clinical pathway and are not troubled by hospital attendance. All patients experience a faster response to their referral when assessed by the telephone interview. Abovementioned may be the key factors in improving the patient satisfaction. The telephone interview also reduces the surgeon's work-load in the outpatient clinic. The nurses found the primary assessment of referrals relevant and worthwhile although they spend additional time to conduct the telephone interview. The telephone interview did not only lower waiting time from *referral* to *surgery*, but also the time from *referral* to the *first evaluation*, which in particular may benefit patients discharged without surgery directly from the telephone interview.

We collected data from interviews by professionals related to the clinic, and recall bias represents a threat to the internal validity of this retrospective study, as it can be a challenge for the interviewed to recall the past. The risk of recall bias, however, can be reduced when the interviewer encourage the study participants to use enough time before answering to reflect and think through their responses.[20,21] Self-administered questionnaires would have had the advantage of avoiding interviewer bias, patients unwillingness to admit complaints and rushed answers and they usually has a worse outcome.[22,23]

Potential challenges with OSS include insufficient information level and wasted theatre time due to cancellation of booked surgery for reasons such as incorrect diagnosis, non-attendance, mild symptoms, patients unprepared for same day surgery or decline of surgery. We found that pre-screening by telephone interview reduced cancellations and

370 postponements substantially while increasing the patient satisfaction scores in patients  
371 discharged with or without surgery, although the latter group might never have met a  
372 surgeon. Still, half of the remaining cancellations on the day of surgery were attributed  
373 to the patient's decline for surgery, and this number might be reduced further by  
374 improving the pre-operative information. Likewise, more interaction with referring  
375 doctors might contribute further to reduce the number of referred patients discharged  
376 without surgery due to lack of indication.

377 A medico legal concern is that patients discharged by the nurse directly from the  
378 telephone interview never meet a surgeon. However, the purpose of the interview was to  
379 identify and discharge referred patients who did not want surgery or had minor  
380 symptoms. Patients unable to decide for surgery, were given the choice to wait and see  
381 or offered an outpatient / OSS appointment. Others have shown a specialist nurse to be  
382 as effective as junior doctors in pre-assessing patients,[24] and OSS has shown to  
383 demonstrate high patient satisfaction levels as well.[25,26] We found that the nurses  
384 provide valuable contributions in evaluating the majority of the patients during the  
385 telephone interview. A minority of the patients with poor language skills, major relevant  
386 co-morbidity, minor symptoms, pregnancy or doubt should, however, were offered a  
387 separate appointment in the outpatient clinic.

388 Other one-stop clinics also include neurophysiological evaluations. Offering relevant  
389 neurophysiological evaluation, home-kits and instructions for suture removals,  
390 resolvable stitches along with more strict pre-selection and improved information could  
391 provide a more genuine OSS service from the patient perspective and not as in our  
392 present practice, where the one-stop concept in reality mostly applies to the surgeon.

Others have reduced waiting time for surgery in CTS by nurse-led patient management and using an operating nurse.[27,28] Like OSS, nurse-led patient management has the potential to improve patient management, reduce waiting time and costs related to CTS.

Cochrane reviews did not favor the endoscopic technique or the open surgical technique.[19,29] The complication rates in the OSS clinic other than SSI was similar to other studies.[7,8,13–19] In our OSS clinic, primary open surgery was conducted in cases of severe neurological impairment or reoperations, which could account for the less good outcome in our study with the planned open procedure. As in the study by Beck et al.,[18] we did not find a poorer outcome in patients with a converted endoscopic to open procedure.

SSI is the most frequent complications and because major complications are rare, minor morbidities such as SSI have a main impact on the perceived quality of care[30,31]. The true incidence of infection is not clear since SSI are evident only after the patient is discharged and the rates generated by hospital surveillance might be incomplete[30].

Moreover, the general practitioner prescribes the antibiotics and the suspected SSI may not be documented in the hospital journal. This may explain the lower infection rate found in other studies[30,32]. As in Atherton et al.,[33] we believe that SSI is probably over-diagnosed and over-treated. The general practitioner most often removes the stitches and may misinterpret redness or wound gap as SSI, and the antibiotic treatment may never come to the attention of the surgical facility. In accordance with Harness et al.,[34] the higher infection rate did not differ significantly between genders.

Further prospective follow-up studies of OSS in CTS are needed including Medical Technology Assessments to uncover the medical and socioeconomic benefits and

disadvantages of OSS patient management. Data collected prospectively according to the Boston Questionnaire and in distinct groups of patients would have been more comparable to others, but this approach was not applicable for the purpose of evaluating our OSS practice. Physical and neurophysiological follow-up and Workers Compensation status should also be added in future prospective follow-up studies.

Conclusions

Increasing demands on the health care system calls for exploration of new approaches to patient management. OSS can contribute to increase patient satisfaction and reduce medical and socioeconomic costs. We found that OSS is safe and associated with high self-reported satisfaction scores and a beneficial long-term outcome. We recommend OSS as the standard procedure for patient management in referred patients being pre-assessed by nurse-conducted telephone interview prior to an OSS appointment.

List of abbreviations

CTS	Carpal tunnel syndrome
OSS	One-stop surgery
EMG	Electromyography
SSI	Surgical site infections

## 435 Ethics

436 The study was approved by the Data Protection Agency file # 2011-41-6315, and  
437 informed consent prior to the interview was obtained.

## 438 Competing interests

439 The authors declare that they have no competing interests.  
440 No authors have any financial or institutional financial interest regarding the content of  
441 the submission.

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## 447 Authors contributions

448 LMJ contributed to the conception and design, data acquisition and analysis and  
449 drafting of the manuscript. KP and KFB contributed to the conception and design and  
450 provided substantial scientific contribution and critical revision of important intellectual  
451 content. AB, MBL, PSP and SB contributed to the acquisition of data. All authors have  
452 reviewed the manuscript critically and approved the final manuscript.

453



454 Data sharing

455 All data from the present study can be obtained upon request to the corresponding  
456 author.

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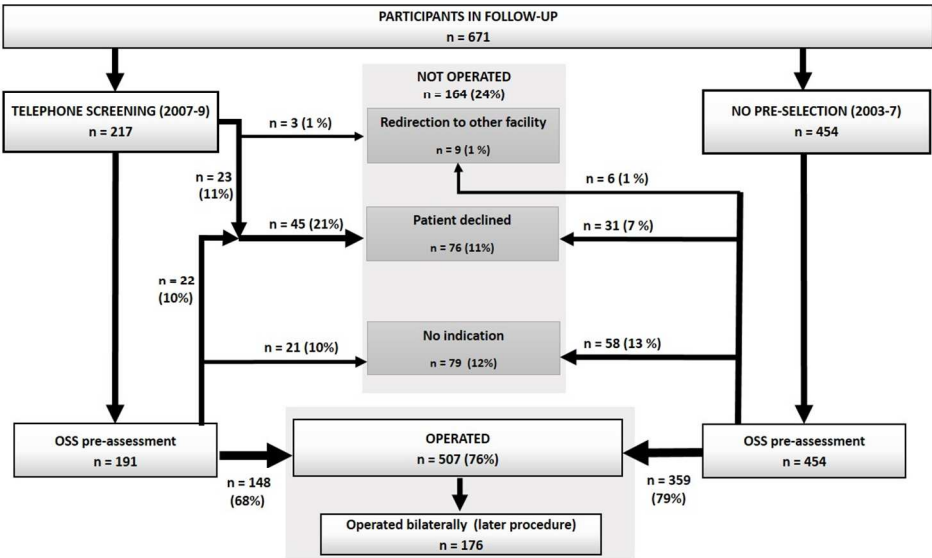
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338x190mm (96 x 96 DPI)

### Legends to flowchart

Flow chart of all referred patients (n = 671) participating in the follow-up study. A larger proportion of patients declined surgery when screened by telephone interview (21%) compared to no pre-selection (7%), and this disposition was not counteracted by the surgeons' decision not to operate.

For peer review only

Cohort and participants in the follow-up study

n (%)	Operated	Non-operated	Total
Original Cohort 2003-9	719	284	1003
[Operated hands]	[955]		
Completed follow-up interview	507 (71)	164 (58)	671 (67)
[Operated hands]	[683]		
Non-participants in the follow-up	212	120	332 (33)
Deceased	57	21	78 (8)
Emmigrated	7	8	15 (1)
Interview could not be completed <sup>1</sup>	36	20	56 (6)
Participation in follow-up declined	21	17	38 (4)
Contact was never established <sup>2</sup>	91	54	145 (14)

Numbers (percentages) of patients discharged with or without surgery from the original cohort at time of the follow-up study. <sup>1</sup>In case of language barriers, severe hearing impairment or mental disability. <sup>2</sup>If the patient did not respond to repeated telephone calls, messages or letters.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	4 (abstract) and 7 (Material and methods: design)
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6 (background)
Objectives	3	State specific objectives, including any prespecified hypotheses	4 (abstract) and 6 (background)
Methods			
Study design	4	Present key elements of study design early in the paper	4 (abstract) and 7 (Material and methods: design)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7 (Material and methods: design)
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7-8 (design)
		(b) For matched studies, give matching criteria and number of exposed and unexposed	Not relevant
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10-11 (Material and methods: primary and secondary outcomes)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	do
Bias	9	Describe any efforts to address potential sources of bias	19 (discussion)
Study size	10	Explain how the study size was arrived at	7-9 (Material and methods: primary and secondary



			outcomes)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10-11 (Material and methods: primary and secondary outcomes and statistics)
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	11 (statistics)
		(b) Describe any methods used to examine subgroups and interactions	do
		(c) Explain how missing data were addressed	Table in Supplementary material
		(d) If applicable, explain how loss to follow-up was addressed	Table in supplementary material
		(e) Describe any sensitivity analyses	Not relevant
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-8 (design) and Table in supplementary material
		(b) Give reasons for non-participation at each stage	Specified in table in supplementary material.
		(c) Consider use of a flow diagram	Given as a figure in supplementary material
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8 (material and methods)
		(b) Indicate number of participants with missing data for each variable of interest	Table 1 and 2
		(c) Summarise follow-up time (eg, average and total amount)	8 (Material and methods)

Outcome data	15*	Report numbers of outcome events or summary measures over time	Table 1 - 5
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11 (statistics) and Table 1-3 (results)
		(b) Report category boundaries when continuous variables were categorized	Not relevant
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not relevant
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	17 (discussion)
<b>Limitations</b>			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17-22 (discussion)
Generalisability	21	Discuss the generalisability (external validity) of the study results	22 (discussion)
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23 (Funding)

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Is one stop surgery for carpal tunnel syndrome safe and efficient? A retrospective long term follow up study in a neurosurgical unit.

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1 Is one stop surgery for carpal tunnel syndrome safe and  
2 efficient? A retrospective long term follow up study in a  
3 neurosurgical unit.

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38  
39

40 Abstract

41 Objectives

42 The aim of this study was to evaluate one-stop surgery (OSS) for carpal tunnel  
43 syndrome (CTS) regarding outcome and patient satisfaction. We hypothesized that OSS  
44 has an outcome comparable to that of non-OSS patients reported in the literature.

45 Design

46 This is a long-term retrospective follow-up study [56.5 months] of 1003 patients  
47 referred for CTS and discharged with or without surgery from an OSS clinic. Of the  
48 original cohort, 671 patients completed the long-term follow-up telephone interview.

49 Results

50 Two thirds of the patients reported to be free of even minor symptoms following  
51 surgery. The outcome and patient satisfaction in this study were comparable to results in  
52 non-OSS patients reported in the literature.

53 Conclusion

54 The implementation of a multidisciplinary clinical pathway and OSS for the  
55 management of CTS was safe with a good long-term clinical outcome and high patient  
56 satisfaction.

