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Long-term results after one-stop carpal tunnel surgery

Authors

1) Louise Møller Jørgensen[1,2,3], MD Louisemoeller@nru.dk
2) Karin Piil[1,4], MhsN, PhD Karin.piil@regionh.dk
3) Asma Bashir[1], MD ab@asmabashir.dk
4) Morten Bo Larsen[5], MD mblarsen@dadlnet.dk
5) Pamela Santiago Poggenborg[1], MD pspoggenborg@gmail.com
6) Sebastian Bjørck[6], MD drsepsis@gmail.com
7) Kåre Fugleholm Buch[1], MD, PhD. Kaare.fugleholm.buch@regionh.dk

[1]Department of Neurosurgery, University Hospital of Copenhagen, Rigshospitalet, Blegdamsvej 9, 2100 Copenhagen, Denmark

[2]Neurobiology Research Unit, University Hospital of Copenhagen, Rigshospitalet, Blegdamsvej 9, 2100 Copenhagen, Denmark

[3]Faculty of Health and Medical Sciences, University of Copenhagen, Blegdamsvej 3, 2200 Copenhagen, Denmark

[4]The University Hospitals Centre for Health Research (UCSF) and Center for Integrated Rehabilitation of cancer Patients (CIRE), Blegdamsvej 9, 2100 Copenhagen Ø, Denmark

[5]Department of Orthopedics, Hvidovre Hospital, Kettegård Alle 30, 2650 Hvidovre, Denmark

[6]Department of Orthopedics, Slagelse Hospital, Ingemannsvej 18, 4200 Slagelse, Denmark

Corresponding author Louise Møller Jørgensen, MD

Address Neurobiology Research Unit 6931

University Hospital of Copenhagen

Rigshospitalet

Blegdamsvej 9

2100 Copenhagen

e-mail: louise.moeller@nru.dk

Phone: (+45) 35 45 14 69

Fax: (+45) 35 45