57

58 **Keywords:** Carpal tunnel syndrome; Follow-up study; Long-term; Outcome; One-stop  
59 surgery; Patient satisfaction.

60

61 **Strengts and limitations of this study**

- 62 • The study include a large number of patients.

- 63 • The follow-up also include patients discharged without surgery from the OSS clinic.
- 64 • All data were collected retrospectively.
- 65 • Data were not collected according to the Boston questionnaire used in many studies.

## 67 Background

68 Increasing demands on the health care system calls for exploration of new approaches to  
69 patient management. Carpal tunnel syndrome (CTS), which is the most frequent  
70 entrapment neuropathy, with an incidence of operative treatment of 0.6-1.7 per 1000  
71 population with geographical variation[1], leads to a considerable symptom burden and  
72 substantial direct and indirect medical and socioeconomic costs[2]. One-stop surgery  
73 (OSS) may reduce three hospital visits (surgical pre-assessment, surgery, and follow-  
74 up) to a single visit. Hence, OSS has a potential to improve patient satisfaction and  
75 make the use of health care resources more efficient [3,4].

76 Potential challenges with OSS include insufficient information and wasted theatre time  
77 in case of same day cancellation[3]. Another concern is that OSS can be associated with  
78 a substandard pre-assessment, and that this may cause poor patient selection and worse  
79 outcome.

80 The aim of the present study is to evaluate the outcome in a large population of patients  
81 referred for operative treatment of CTS in a Neurosurgical Department in Copenhagen.  
82 We hypothesize that OSS for CTS is safe and has a comparable outcome to that of non-  
83 OSS patients reported in the literature.

84 Previous studies of OSS for CTS, in highly pre-selected patients, reported a high quality  
85 outcome and patient satisfaction[3–5]. One study also included a same day nerve  
86 conduction study in the OSS patient management[4].

87 This study presents a long-term follow-up of outcome and patient satisfaction in a large  
88 population of patients referred for surgery in a neurosurgical OSS clinic.

## 90 Material and methods

91 The aim of this study was to evaluate OSS for CTS in a neurosurgical department  
92 regarding outcome and patient satisfaction.

### 93 Study design

94 This is a retrospective long-term follow-up study of 1003 patients discharged with or  
95 without CTS surgery from the neurosurgical OSS clinic from 2003-2009.

96 Data were retrieved from patient files and a team of two medical students and three  
97 medical doctors conducted the long-term follow-up telephone interviews.

98 Patients were excluded from the telephone interview follow-up if they were not able to  
99 understand Danish or English, had significant cognitive and/or hearing impairment or  
100 had emigrated from Denmark.

### 101 Participants

102 A large majority (67%, n=671) of the 1003 patients in the original cohort (2003-2009)  
103 completed the follow-up interview and constituted the study population. Of the 671  
104 included patients, 507 (78%) patients were discharged from the OSS clinic with surgery



in one or both hands representing overall 683 carpal tunnel releases. An overview of the original cohort, the study population and the non-participants of both operated and non-operated patients can be seen in the supplementary material. Time from referral to follow-up was 56.5 months [15.3-103.6]. The average age was 55 years [21-97] for the operated patients with 77% being female and 53 years [26-89] for the non-operated patients with 73% being female.

The majority (93%) of the operated patients had a neurophysiological evaluation. Patients referred without a neurophysiological evaluation were redirected for an EMG prior to the OSS appointment with the exception of distinct cases presenting a classical clinical picture and history of a successful operation on the opposite hand.

Relevant co-morbidities for all patients in the follow-up study were polyneuropathy (5%), metabolic disorder (5%) primary myxedema; connective tissue disease (9%); diabetes (14%); arthrosis and rheumatism (21%); obesity (14%); excessive use of alcohol exceeding 14/21 units per week for women/men (7%). Other co-variables were age above 70 years (16%), poor communication skills (1%), atrophy of the thenar (7%) and duration of symptoms >3 years (22 %). Of the operated patients, 53% were on medication, which were true for 26% of the non-operated patients.

#### **The patient flow from referral to discharge from the OSS clinic**

The neurosurgical department received referrals from general practitioners and neurologists. During the initial study period (2003-2007) all patients were offered an OSS appointment, as there was no pre-selection of patients for OSS. Later (2007-2009), we introduced pre-selection by a nurse-conducted telephone interview prior to the OSS appointment with the aim to screen out those patients unlikely to undergo OSS. Those

128 patients were discharged directly from the telephone interview. In case of atypical  
129 presentation, inconclusive nerve conduction studies, pregnancy, history of relevant  
130 fractures or severe comorbidities, patients were offered a separate outpatient assessment  
131 instead of an OSS appointment before decision for surgery. Patient selected for OSS  
132 received written information about the procedure and an appointment. A diagram of the  
133 patient flow can be seen in figure 1.

134 At the day of the OSS appointment, the surgeon performed a regular pre-assessment of  
135 the patient and – if indicated - performed surgery immediately afterwards. Patients were  
136 first operated on the side most affected. Patients with CTS in both hands, who had  
137 previously been operated with good outcome, were offered a new appointment for OSS  
138 on the opposite hand. During the study period (2003-2009), there was initially (2003-  
139 2005) no routine postoperative follow-up. Later (2006-2009), the outpatient nurse  
140 conducted postoperative follow-up by a telephone interview on day 1 and day 14 with  
141 the aim to identify postoperative complications requiring medical attention or guidance.

142 The outpatient clinic houses the OSS clinic 3-4 days per month. The clinic  
143 accommodates 5-6 procedures per day. The patients were scheduled for their OSS  
144 appointment with a time interval of 45-60 minutes depending on the surgeon. Two  
145 nurses assisted the surgical procedure in: a) getting the patient ready for surgery, b)  
146 surgery, c) attending the patient during surgery d) cleaning and preparation for the next  
147 procedure and e) providing post-operative information and support to the patient. In  
148 routine cases, the patient left the outpatient clinic when comfortable after surgery.

149 The standard surgical procedure was the endoscopic procedure with the single portal  
150 Wolf system[6]. The surgery was performed in local infiltration anesthesia with up to

10 mL of Marcain-Adrenalin (5 mg/mL + 5 ug/mL) placed in the wrist and palm region without the use of a tourniquet. The reasons for conversion to open surgery were anatomical variations, insufficient space or pain during dissection or at the attempt to introduce the endoscopic tube. Open surgery was used in all re-operations and at the surgeon's individual choice, mostly in the case of severe compression with fixed neurological deficits and suspicion of a very narrow carpal tunnel. The surgeons were board certified neurosurgeons or trainees supervised by a board certified neurosurgeon.

### Outcome measures

We evaluated the long-term outcome of the 671 referred patients to the OSS clinic regarding residual symptoms, surgical complications and patient satisfaction scores. The questions asked were designed to match the questions used in the nurse conducted pre-selection telephone questionnaire used from 2007-2009.

#### *Primary outcome; Residual symptoms*

Residual symptoms were uncovered by questioning the patient: *Do you have any symptoms from your hand?* If so, this was specified as 1) Wake-ups at night due to pain or numbness in the hand, 2) Constant symptoms from the hand, 3) Weakness in the hand, 4) Worsening of symptoms with activity such as using the telephone, using computer, biking, etc., 5) Pain from the wrist, and 6) Pain from the palm.

#### *Secondary outcomes: Patient satisfaction scores and surgical complications*

Patients were asked to assess the following on a 10-point scale (1= very unsatisfied, 10 = very satisfied) related to the effect of the surgery, the information level, and the overall impression of the patient care and management.

173 The numbers and types of complications including suspected surgical site infections  
174 (SSI) treated with antibiotics, were recorded from the patient files and the long-term  
175 follow-up interviews.

176 The outcome measures were analyzed in subgroups of A) surgical technique  
177 (endoscopic, converted or a planned open procedure), B) +/- EMG, C) the surgeon, D)  
178 patient characteristics as described in the demographic section. Six surgeons performed  
179 between 53 and 167 of the total 683 procedures. We pooled surgeons and supervised  
180 residents with less than twenty procedures in one group of total 52 procedures.

181 **Statistical analyses**

182 Data was organized in a relational database. The statistical analyses were performed  
183 with the multivariate logistic regression analysis for co-variants described in the  
184 demographic section. The patient satisfaction scores (1-10) were analyzed with the t-test  
185 of each group.

187 **Results**

188 **Primary and secondary outcomes**

189 *Good long-term outcome at follow-up*

190 The average self-reported satisfaction score of the effect of surgery was 9.0 on a 1-10  
191 scale. At time of follow-up, a vast majority of the operated patients had relief of  
192 symptoms, and 66% of the operated patients (Table 1) became completely free of even  
193 minor symptoms compared to 37% of patients discharged without surgery (Table 2).

The outcomes were equally good in operated patients with co-morbidities, except in patients who had arthrosis, polyneuropathy or atrophy (Tables 1 and 2).

Table 1. Long-term residual symptoms and patient satisfaction scores after one-stop carpal tunnel surgery.

	Co-morbidities and/or risk factors of poor outcome											
	No risk factors	Polyneuropathy	Diabetes	Connective tissue disease	Metabolic disorder	Arthrosis	Symptoms > 3 year	Atrophy	Excessive use of alcohol	Age > 70	Obesity	Use of translator
Number of operated hands (n)	153	35	107	63	40	164	198	57	51	117	125	9
Number of operated patients (n)	120	25	75	44	27	117	148	48	36	86	85	7
Hands (%) free of any symptom	66	43 **	62	62	65	60 *	62	65	61	65	69	78
Hands (%) with symptoms	34	57 **	38	38	35	40 *	38	35	39	35	31	22
Wake-up at nights (%)	8	14	6	14	3	10	5	11	12	9	7	0
Constant symptoms (%)	12	26 *	14	11	15	11	10	19 *	16	16	10	11
Weakness (%)	22	29	25	27	15	23	18	23	20	20	15	11
Worsening (%)	18	34 **	15	19	18	20	21	18	25	9 *	20	22
Paresthesias (%)	19	49 **	31	32	28	31 *	24	32	27	26	26	11
Pain (wrist) (%)	14	17	10	16	10	13	11	7	12	9	12	0
Pain (palm) (%)	7	11	9	13	10	11 *	7	7	8	7	6	0
Self-reported score on a scale of 1-10 (mean)												
Effect of surgery in the hand	9.0	8.9	8.9	8.6	9.0	8.8	9.1	8.9	9.1	9.1	8.9	9.8 **
Level of information	8.9	8.9	8.6	9.1	8.9	8.9	9.0	9.1	8.7	9.5 **	9.0	9.2
Overall impression	8.9	8.9	8.8	8.5	8.5	8.8	9.0	8.9	9.2	9.1	8.8	9.8

The numbers of operated hands and patients are listed according to co-morbidity and other co-variants such as duration of symptoms, atrophy of the thenar, age and communication difficulties. The percentages of operated hands with none or residual symptoms are listed accordingly. Statistical analysis of none or residual symptoms were performed with multivariate logistic regression analysis and the level of statistical significance level was chosen at  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*). The patient satisfaction scores (1-10) are listed as the mean and the statistical analysis was performed with t-test within each group. There is a statistical significant worse outcome in patients with comorbidities of polyneuropathy, arthrosis, atrophy and age with variation in regard to type of symptom, but not with other co-morbidities. Patients age > 70 years and those needing a translator had higher satisfaction scores as compared to other groups of patients.

Table 2. Long-term residual symptoms and patient satisfaction scores in non-operated patients discharged from the OSS clinic.

#### Co-morbidities and/or risk factors of poor outcome

	No risk factors	Polynuropathy	Diabetes	Connective tissue disease	Metabolic disorder	Arthrosis	Excessive use of alcohol	Age > 70	Obesity	Use of translator	> 1 risk factor
Number of patients [hands]	82	7	18	12	3	18	8	20	8	3	26
Hands (%) free of any symptom	37	29	39	39	33	11 *	38	50	38	0	35
Hands (%) with symptoms	63	71	71	61	67	89 *	63	50	63	100	65
Wake-up at nights (%)	21	43	43	28	67	33	38	10	25	100	31
Constant symptoms (%)	18	43	43	33	67	28	25	15	13	67	27
Weakness (%)	38	43	43	33	33	44	50	25	50	67	42
Worsening (%)	43	71	71	61	67	61	50	35	50	100	50
Paresthesies (%)	54	71	71	56	67	67	63	45	38	100	50
Pain (wrist) (%)	21	43	43	33	33	17	13	20	25	33	23
Pain (palm) (%)	11	29	29	17	0	0	13	10	13	33	8
Self-reported score of 1-10 (mean)											
Effect of surgery in the hand											
Level of information	7.8	6.6	7.8	7.7	7.7	7.0	6.3	7.7	7.3	1.0	6.6
Overall impression	7.8	7.0	8.4	7.4	7.3	6.9	6.9	6.7	7.8	1.0	6.2

The numbers of patients discharged without surgery from the OSS clinic and did not have surgery later on in another facility (n=145). An additional 19 patients reported at follow-up that they have had surgery later on in another facility, but their symptoms at follow-up did not differ significantly from the 145 never operated patients. The patients are listed according to co-morbidity and other co-variants such as duration of symptoms, atrophy of the thenar, age and communication difficulties. The percentages of patients with none or residual symptoms are listed accordingly. Statistical analysis was performed with multivariate logistic regression analysis and the level of statistical significance level was chosen at  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*). The patient satisfaction scores (1-10) are listed as the mean and the statistical analysis was performed with t-test within each group. The percentage of patients free of any symptoms at long term follow up was significantly lower as compared to groups of patients with other co-morbidities.

There was no difference in outcome between the endoscopic and the converted procedure. With the planned open procedure, however, which was conducted only in selected cases with severe neurological deficits and in reoperations, the outcome was worse (Table 3).

Table 3. Residual symptoms, effect score and SSI according to surgical technique

	Endoscopic	Converted	Primary open
	n	n	n

Number of operated hands [patients]	487 [366]	140 [108]	56 [33]
<b>Hands (%) free of any symptom</b>	67	66	43 ***
<b>Hands (%) with symptoms</b>	33	34	57 ***
<b>Wake-up at nights (%)</b>	6	8	29 ***
<b>Constant symptoms (%)</b>	11	7	23 **
<b>Weakness (%)</b>	18	20	30 *
<b>Worsening (%)</b>	16	22	30 **
<b>Paresthesias (%)</b>	21	26	38 **
<b>Pain (wrist) (%)</b>	11	9	29 ***
<b>Pain (palm) (%)</b>	7	7	13
<b>Self-reported VRNS score of 1-10 (mean)</b>			
<b>Effect of surgery in the hand</b>	8.9 *	8.9	7.4 ***
<b>Level of information</b>	9.1	8.9	9.3
<b>Overall impression</b>	9.1	8.9	8.9

The numbers and percentages (%) of operated hands with residual symptoms and self-reported scores (1-10) on a 10-point scale (1 = very unsatisfied, 10 = very satisfied) are listed according to surgical technique of the endoscopic, converted and planned open procedures. Statistical analysis was performed with multivariate logistic regression analysis and the level of statistical significance level was chosen at  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*). The patient satisfaction scores (1-10) are listed as the mean and the statistical analysis was performed with t-test within each group. There was no statistical significant outcome in patients having had endoscopic or converted surgery, but patients with primary open surgery had a statistical worse outcome throughout.

Of the 164 patients discharged from the OSS clinic without surgery, nineteen (12%) were operated in another facility at a later stage. This group of patients, however, had residual symptoms equivalent to patients discharged without surgery that had not been operated at time of follow-up.

## Complications

None of the 683 procedures resulted in severe complications. Of the 212 patients who did not participate in the follow-up interview, however, one developed reflex sympathetic dystrophy and another patient had damage to the recurrent muscular branch of the median nerve after surgery.

The follow-up interviews did not reveal any complications unknown to the surgeons, except for a few patients treated with antibiotics for suspected surgical site infections (SSI) (Table 4).



Table 4. Complications and reoperations.

	No	2.49%
Procedures	683	
Complications other than SSI	16	2.3
Excessive bleeding during surgery	1	0.1
Severe spasms (reschedule for generalized anesthesia)	1	0.1
Severe pain (admitted 24 hours)	1	0.1
Re-operations		
Postoperative hematoma	1	0.1
Deep infection	3	0.4
No effect or recurrence	5	1.0
Worsening	2	0.3
Tenosynovitis	1	0.1
Granuloma	1	0.1
Antibiotic use (suspected superficial SSI).	34	5.0

The complications, reoperations and suspected superficial surgical site infection (SSI) are listed in all 683 procedures conducted in patients referred to the OSS clinic in the seven year period 2003-2009 and included in the long-term follow-up interview. The follow-up interview did not reveal any un-documented complications in the journals with the exception of a few patient reports on antibiotic use.

The use of antibiotics for suspected SSI was 5% and significantly higher for the converted procedure. The rate of suspected SSI did not differ significantly between patient gender and age, but differed between surgeons (1.3% to 11.8%) and was significantly higher for two surgeons. Other complications did not relate to the surgical technique or a specific surgeon. Patients with suspected SSI had a significantly worse outcome except from the presence of constant symptoms and weakness, but the self-reported satisfaction score of the effect of surgery (8.7) was not significantly reduced. Patients with complications other than SSI had significantly lower self-reported satisfaction score of the effect of surgery (6.3).

Discussion

We have shown that OSS for CTS in our setting is safe, has a beneficial long-term outcome and a high self-reported satisfaction score. The effectiveness of CTS is usually



reported to be very high, although patients might still have some residual symptoms. In consistence with other studies of outcome after non-OSS[7,8], we found that two-thirds of patients were completely free of even minor residual or scar symptoms, and an additional group of patients benefitted from surgery to some extent. Non-operated patients had a worse outcome at long-term follow-up, which raises the concern that they could have been discharged in the presence of a carpal tunnel syndrome requiring surgery. However, the patients in this group who went on to have surgery in a later stage in another facility, had no benefit compared to the patients who never had an operation, which does not support this assumption.

The results of CTS are often evaluated by physical findings, while patients might be more concerned about symptoms and functions. The strongest predictor of satisfaction of the outcome after CTS symptoms is relief of symptoms, which correlates more with satisfaction than improvement of function[9,10]. We found a good outcome with OSS for CTS with high self-reported satisfaction scores. Patients with more severe symptoms and functional impairment assign higher importance to relief of symptoms[11], which might explain the higher satisfaction scores in the operated patients. A non-OSS follow-up consultation for patients discharged without surgery may increase patient satisfaction and safety in this subgroup of patients.

Equivalent to others[3,12], we found a good outcome in the elderly patients. The outcome was not poorer in patients with co-morbidities such as diabetes, excessive use of alcohol or metabolic disorders unless they also had polyneuropathy, arthrosis or atrophy of the thenar. Therefore, in our OSS clinic, we perform surgery in the elderly and in patients with these co-morbidities when otherwise relevant.

291 SSI was the most frequent complication, and the complication rates in the OSS clinic  
292 other than SSI was similar to that found in other studies[7,8,13–19].

293 We collected data from interviews by professionals related to the clinic, and recall bias  
294 represents a threat to the internal validity of this retrospective study, as it can be a  
295 challenge for the interviewed to recall the past. The risk of recall bias, however, can be  
296 reduced when the interviewer encourage the study participants to use enough time  
297 before answering to reflect and think through their responses[20,21]. Self-administered  
298 questionnaires are generally resulting in a worse reported outcome than telephone  
299 interviews[22,23].

300 Other one-stop clinics also include neurophysiological evaluations. Offering relevant  
301 neurophysiological evaluation, home-kits and instructions for suture removals,  
302 resolvable stitches along with more strict pre-selection and improved information could  
303 provide a more genuine OSS service from the patient perspective and not as in our  
304 present practice, where the one-stop concept in reality mostly applies to the surgeon.

305 Cochrane reviews did not favor the endoscopic technique or the open surgical  
306 technique[19,24]. The complication rates in the OSS clinic other than SSI was similar to  
307 other studies[7,8,13–19]. In our OSS clinic, primary open surgery was conducted in  
308 cases of severe neurological impairment or reoperations, which could account for the  
309 less good outcome in our study with the planned open procedure. As in the study by  
310 Beck et al.[18], we did not find a poorer outcome in patients with a converted  
311 endoscopic to open procedure.

312 SSI is the most frequent complications and because major complications are rare, minor  
313 morbidities such as SSI have a main impact on the perceived quality of care[25,26]. The

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4 314 true incidence of infection is not clear since SSI are evident only after the patient is  
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6 315 discharged and the rates generated by hospital surveillance might be incomplete[25].  
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8 316 Moreover, the general practitioner prescribes the antibiotics and the suspected SSI may  
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10 317 not be documented in the hospital journal. This may explain the lower infection rate  
11  
12 318 found in other studies[25,27]. As in Atherton et al.[28], we believe that SSI is probably  
13  
14 319 over-diagnosed and over-treated. The general practitioner most often removes the  
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16 320 stitches and may misinterpret redness or wound gap as SSI, and the antibiotic treatment  
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18 321 may never come to the attention of the surgical facility. In accordance with Harness et  
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20 322 al.[29] the higher infection rate did not differ significantly between genders.  
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25 323 Further prospective follow-up studies of OSS in CTS are needed including Medical  
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27 324 Technology Assessments to uncover the medical and socioeconomic benefits and  
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29 325 disadvantages of OSS patient management. Data collected prospectively according to  
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31 326 the Boston Questionnaire and in distinct groups of patients would have been more  
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33 327 comparable to others, but this approach was not applicable for the purpose of evaluating  
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35 328 our OSS practice. Physical and neurophysiological follow-up and Workers  
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37 329 Compensation status should also be added in future prospective follow-up studies.  
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## 41 330 Conclusions

42  
43 331 Increasing demands on the health care system calls for exploration of new approaches to  
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45 332 patient management. OSS can contribute to increase patient satisfaction and reduce  
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47 333 medical and socioeconomic costs. We found that OSS is safe and associated with high  
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49 334 self-reported satisfaction scores and a beneficial long-term outcome. We recommend  
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51 335 OSS as the standard procedure for surgical treatment of CTS.  
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337    **List of abbreviations**

338    CTS            Carpal tunnel syndrome

339    OSS            One-stop surgery

340    EMG            Electromyography

341    SSI            Surgical site infections

342

343    **Ethics**

344    The study was approved by the Data Protection Agency file # 2011-41-6315, and  
345    informed consent prior to the interview was obtained.

346    **Competing interests**

347    The authors declare that they have no competing interests.  
348    No authors have any financial or institutional financial interest regarding the content of  
349    the submission.

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354    sending out letters. The authors did not receive money or benefits.

## Authors contributions

LMJ contributed to the conception and design, data acquisition and analysis and drafting of the manuscript. KP and KF contributed to the conception and design and provided substantial scientific contribution and critical revision of important intellectual content. AB, MBL, PSP and SB contributed to the acquisition of data. All authors have reviewed the manuscript critically and approved the final manuscript.

## Data sharing

All data from the present study can be obtained upon request to the corresponding author.

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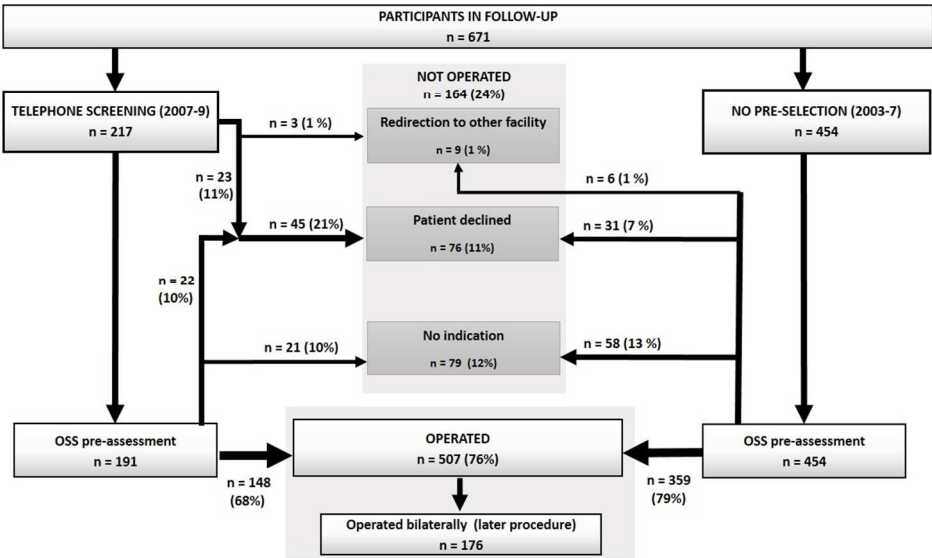


434 Legends to figure 1

435 Flow chart of all referred patients (n = 671) participating in the follow-up study.

436

For peer review only



# Cohort and participants in the follow-up study

n (%)	Operated	Non-operated	Total
Original Cohort 2003-9	719	284	1003
[Operated hands]	[955]		
Completed follow-up interview	507 (71)	164 (58)	671 (67)
[Operated hands]	[683]		
Non-participants in the follow-up	212	120	332 (33)
Deceased	57	21	78 (8)
Emmigrated	7	8	15 (1)
Interview could not be completed <sup>1</sup>	36	20	56 (6)
Participation in follow-up declined	21	17	38 (4)
Contact was never established <sup>2</sup>	91	54	145 (14)

Numbers (percentages) of patients discharged with or without surgery from the original cohort at time of the follow-up study. <sup>1</sup>In case of language barriers, severe hearing impairment or mental disability. <sup>2</sup>If the patient did not respond to repeated telephone calls, messages or letters.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	4 (abstract) and 7 (Material and methods: design)
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6 (background)
Objectives	3	State specific objectives, including any prespecified hypotheses	4 (abstract) and 6 (background)
Methods			
Study design	4	Present key elements of study design early in the paper	4 (abstract) and 7 (Material and methods: design)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7 (Material and methods: design)
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7-8 (design)
		(b) For matched studies, give matching criteria and number of exposed and unexposed	Not relevant
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10-11 (Material and methods: primary and secondary outcomes)
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	do
Bias	9	Describe any efforts to address potential sources of bias	19 (discussion)
Study size	10	Explain how the study size was arrived at	7-9 (Material and methods: primary and secondary

			outcomes)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10-11 (Material and methods: primary and secondary outcomes and statistics)
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	11 (statistics)
		(b) Describe any methods used to examine subgroups and interactions	do
		(c) Explain how missing data were addressed	Table in Supplementary material
		(d) If applicable, explain how loss to follow-up was addressed	Table in supplementary material
		(e) Describe any sensitivity analyses	Not relevant
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-8 (design) and Table in supplementary material
		(b) Give reasons for non-participation at each stage	Specified in table in supplementary material.
		(c) Consider use of a flow diagram	Given as a figure in supplementary material
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8 (material and methods)
		(b) Indicate number of participants with missing data for each variable of interest	Table 1 and 2
		(c) Summarise follow-up time (eg, average and total amount)	8 (Material and methods)

Outcome data	15*	Report numbers of outcome events or summary measures over time	Table 1 - 5
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11 (statistics) and Table 1-3 (results)
		(b) Report category boundaries when continuous variables were categorized	Not relevant
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not relevant
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	17 (discussion)
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17-22 (discussion)
Generalisability	21	Discuss the generalisability (external validity) of the study results	22 (discussion)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23 (Funding)

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Is one stop surgery for carpal tunnel syndrome safe? A retrospective long-term follow-up study in a neurosurgical unit.

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1 Is one stop surgery for carpal tunnel syndrome safe? A  
2 retrospective long-term follow-up study in a neurosurgical  
3 unit.

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40 Abstract

41 Objectives

42 The aim of this study was to evaluate one-stop surgery (OSS) for carpal tunnel  
43 syndrome (CTS) regarding symptom relief and patient satisfaction. OSS in our setting  
44 means only one visit to the hospital for surgery and no hospital appointments for pre-  
45 assessment or follow-up. We hypothesized that relief of symptoms with OSS is  
46 comparable to that in non-OSS patients reported in the literature.

47 Design

48 This is a long-term retrospective follow-up study [56.5 months] of 1003 patients  
49 referred for CTS and discharged with or without surgery from an OSS clinic. Of the  
50 original cohort, 671 patients completed the long-term follow-up telephone interview.

51 Results

52 Two thirds of the patients were free of even minor symptoms following surgery. The  
53 symptom relief and patient satisfaction in this study were comparable to results in non-  
54 OSS patients reported in the literature.

55 Conclusion

56 The implementation of a clinical pathway and OSS for the management of CTS was  
57 safe with good long-term symptom relief and high patient satisfaction.

59 **Keywords:** Carpal tunnel syndrome; Follow-up study; Long-term; Symptom relief;  
60 One-stop surgery; Patient satisfaction.

62 **Strengths and limitations of this study**

- 63 • The study include a large number of patients.
- 64 • The follow-up also includes patients discharged without surgery from the OSS
- 65 clinic.
- 66 • All data were collected retrospectively.
- 67 • A recognized patient reported outcome measure for CTS was not used.

68 Background

69 Increasing demands on the health care system call for exploration of new approaches to  
70 patient management. Carpal tunnel syndrome (CTS), which is the most frequent  
71 entrapment neuropathy, with an incidence of operative treatment of 0.6-1.7 per 1000  
72 population with geographical variation[1], leads to a considerable symptom burden and  
73 substantial direct and indirect medical and socioeconomic costs[2]. One-stop surgery  
74 (OSS) may reduce three hospital visits (surgical pre-assessment, surgery, and follow-  
75 up) to a single visit. Hence, OSS has a potential to improve patient satisfaction and  
76 make the use of health care resources more efficient [3,4].

77 Potential challenges with OSS include late consent from the patient and wasted theatre  
78 time in case of same day cancellation[3]. Another concern is that OSS can be associated  
79 with a substandard pre-assessment, and that this may cause poor patient selection and  
80 worse outcome.

81 The aim of the present study is to evaluate the long-term symptom relief in a large  
82 population of patients referred for operative treatment of CTS in a Neurosurgical  
83 Department in Copenhagen. We hypothesize that OSS for CTS is safe and has a  
84 comparable outcome to that of non-OSS patients reported in the literature.

85 Previous studies of OSS for CTS, in highly pre-selected patients, reported a high quality  
86 outcome and patient satisfaction[3–5]. One study also included a same day nerve  
87 conduction study in the OSS patient management[4].

88

## 89 Material and methods

### 90 Study design

91 This is a retrospective long-term follow-up study of 1003 patients discharged with or  
92 without CTS surgery from the neurosurgical OSS clinic from 2003-2009. Data were  
93 retrieved from patient files and a team of two medical students and three medical  
94 doctors conducted long-term follow-up telephone interviews. Patients were excluded  
95 from the telephone interview follow-up if they were not able to understand Danish or  
96 English, had significant cognitive and/or hearing impairment or had emigrated from  
97 Denmark.

98 The study was approved by the Data Protection Agency j.nr. 2011-41-6315, and  
99 participants in the long-term follow-up interview gave their informed consent prior to  
100 the interview.

### 102 The patient flow from referral to discharge

103 The neurosurgical department received referrals from general practitioners and  
104 neurologists. During the initial study period (2003-2007) all patients were offered an  
105 OSS appointment, as there was no pre-selection of patients for OSS. Later (2007-2009),  
106 we introduced pre-selection by a nurse-conducted telephone interview prior to the OSS  
107 appointment with the aim to screen out those patients unlikely to undergo OSS. Those  
108 patients were discharged directly from the telephone interview. In case of atypical  
109 presentation, inconclusive nerve conduction studies, pregnancy, history of relevant  
110 fractures or severe comorbidities, patients were offered a separate outpatient assessment  
111 instead of an OSS appointment before decision for surgery. Patient selected for OSS

112 received written information about the procedure and an appointment. A diagram of the  
113 patient flow can be seen in figure 1.

114 At the day of the OSS appointment, the surgeon performed a regular pre-assessment of  
115 the patient and – if indicated - performed surgery immediately afterwards. Patients were  
116 first operated on the side most affected. Patients with CTS in both hands, who had  
117 previously been operated with good symptom relief, were offered a new appointment  
118 for OSS on the opposite hand. During the study period (2003-2009), there was initially  
119 (2003-2005) no routine postoperative follow-up. Later (2006-2009), the outpatient nurse  
120 conducted postoperative follow-up by a telephone interview on day 1 and day 14 with  
121 the aim to identify postoperative complications requiring medical attention or guidance.

122 The standard surgical procedure was the endoscopic procedure with the single portal  
123 Wolf system[6]. The surgery was performed with local infiltration anesthesia with up to  
124 10 mL of Marcain-Adrenalin (5 mg/mL + 5 ug/mL) placed in the wrist and palm region  
125 without the use of a tourniquet. Open surgery was used in all re-operations and at the  
126 surgeon's individual choice, mostly in the case of severe compression with fixed  
127 neurological deficits and suspicion of a very narrow carpal tunnel. The surgeons were  
128 board certified neurosurgeons or trainees supervised by a board certified neurosurgeon.

129 **Outcome measures**

130 *Primary outcome; Residual symptoms*

131 The 671 referred patients were evaluated by a structured telephone interview. Patients  
132 were first asked whether they had any residual symptoms at all. If the answer to this was  
133 'yes' then specific enquiries were made about night-waking due to hand symptoms,  
134 hand weakness, aggravation of symptoms by hand activity, wrist pain and palm pain.

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4 135 Patients were also asked whether any of these symptoms were intermittent or  
5  
6 136 continuous.

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8  
9 137 *Secondary outcomes: Patient satisfaction scores and surgical complications*

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11  
12 138 Patients were asked to assess the following on a 10-point scale (1= very unsatisfied, 10  
13  
14 139 = very satisfied) related to the effect of the surgery, the information level, and the  
15  
16 140 overall impression of the patient care and management.

17  
18  
19  
20 141 The numbers and types of complications including suspected surgical site infections  
21  
22 142 (SSI) treated with antibiotics, were recorded from the patient files and the long-term  
23  
24 143 follow-up interviews.

25  
26  
27 144 The outcome measures were analyzed in subgroups of A) surgical technique  
28  
29 145 (endoscopic, converted or a planned open procedure), B) the surgeon and C) patient  
30  
31 146 characteristics as described in the demographic section. Six surgeons performed  
32  
33 147 between 53 and 167 of the total 683 procedures. We pooled surgeons and supervised  
34  
35 148 residents with less than twenty procedures in one group of total 52 procedures.

36  
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38  
39 149 **Statistical analyses**

40  
41  
42 150 Data was organized in a relational database. The statistical analyses were performed  
43  
44 151 post-hoc using the SPSS software with multivariate logistic regression analysis  
45  
46 152 analyzed for each symptom independently with the specific (or none) symptom as the  
47  
48 153 dependent and the following predictors: No risk factor, polyneuropathy, diabetes,  
49  
50 154 connective tissue disease, metabolic disorder, arthrosis, symptoms > 3 years, atrophy,  
51  
52 155 excessive use of alcohol, age > 70 and obesity. Each subgroup of patient satisfaction  
53  
54 156 scores (1-10) were tested independently by two-sample t-test between the group of  
55  
56  
57  
58  
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60

157 patients with no residual symptoms against each group of patients with a specific co-  
158 morbidity. The level of statistical significance level ( $p_{\text{uncorrected}}$ ) for the post-hoc analysis  
159 was chosen at  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*).

161 Results

162 Descriptive statistics of the cohort

163 A large majority (67%,  $n=671$ ) of the 1003 patients in the original cohort (2003-2009)  
164 completed the follow-up interview and constituted the study population. Of the 671  
165 included patients, 507 (78%) patients were discharged from the OSS clinic with surgery  
166 in one or both hands representing overall 683 carpal tunnel releases. An overview of the  
167 original cohort, the study population and the non-participants of both operated and non-  
168 operated patients can be seen in Table I (supplementary material). Time from referral to  
169 follow-up was 56.5 months [15.3-103.6]. The average age was 55 years [21-97] for the  
170 operated patients with 77% being female and 53 years [26-89] for the non-operated  
171 patients with 73% being female.

172 The majority (93%) of the operated patients had a neurophysiological evaluation.  
173 Patients referred without a neurophysiological evaluation were redirected for an EMG  
174 prior to the OSS appointment with the exception of distinct cases presenting a classical  
175 clinical picture and history of a successful operation on the opposite hand.

176 Relevant co-morbidities for all patients in the follow-up study were polyneuropathy  
177 (5%), metabolic disorder (5%) primary myxedema; connective tissue disease (9%);  
178 diabetes (14%); arthrosis and rheumatism (21%); obesity (14%); excessive use of



alcohol exceeding 14/21 units per week for women/men (7%). Other co-variates were age above 70 years (16%), use of translator (1%), atrophy of the thenar (7%) and duration of symptoms >3 years (22 %). Of the operated patients, 53% were on medication, which were true for 26% of the non-operated patients.

## Primary and secondary outcomes

### *Good long-term symptom relief at follow-up*

At time of follow-up, a vast majority of the operated patients had relief of symptoms, and 66% of the operated patients (Table 1) became completely free of even minor symptoms compared to 37% of patients discharged without surgery (Table 2). The average self-reported satisfaction score of the effect of surgery was 9.0 on a 1-10 scale. Patients with arthrosis, polyneuropathy or atrophy had less symptom relief as compared to patients with none or other co-morbidities (Tables 1 and 2).

Table 1. Long-term residual symptoms and patient satisfaction scores after one-stop carpal tunnel surgery.

Co-morbidities or risk factors of poor symptom relief	No risk factors	Polyneuropathy	Diabetes	Connective tissue disease	Metabolic disorder	Arthrosis	Symptoms > 3 year	Atrophy	Excessive use of alcohol	Age > 70	Obesity	1 risk factor
Number of operated hands (n)	153	35	107	63	40	164	198	57	51	117	125	279
Number of operated patients (n)	120	25	75	44	27	117	148	48	36	86	85	200
Hands (%) free of any symptom	66	43 **	62	62	65	60 *	62	65	61	65	69	64
Hands (%) with symptoms	34	57 **	38	38	35	40 *	38	35	39	35	31	36
Wake-up at nights (%)	8	14	6	14	3	10	5	11	12	9	7	9
Constant symptoms (%)	12	26 *	14	11	15	11	10	19 *	16	16	10	13
Weakness (%)	22	29	25	27	15	23	18	23	20	20	15	21
Worsening (%)	18	34 **	15	19	18	20	21	18	25	9 *	20	18
Paresthesies (%)	19	49 **	31	32	28	31 *	24	32	27	26	26	28
Pain (wrist) (%)	14	17	10	16	10	13	11	7	12	9	12	11
Pain (palm) (%)	7	11	9	13	10	11 *	7	7	8	7	6	8

Self-reported score on a scale of 1-10 (mean)												
Effect of surgery in the hand	9.0	8.9	8.9	8.6	9.0	8.8	9.1	8.9	9.1	9.1	8.9	9.0
Level of information	8.9	8.9	8.6	9.1	8.9	8.9	9.0	9.1	8.7	9.5 **	9.0	9.1
Overall impression	8.9	8.9	8.8	8.5	8.5	8.8	9.0	8.9	9.2	9.1	8.8	8.9

The numbers of operated hands and patients are listed according to predictors of co-morbidity, duration of symptoms > 3 years, atrophy of the thenar and age > 70 years. The percentages of operated hands with none or residual symptoms are listed accordingly. The level of statistical significance ( $p_{uncorrected}$ ) for the post-hoc analysis was  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*). The patient satisfaction scores (1-10) are given as average scores.

**Table 2. Long-term residual symptoms and patient satisfaction scores in non-operated patients discharged from the OSS clinic.**

Co-morbidities or risk factors	No risk factors	Polyneuropathy	Diabetes	Connective tissue disease	Metabolic disorder	Arthrosis	Excessive use of alcohol	Age > 70	Obesity	≥ 1 risk factor
Number of patients [hands]	82	7	18	12	3	18	8	20	8	26
Hands (%) free of any symptom	37	29	39	39	33	11 *	38	50	38	35
Hands (%) with symptoms	63	71	71	61	67	89 *	63	50	63	65
Wake-up at nights (%)	21	43	43	28	67	33	38	10	25	31
Constant symptoms (%)	18	43	43	33	67	28	25	15	13	27
Weakness (%)	38	43	43	33	33	44	50	25	50	42
Worsening (%)	43	71	71	61	67	61	50	35	50	50
Paresthesias (%)	54	71	71	56	67	67	63	45	38	50
Pain (wrist) (%)	21	43	43	33	33	17	13	20	25	23
Pain (palm) (%)	11	29	29	17	0	0	13	10	13	8
Self-reported score of 1-10 (mean)										
Effect of surgery in the hand	7.8	6.6	7.8	7.7	7.7	7.0	6.3	7.7	7.3	6.6
Level of information	7.8	7.0	8.4	7.4	7.3	6.9	6.9	6.7	7.8	6.2
Overall impression	7.8	7.0	8.4	7.4	7.3	6.9	6.9	6.7	7.8	6.2

The numbers of patients discharged without surgery from the OSS clinic which did not have surgery later on in another facility (n=145). The patients are listed according to co-morbidity and other co-variants of duration of symptoms > 3 years, atrophy of the thenar and age > 70 years. The percentages of operated hands with none or residual symptoms are listed accordingly. The level of statistical significance ( $p_{uncorrected}$ ) for the post-hoc analysis was  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*). The patient satisfaction scores (1-10) are given as average scores.

The number of endoscopic, converted and primary open procedures are given in Table 3. Reasons for conversion to open surgery were anatomical variations, insufficient space or pain during dissection or at the attempt to introduce the endoscopic guide tube. There was little difference in symptom relief between the endoscopic and the converted

procedure. With the planned open procedure, however, which was conducted only in selected cases with severe neurological deficits and in reoperations, fewer patients experienced symptom relief (Table 3).

**Table 3. Residual symptoms, effect score and SSI according to surgical technique**

	Endoscopic <i>n</i>	Converted <i>n</i>	Primary open <i>n</i>
Number of operated hands [patients]	487 [366]	140 [108]	56 [33]
Hands (%) free of any symptom	67	66	43 ***
Hands (%) with symptoms	33	34	57 ***
Wake-up at nights (%)	6	8	29 ***
Constant symptoms (%)	11	7	23 **
Weakness (%)	18	20	30 *
Worsening (%)	16	22	30 **
Paresthesies (%)	21	26	38 **
Pain (wrist) (%)	11	9	29 ***
Pain (palm) (%)	7	7	13
Self-reported VRNS score of 1-10 (mean)			
Effect of surgery in the hand	8.9 *	8.9	7.4 ***
Level of information	9.1	8.9	9.3
Overall impression	9.1	8.9	8.9

The numbers and percentages (%) of operated hands with residual symptoms and self-reported scores (1-10) on a 10-point scale (1 = very unsatisfied, 10 = very satisfied) are listed according to surgical technique of the endoscopic, converted and planned open procedures. The level of statistical significance ( $p_{\text{uncorrected}}$ ) level was chosen at  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*). The patient satisfaction scores (1-10) are given as the average mean score.

Of the 164 patients discharged from the OSS clinic without surgery, nineteen (12%) were operated in another facility at a later stage. The nineteen patients undergoing surgery in another facility after having been discharged from our clinic without surgery, had at time of follow-up not improved when compared to the remaining 145 patients discharged without surgery, which had never undertaken surgery at time of follow-up.

## Complications

None of the 683 procedures resulted in severe complications. However, from review of patient journals in an additional 212 patients who did not complete or declined to participate in the follow-up interview, one patient developed reflex sympathetic dystrophy and another patient had damage to the recurrent muscular branch of the median nerve after surgery. The follow-up interviews did not reveal any complications unknown to the surgeons, except for a few patients treated with antibiotics for suspected surgical site infections (SSI) (Table 4).

**Table 4. Complications and reoperations.**

	No	238%
<b>Procedures</b>	<b>683</b>	
<b>Complications other than SSI</b>	<b>16</b>	<b>2.3</b>
Excessive bleeding during surgery	1	0.1
Severe spasms (reschedule for generalized anesthesia)	1	0.1
Severe pain (admitted 24 hours)	1	0.1
<b>Re-operations</b>		
Postoperative hematoma	1	0.1
Deep infection	3	0.4
No effect or recurrence	5	1.0
Worsening	2	0.3
Tenosynovitis	1	0.1
Granuloma	1	0.1
<b>Antibiotic use (suspected superficial SSI).</b>	<b>34</b>	<b>5.0</b>

The complications, reoperations and suspected superficial surgical site infection (SSI) are listed in all 683 procedures conducted in patients referred to the OSS clinic in the seven year period 2003-2009 and included in the long-term follow-up interview.

The use of antibiotics for suspected SSI was 5% and significantly higher for the converted procedure. The rate of suspected SSI did not vary with patient age or gender, but differed between surgeons (1.3% to 11.8%), and was significantly higher for two surgeons. Other complications did not relate to the surgical technique or a specific surgeon. Patients treated with antibiotics with or without microbiological confirmation of SSI were more likely to report residual symptoms at time of follow-up, but their self-

249 reported satisfaction score of the effect of surgery (8.7) was not reduced as compared to  
250 patients not treated for SSI. Patients with complications other than SSI had significantly  
251 lower self-reported satisfaction score of the effect of surgery (6.3).

252

## 253 Discussion

254 We have shown that OSS for CTS in our setting is safe, has a good long-term symptom  
255 relief and a high self-reported satisfaction score. The effectiveness of CTS is usually  
256 reported to be very high, although patients might still have some residual symptoms.  
257 Consistent with other studies of symptom relief after non-OSS[7,8], we found that two-  
258 thirds of patients were completely free of even minor residual or scar symptoms, and an  
259 additional group of patients benefitted from surgery to some extent. Non-operated  
260 patients had less symptom relief at long-term follow-up, which raises the concern that  
261 they could have been discharged in the presence of a carpal tunnel syndrome requiring  
262 surgery. However, the patients in this group who went on to have surgery in a later  
263 stage in another facility, had no benefit compared to the patients who never had an  
264 operation, which does not support this assumption.

265 The results of CTS are often evaluated by physical findings, while patients might be  
266 more concerned about symptoms and functions, and symptom relief is the strongest  
267 predictor of satisfaction as compared to other outcome measures such as improvement  
268 of function[9,10]. We demonstrate a good outcome with OSS for CTS in regard to  
269 symptom relief and a high self-reported satisfaction scores. Others have demonstrated  
270 that patients with more severe symptoms and functional impairment assign higher  
271 importance to relief of symptoms[11], which is in line with the higher satisfaction

272 scores in the operated patients observed in our study. A non-OSS follow-up consultation  
273 for patients discharged without surgery could potentially increase patient satisfaction  
274 and safety in this subgroup of patients.

275 Equivalent to others[3,12], we found good symptom relief in the elderly patients. The  
276 symptom relief was not less in patients with co-morbidities such as diabetes, excessive  
277 use of alcohol or metabolic disorders unless they also had polyneuropathy, arthrosis or  
278 atrophy of the thenar. Therefore, in our OSS clinic, we perform surgery in the elderly  
279 and in patients with these co-morbidities when otherwise relevant.

280 SSI was the most frequent complication, and the complication rates in the OSS clinic  
281 other than SSI was similar to that found in other studies[7,8,13–19]. Since SSI is the  
282 most frequent complication and major complications are rare, minor morbidities such as  
283 SSI may have a disproportionate impact on the perceived quality of care[20,21]. The  
284 true incidence of infection is not clear since SSI are evident only after the patient is  
285 discharged and rates derived from hospital records may be underestimates because of  
286 incomplete ascertainment[20,22]. As in Atherton et al.[23], we believe that SSI is  
287 probably over-diagnosed and over-treated. In accordance with Harness et al.[24] the  
288 higher infection rate did not differ significantly between genders.

289 We collected data from interviews by professionals related to the clinic, and recall bias  
290 represents a threat to the internal validity of this retrospective study, as it can be a  
291 challenge for the interviewed to recall the past. The risk of recall bias, however, can be  
292 reduced when the interviewer encourages the study participant to reflect and think  
293 through responses before answering [22,25]. Self-administered questionnaires generally  
294 result in a worse reported outcome than telephone interviews[26,27].

295 Cochrane reviews did not favor the endoscopic technique or the open surgical  
296 technique[19,28]. The complication rates in the OSS clinic other than SSI was similar to  
297 other studies[7,8,13–19]. In our OSS clinic, primary open surgery was conducted in  
298 cases of severe neurological impairment or reoperations, which could account for the  
299 less good symptom relief observed in our study with the planned open procedure. As in  
300 the study by Beck et al.[18], we did not find a difference in symptom relief between the  
301 converted and endoscopic procedure.

302 Other one-stop clinics also include neurophysiological evaluations. Offering relevant  
303 neurophysiological evaluation, home-kits and instructions for suture removals,  
304 resolvable stitches along with more strict pre-selection and improved information could  
305 provide a more genuine OSS service from the patient perspective and not as in our  
306 present practice, where the one-stop concept in reality mostly applies to the surgeon.

## 307 Conclusions

308 Increasing demands on the health care system call for exploration of new approaches to  
309 patient management. OSS can increase patient satisfaction and reduce medical and  
310 socioeconomic costs. We found that OSS is safe and associated with high self-reported  
311 satisfaction scores and a long-term symptom relief comparable to that of non-OSS  
312 patients. We recommend OSS as the standard procedure for surgical treatment of CTS.

313

## 314 List of abbreviations

315 CTS Carpal tunnel syndrome

316 OSS One-stop surgery



317 EMG Electromyography

318 SSI Surgical site infections

319

320 Ethics

321 The study was approved by the Data Protection Agency file # 2011-41-6315, and  
322 informed consent prior to the interview was obtained.

323 Competing interests

324 The authors declare that they have no competing interests.

325 No authors have any financial or institutional financial interest regarding the content of  
326 the submission.

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331 sending out letters. The authors did not receive money or benefits.

332 Authors contributions

333 LMJ contributed to the conception and design, data acquisition and analysis and  
334 drafting of the manuscript. KP and KF contributed to the conception and design and  
335 provided substantial scientific contribution and critical revision of important intellectual



content. AB, MBL, PSP and SB contributed to the acquisition of data. All authors have reviewed the manuscript critically and approved the final manuscript.

## Data sharing

All data from the present study can be obtained upon request to the corresponding author.

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409   Legends to figure 1

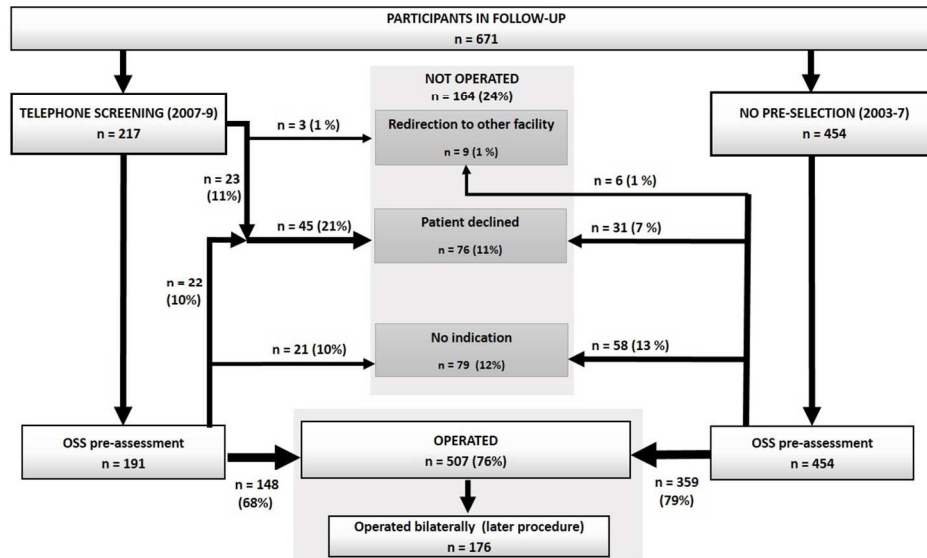
410   Flow chart of all referred patients (n = 671) participating in the follow-up study. The patient

411       was discharged from the clinic without surgery for the following reasons: 1)

412       redirection to another surgical facility, 2) Patient declined surgery and 3) The

413       surgeon did not find an indication to perform carpal tunnel decompression on the

414       referred patient.



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**Table I. Cohort and participants in the follow-up study**

n (%)	Operated	Non-operated	Total
Original Cohort 2003-9	719	284	1003
[Operated hands]	[955]		
Completed follow-up interview	507 (71)	164 (58)	671 (67)
[Operated hands]	[683]		
Non-participants in the follow-up	212	120	332 (33)
Deceased	57	21	78 (8)
Emmigrated	7	8	15 (1)
Interview could not be completed <sup>1</sup>	36	20	56 (6)
Participation in follow-up declined	21	17	38 (4)
Contact was never established <sup>2</sup>	91	54	145 (14)

Numbers (percentages) of patients discharged with or without surgery from the original cohort at time of the follow-up study. <sup>1</sup>In case of language barriers, severe hearing impairment or mental disability. <sup>2</sup>If the patient did not respond to repeated telephone calls, messages or letters.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	4 (abstract) and 7 (Material and methods: design)
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6 (background)
Objectives	3	State specific objectives, including any prespecified hypotheses	4 (abstract) and 6 (background)
Methods			
Study design	4	Present key elements of study design early in the paper	4 (abstract) and 7 (Material and methods: design)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7 (Material and methods: design)
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7-8 (design)
		(b) For matched studies, give matching criteria and number of exposed and unexposed	Not relevant
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10-11 (Material and methods: primary and secondary outcomes)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	do
Bias	9	Describe any efforts to address potential sources of bias	19 (discussion)
Study size	10	Explain how the study size was arrived at	7-9 (Material and methods: primary and secondary

			outcomes)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10-11 (Material and methods: primary and secondary outcomes and statistics)
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	11 (statistics)
		(b) Describe any methods used to examine subgroups and interactions	do
		(c) Explain how missing data were addressed	Table in Supplementary material
		(d) If applicable, explain how loss to follow-up was addressed	Table in supplementary material
		(e) Describe any sensitivity analyses	Not relevant
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-8 (design) and Table in supplementary material
		(b) Give reasons for non-participation at each stage	Specified in table in supplementary material.
		(c) Consider use of a flow diagram	Given as a figure in supplementary material
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8 (material and methods)
		(b) Indicate number of participants with missing data for each variable of interest	Table 1 and 2
		(c) Summarise follow-up time (eg, average and total amount)	8 (Material and methods)



Outcome data	15*	Report numbers of outcome events or summary measures over time	Table 1 - 5
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11 (statistics) and Table 1-3 (results)
		(b) Report category boundaries when continuous variables were categorized	Not relevant
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not relevant
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	17 (discussion)
<b>Limitations</b>			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17-22 (discussion)
Generalisability	21	Discuss the generalisability (external validity) of the study results	22 (discussion)
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23 (Funding)

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Is one stop surgery for carpal tunnel syndrome safe? A retrospective long-term follow-up study in a neurosurgical unit in Copenhagen.

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Keywords:	Hand & wrist < ORTHOPAEDIC & TRAUMA SURGERY, QUALITATIVE RESEARCH, Neurosurgery < SURGERY

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1 Is one stop surgery for carpal tunnel syndrome safe? A  
2 retrospective long-term follow-up study in a neurosurgical  
3 unit in Copenhagen

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40 Abstract

41 Objectives

42 The aim of this study was to evaluate one-stop surgery (OSS) for carpal tunnel  
43 syndrome (CTS) regarding symptom relief and patient satisfaction. OSS in our setting  
44 means only one visit to the hospital for surgery and no hospital appointments for pre-  
45 assessment or follow-up. We hypothesized that relief of symptoms with OSS is  
46 comparable to that in non-OSS patients reported in the literature.

47 Design

48 This is a long-term retrospective follow-up study [56.5 months] of 1003 patients  
49 referred for CTS and discharged with or without surgery from an OSS clinic. Of the  
50 original cohort, 671 patients completed the long-term follow-up telephone interview.

51 Results

52 Two thirds of the patients were free of even minor symptoms following surgery. The  
53 symptom relief and patient satisfaction in this study were comparable to results in non-  
54 OSS patients reported in the literature.

55 Conclusion

56 The implementation of a clinical pathway and OSS for the management of CTS was  
57 safe with good long-term symptom relief and high patient satisfaction.

59 **Keywords:** Carpal tunnel syndrome; Follow-up study; Long-term; Symptom relief;  
60 One-stop surgery; Patient satisfaction.

62 **Strengths and limitations of this study**

- 63 • The study includes a large number of patients.
- 64 • The follow-up also includes patients discharged without surgery from the OSS
- 65 clinic.
- 66 • All data were collected retrospectively.
- 67 • A recognized patient reported outcome measure for CTS was not used.

68 Background

69 Increasing demands on the health care system call for exploration of new approaches to  
70 patient management. Carpal tunnel syndrome (CTS), which is the most frequent  
71 entrapment neuropathy, with an incidence of operative treatment of 0.6-1.7 per 1000  
72 population with geographical variation[1], leads to a considerable symptom burden and  
73 substantial direct and indirect medical and socioeconomic costs[2]. One-stop surgery  
74 (OSS) may reduce three hospital visits (surgical pre-assessment, surgery, and follow-  
75 up) to a single visit. Hence, OSS has a potential to improve patient satisfaction and  
76 make the use of health care resources more efficient [3,4].

77 Potential challenges with OSS include late consent from the patient and wasted theatre  
78 time in case of same day cancellation[3]. Another concern is that OSS can be associated  
79 with a substandard pre-assessment, and that this may cause poor patient selection and  
80 worse outcome.

81 The aim of the present study is to evaluate the long-term symptom relief in a large  
82 population of patients referred for operative treatment of CTS in a Neurosurgical  
83 Department in Copenhagen. We hypothesize that OSS for CTS is safe and has a  
84 comparable outcome to that of non-OSS patients reported in the literature.

85 Previous studies of OSS for CTS, in highly pre-selected patients, reported a high quality  
86 outcome and patient satisfaction[3–5]. One study also included a same day nerve  
87 conduction study in the OSS patient management[4].

88

## 89 Material and methods

### 90 Study design

91 This is a retrospective long-term follow-up study of 1003 patients discharged with or  
92 without CTS surgery from the neurosurgical OSS clinic from 2003-2009. Data were  
93 retrieved from patient files and a team of two medical students and three medical  
94 doctors conducted long-term follow-up telephone interviews. Patients were excluded  
95 from the telephone interview follow-up if they were not able to understand Danish or  
96 English, had significant cognitive and/or hearing impairment or had emigrated from  
97 Denmark.

98 The study was approved by the Data Protection Agency j.nr. 2011-41-6315, and  
99 participants in the long-term follow-up interview gave their informed consent prior to  
100 the interview.

### 102 The patient flow from referral to discharge

103 The neurosurgical department received referrals from general practitioners and  
104 neurologists. During the initial study period (2003-2007) all patients were offered an  
105 OSS appointment, as there was no pre-selection of patients for OSS. Later (2007-2009),  
106 we introduced pre-selection by a nurse-conducted telephone interview prior to the OSS  
107 appointment with the aim to screen out those patients unlikely to undergo OSS. Those  
108 patients were discharged directly from the telephone interview. In case of atypical  
109 presentation, inconclusive nerve conduction studies, pregnancy, history of relevant  
110 fractures or severe comorbidities, patients were offered a separate outpatient assessment  
111 instead of an OSS appointment before decision for surgery. Patient selected for OSS



received written information about the procedure and an appointment. A diagram of the patient flow can be seen in figure 1.

At the day of the OSS appointment, the surgeon performed a regular pre-assessment of the patient and, if indicated, performed surgery immediately afterwards. Patients were first operated on the side most affected. Patients with CTS in both hands, who had previously been operated with good symptom relief, were offered a new appointment for OSS on the opposite hand. During the study period (2003-2009), there was initially (2003-2005) no routine postoperative follow-up. Later (2006-2009), the outpatient nurse conducted postoperative follow-up by a telephone interview on day 1 and day 14 with the aim to identify postoperative complications requiring medical attention or guidance.

The standard surgical procedure was the endoscopic procedure with the single portal Wolf system[6]. The surgery was performed with local infiltration anesthesia with up to 10 mL of Marcain-Adrenalin (5 mg/mL + 5 ug/mL) placed in the wrist and palm region without the use of a tourniquet. Open surgery was used in all re-operations and at the surgeon's individual choice, mostly in the case of severe compression with fixed neurological deficits and suspicion of a very narrow carpal tunnel. The surgeons were board certified neurosurgeons or trainees supervised by a board certified neurosurgeon.

**Outcome measures**

*Primary outcome; Residual symptoms*

The 671 referred patients were evaluated by a structured telephone interview. Patients were first asked whether they had any residual symptoms at all. If the answer to this was 'yes' then specific enquiries were made about night-waking due to hand symptoms, hand weakness, aggravation of symptoms by hand activity, wrist pain and palm pain.

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4 135 Patients were also asked whether any of these symptoms were intermittent or  
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9 137 *Secondary outcomes: Patient satisfaction scores and surgical complications*

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12 138 Patients were asked to assess the following on a 10-point scale (1= very unsatisfied, 10  
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14 139 = very satisfied) related to the effect of the surgery, the information level, and the  
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16 140 overall impression of the patient care and management.

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20 141 The numbers and types of complications including suspected surgical site infections  
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22 142 (SSI) treated with antibiotics, were recorded from the patient files and the long-term  
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24 143 follow-up interviews.

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27 144 The outcome measures were analyzed in subgroups of A) surgical technique  
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29 145 (endoscopic, converted or a planned open procedure), B) the surgeon and C) patient  
30  
31 146 characteristics as described in the demographic section. Six surgeons performed  
32  
33 147 between 53 and 167 of the total 683 procedures. We pooled surgeons and supervised  
34  
35 148 residents with less than twenty procedures in one group of total 52 procedures.

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39 149 **Statistical analyses**

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42 150 Data was organized in a relational database. The statistical analyses were performed  
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44 151 post-hoc using the SPSS software with multivariate logistic regression analysis  
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46 152 analyzed for each symptom independently with the specific (or none) symptom as the  
47  
48 153 dependent and the following predictors: No risk factor, polyneuropathy, diabetes,  
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50 154 connective tissue disease, metabolic disorder, arthrosis, symptoms > 3 years, atrophy,  
51  
52 155 excessive use of alcohol, age > 70 and obesity. Each subgroup of patient satisfaction  
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54 156 scores (1-10) were tested independently by two-sample t-test between the group of  
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157 patients with no residual symptoms against each group of patients with a specific co-  
158 morbidity. The level of statistical significance level ( $p_{\text{uncorrected}}$ ) for the post-hoc analysis  
159 was chosen at  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*).

161 Results

162 Descriptive statistics of the cohort

163 A large majority (67%,  $n=671$ ) of the 1003 patients in the original cohort (2003-2009)  
164 completed the follow-up interview and constituted the study population. Of the 671  
165 included patients, 507 (78%) patients were discharged from the OSS clinic with surgery  
166 in one or both hands representing overall 683 carpal tunnel releases. An overview of the  
167 original cohort, the study population and the non-participants of both operated and non-  
168 operated patients can be seen in Table I (supplementary material). Time from referral to  
169 follow-up was 56.5 months [15.3-103.6]. The average age was 55 years [21-97] for the  
170 operated patients with 77% being female and 53 years [26-89] for the non-operated  
171 patients with 73% being female.

172 The majority (93%) of the operated patients had a neurophysiological evaluation.  
173 Patients referred without a neurophysiological evaluation were redirected for an EMG  
174 prior to the OSS appointment with the exception of distinct cases presenting a classical  
175 clinical picture and history of a successful operation on the opposite hand.

176 Relevant co-morbidities for all patients in the follow-up study were polyneuropathy  
177 (5%), metabolic disorder (5%) primary myxedema; connective tissue disease (9%);  
178 diabetes (14%); arthrosis and rheumatism (21%); obesity (14%); excessive use of

alcohol exceeding 14/21 units per week for women/men (7%). Other co-variates were age above 70 years (16%), use of translator (1%), atrophy of the thenar (7%) and duration of symptoms >3 years (22 %). Of the operated patients, 53% were on medication, which were true for 26% of the non-operated patients.

## Primary and secondary outcomes

### *Good long-term symptom relief at follow-up*

At time of follow-up, a vast majority of the operated patients had relief of symptoms, and 66% of the operated patients (Table 1) became completely free of even minor symptoms compared to 37% of patients discharged without surgery (Table 2). The average self-reported satisfaction score of the effect of surgery was 9.0 on a 1-10 scale. Patients with arthrosis, polyneuropathy or atrophy had less symptom relief as compared to patients with none or other co-morbidities (Tables 1 and 2).

Table 1. Long-term residual symptoms and patient satisfaction scores after one-stop carpal tunnel surgery.

Co-morbidities or risk factors of poor symptom relief	No risk factors	Polyneuropathy	Diabetes	Connective tissue disease	Metabolic disorder	Arthrosis	Symptoms > 3 year	Atrophy	Excessive use of alcohol	Age > 70	Obesity	1 risk factor
Number of operated hands (n)	153	35	107	63	40	164	198	57	51	117	125	279
Number of operated patients (n)	120	25	75	44	27	117	148	48	36	86	85	200
Hands (%) free of any symptom	66	43 **	62	62	65	60 *	62	65	61	65	69	64
Hands (%) with symptoms	34	57 **	38	38	35	40 *	38	35	39	35	31	36
Wake-up at nights (%)	8	14	6	14	3	10	5	11	12	9	7	9
Constant symptoms (%)	12	26 *	14	11	15	11	10	19 *	16	16	10	13
Weakness (%)	22	29	25	27	15	23	18	23	20	20	15	21
Worsening (%)	18	34 **	15	19	18	20	21	18	25	9 *	20	18
Paresthesies (%)	19	49 **	31	32	28	31 *	24	32	27	26	26	28
Pain (wrist) (%)	14	17	10	16	10	13	11	7	12	9	12	11
Pain (palm) (%)	7	11	9	13	10	11 *	7	7	8	7	6	8

Self-reported score on a scale of 1-10 (mean)												
Effect of surgery in the hand	9.0	8.9	8.9	8.6	9.0	8.8	9.1	8.9	9.1	9.1	8.9	9.0
Level of information	8.9	8.9	8.6	9.1	8.9	8.9	9.0	9.1	8.7	9.5 **	9.0	9.1
Overall impression	8.9	8.9	8.8	8.5	8.5	8.8	9.0	8.9	9.2	9.1	8.8	8.9

The numbers of operated hands and patients are listed according to predictors of co-morbidity, duration of symptoms > 3 years, atrophy of the thenar and age > 70 years. The percentages of operated hands with none or residual symptoms are listed accordingly. The level of statistical significance ( $p_{\text{uncorrected}}$ ) for the post-hoc analysis was  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*). The patient satisfaction scores (1-10) are given as average scores.

**Table 2. Long-term residual symptoms and patient satisfaction scores in non-operated patients discharged from the OSS clinic.**

Co-morbidities or risk factors	No risk factors	Polynuropathy	Diabetes	Connective tissue disease	Metabolic disorder	Arthrosis	Excessive use of alcohol	Age > 70	Obesity	> 1 risk factor
Number of patients [hands]	82	7	18	12	3	18	8	20	8	26
Hands (%) free of any symptom	37	29	39	39	33	11 *	38	50	38	35
Hands (%) with symptoms	63	71	71	61	67	89 *	63	50	63	65
Wake-up at nights (%)	21	43	43	28	67	33	38	10	25	31
Constant symptoms (%)	18	43	43	33	67	28	25	15	13	27
Weakness (%)	38	43	43	33	33	44	50	25	50	42
Worsening (%)	43	71	71	61	67	61	50	35	50	50
Paresthesias (%)	54	71	71	56	67	67	63	45	38	50
Pain (wrist) (%)	21	43	43	33	33	17	13	20	25	23
Pain (palm) (%)	11	29	29	17	0	0	13	10	13	8
Self-reported score of 1-10 (mean)										
Effect of surgery in the hand	7.8	6.6	7.8	7.7	7.7	7.0	6.3	7.7	7.3	6.6
Level of information	7.8	7.0	8.4	7.4	7.3	6.9	6.9	6.7	7.8	6.2
Overall impression	7.8	7.0	8.4	7.4	7.3	6.9	6.9	6.7	7.8	6.2

The numbers of patients discharged without surgery from the OSS clinic which did not have surgery later on in another facility (n=145). The patients are listed according to co-morbidity and other co-variants of duration of symptoms > 3 years, atrophy of the thenar and age > 70 years. The percentages of operated hands with none or residual symptoms are listed accordingly. The level of statistical significance ( $p_{\text{uncorrected}}$ ) for the post-hoc analysis was  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*). The patient satisfaction scores (1-10) are given as average scores.

The number of endoscopic, converted and primary open procedures are given in Table 3. Reasons for conversion to open surgery were anatomical variations, insufficient space or pain during dissection or at the attempt to introduce the endoscopic guide tube. There was little difference in symptom relief between the endoscopic and the converted

procedure. With the planned open procedure, however, which was conducted only in selected cases with severe neurological deficits and in reoperations, fewer patients experienced symptom relief (Table 3).

**Table 3. Residual symptoms, effect score and SSI according to surgical technique**

	Endoscopic <i>n</i>	Converted <i>n</i>	Primary open <i>n</i>
Number of operated hands [patients]	487 [366]	140 [108]	56 [33]
Hands (%) free of any symptom	67	66	43 ***
Hands (%) with symptoms	33	34	57 ***
Wake-up at nights (%)	6	8	29 ***
Constant symptoms (%)	11	7	23 **
Weakness (%)	18	20	30 *
Worsening (%)	16	22	30 **
Paresthesias (%)	21	26	38 **
Pain (wrist) (%)	11	9	29 ***
Pain (palm) (%)	7	7	13
<b>Self-reported VRNS score of 1-10 (mean)</b>			
Effect of surgery in the hand	8.9 *	8.9	7.4 ***
Level of information	9.1	8.9	9.3
Overall impression	9.1	8.9	8.9

The numbers and percentages (%) of operated hands with residual symptoms and self-reported scores (1-10) on a 10-point scale (1 = very unsatisfied, 10 = very satisfied) are listed according to surgical technique of the endoscopic, converted and planned open procedures. The level of statistical significance ( $p_{\text{uncorrected}}$ ) level was chosen at  $p < 0.05$  (\*),  $p < 0.01$  (\*\*) and  $p < 0.001$  (\*\*\*). The patient satisfaction scores (1-10) are given as the average mean score.

Of the 164 patients discharged from the OSS clinic without surgery, nineteen (12%) were operated in another facility at a later stage. The nineteen patients undergoing surgery in another facility after having been discharged from our clinic without surgery, had at time of follow-up not improved when compared to the remaining 145 patients discharged without surgery, who had never undertaken surgery at time of follow-up.

## Complications

None of the 683 procedures resulted in severe complications. However, from review of patient journals in an additional 212 patients who did not complete or declined to participate in the follow-up interview, one patient developed reflex sympathetic dystrophy and another patient had damage to the recurrent muscular branch of the median nerve after surgery. The follow-up interviews did not reveal any complications unknown to the surgeons, except for a few patients treated with antibiotics for suspected surgical site infections (SSI) (Table 4).

**Table 4. Complications and reoperations.**

	No	238%
<b>Procedures</b>	<b>683</b>	
<b>Complications other than SSI</b>	<b>16</b>	<b>2.3</b>
Excessive bleeding during surgery	1	0.1
Severe spasms (reschedule for generalized anesthesia)	1	0.1
Severe pain (admitted 24 hours)	1	0.1
<b>Re-operations</b>		
Postoperative hematoma	1	0.1
Deep infection	3	0.4
No effect or recurrence	5	1.0
Worsening	2	0.3
Tenosynovitis	1	0.1
Granuloma	1	0.1
<b>Antibiotic use (suspected superficial SSI).</b>	<b>34</b>	<b>5.0</b>

The complications, reoperations and suspected superficial surgical site infection (SSI) are listed in all 683 procedures conducted in patients referred to the OSS clinic in the seven year period 2003-2009 and included in the long-term follow-up interview.

The use of antibiotics for suspected SSI was 5% and significantly higher for the converted procedure. The rate of suspected SSI did not vary with patient age or gender, but differed between surgeons (1.3% to 11.8%), and was significantly higher for two surgeons. Other complications did not relate to the surgical technique or a specific surgeon. Patients treated with antibiotics with or without microbiological confirmation of SSI were more likely to report residual symptoms at time of follow-up, but their self-



249 reported satisfaction score of the effect of surgery (8.7) was not reduced as compared to  
250 patients not treated for SSI. Patients with complications other than SSI had significantly  
251 lower self-reported satisfaction score of the effect of surgery (6.3).

252

## 253 Discussion

254 We have shown that OSS for CTS in our setting is safe, provide good long-term  
255 symptom relief and a high self-reported satisfaction score. The effectiveness of CTS is  
256 usually reported to be very high, although patients might still have some residual  
257 symptoms. Consistent with other studies of symptom relief after non-OSS[7,8], we  
258 found that two-thirds of patients were completely free of even minor residual or scar  
259 symptoms, and an additional group of patients benefitted from surgery to some extent.  
260 Non-operated patients had less symptom relief at long-term follow-up, which raises the  
261 concern that they could have been discharged in the presence of a carpal tunnel  
262 syndrome requiring surgery. However, the patients in this group who went on to have  
263 surgery in a later stage in another facility, had no benefit compared to the patients who  
264 never had an operation, which does not support this assumption.

265 The results of CTS are often evaluated by physical findings, while patients might be  
266 more concerned about symptoms and functions, and symptom relief is the strongest  
267 predictor of satisfaction as compared to other outcome measures such as improvement  
268 of function[9,10]. We demonstrate a good outcome with OSS for CTS in regard to  
269 symptom relief and high self-reported satisfaction scores. Others have demonstrated that  
270 patients with more severe symptoms and functional impairment assign higher  
271 importance to relief of symptoms[11], which is in line with the higher satisfaction



272 scores in the operated patients observed in our study. A non-OSS follow-up consultation  
273 for patients discharged without surgery could potentially increase patient satisfaction  
274 and safety in this subgroup of patients.

275 Equivalent to others[3,12], we found good symptom relief in the elderly patients. The  
276 only factors significantly associated with poor polyneuropathy, arthrosis or atrophy of  
277 the thenar. Although diabetes, excessive alcohol use and age > 70 years have previously  
278 been suggested to be poor prognostic factors we did not find this. Therefore, in our OSS  
279 clinic, we perform surgery in the elderly and in patients with these co-morbidities when  
280 otherwise relevant.

281 SSI was the most frequent complication, and the complication rate in the OSS clinic  
282 other than SSI was similar to that found in other studies[7,8,13–19]. Since SSI is the  
283 most frequent complication and major complications are rare, minor morbidities such as  
284 SSI may have a disproportionate impact on the perceived quality of care[20,21]. The  
285 true incidence of infection is not clear since SSI are evident only after the patient is  
286 discharged and rates derived from hospital records may be underestimates because of  
287 incomplete ascertainment[20,22]. As in Atherton et al.[23], we believe that SSI is  
288 probably over-diagnosed and over-treated. In accordance with Harness et al.[24] the  
289 higher infection rate did not differ significantly between genders.

290 We collected data from interviews by professionals related to the clinic, and recall bias  
291 represents a threat to the internal validity of this retrospective study, as it can be a  
292 challenge for the interviewed to recall the past. The risk of recall bias, however, can be  
293 reduced when the interviewer encourages the study participant to reflect and think

294 through responses before answering [22,25]. Self-administered questionnaires generally  
295 result in a worse reported outcome than telephone interviews[26,27].

296 Cochrane reviews did not favor the endoscopic technique or the open surgical  
297 technique[19,28]. The complication rates in the OSS clinic other than SSI was similar to  
298 other studies[7,8,13–19]. In our OSS clinic, primary open surgery was conducted in  
299 cases of severe neurological impairment or reoperations, which could account for the  
300 less good symptom relief observed in our study with the planned open procedure. As in  
301 the study by Beck et al.[18], we did not find a difference in symptom relief between the  
302 converted and endoscopic procedure.

303 Our findings are applicable to outpatient clinics with surgical facilities. However, other  
304 one-stop clinics also include neurophysiological evaluations. Offering relevant  
305 neurophysiological evaluation, home-kits and instructions for suture removals,  
306 resolvable stitches along with more strict pre-selection and improved information could  
307 provide a more genuine OSS service from the patient perspective and not as in our  
308 present practice, where the one-stop concept in reality mostly applies to the surgeon.

## 309 Conclusions

310 Increasing demands on the health care system call for exploration of new approaches to  
311 patient management. OSS can increase patient satisfaction and reduce medical and  
312 socioeconomic costs. We found that OSS is safe and associated with high self-reported  
313 satisfaction scores and a long-term symptom relief comparable to that of non-OSS  
314 patients. We recommend OSS as the standard procedure for surgical treatment of CTS.

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316 List of abbreviations

317 CTS Carpal tunnel syndrome

318 OSS One-stop surgery

319 EMG Electromyography

320 SSI Surgical site infections

321

322 Ethics

323 The study was approved by the Data Protection Agency file # 2011-41-6315, and  
324 informed consent prior to the interview was obtained.

325 Competing interests

326 The authors declare that they have no competing interests.

327 No authors have any financial or institutional financial interest regarding the content of  
328 the submission.

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## Authors contributions

LMJ contributed to the conception and design, data acquisition and analysis and drafting of the manuscript. KP and KF contributed to the conception and design and provided substantial scientific contribution and critical revision of important intellectual content. AB, MBL, PSP and SB contributed to the acquisition of data. All authors have reviewed the manuscript critically and approved the final manuscript.

## Data sharing

All data from the present study can be obtained upon request to the corresponding author.

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411   Legends to figure 1

412   Flow chart of all referred patients (n = 671) participating in the follow-up study. The patient

413       was discharged from the clinic without surgery for the following reasons: 1)

414       redirection to another surgical facility, 2) Patient declined surgery and 3) The

415       surgeon did not find an indication to perform carpal tunnel decompression on the

416       referred patient.

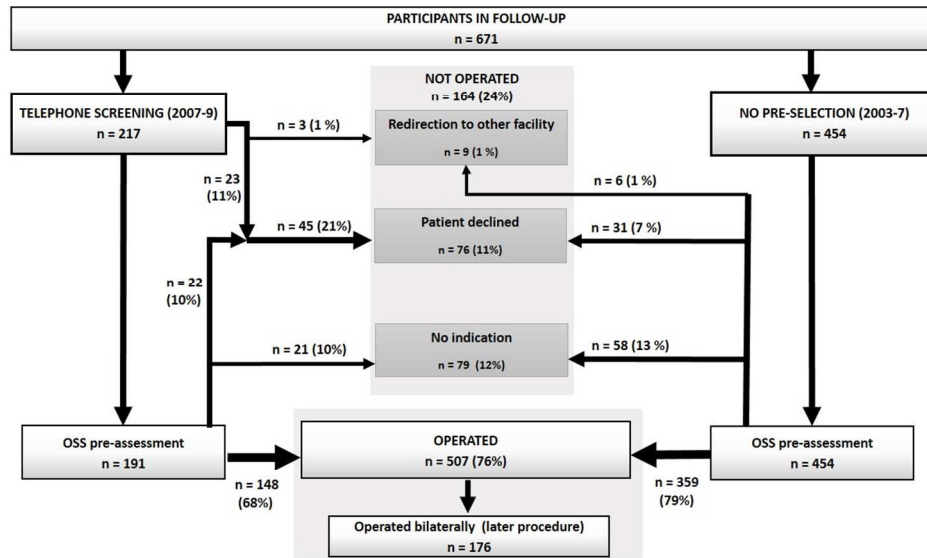




Table I. Cohort and participants in the follow-up study

n (%)	Operated	Non-operated	Total
Original Cohort 2003-9	719	284	1003
[Operated hands]	[955]		
Completed follow-up interview	507 (71)	164 (58)	671 (67)
[Operated hands]	[683]		
Non-participants in the follow-up	212	120	332 (33)
Deceased	57	21	78 (8)
Emmigrated	7	8	15 (1)
Interview could not be completed <sup>1</sup>	36	20	56 (6)
Participation in follow-up declined	21	17	38 (4)
Contact was never established <sup>2</sup>	91	54	145 (14)

Numbers (percentages) of patients discharged with or without surgery from the original cohort at time of the follow-up study. <sup>1</sup>In case of language barriers, severe hearing impairment or mental disability. <sup>2</sup>If the patient did not respond to repeated telephone calls, messages or letters.

**STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology\***  
**Checklist for cohort, case-control, and cross-sectional studies (combined)**

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any pre-specified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-8
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	7
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed Case-control study—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-9
Bias	9	Describe any efforts to address potential sources of bias	14, 16 + supplementary material
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9-10
		(b) Describe any methods used to examine subgroups and interactions	9
		(c) Explain how missing data were addressed	14 + supplementary

			material
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed Case-control study—If applicable, explain how matching of cases and controls was addressed Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10 + Figure 1 + supplementary material
		(b) Give reasons for non-participation at each stage	Figure 1 + Supplementary material
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	10, 14, 16
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)	10
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time	10-13
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Tables and 9
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Tables and 9
Discussion			
Key results	18	Summarise key results with reference to study objectives	15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16-17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18
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\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

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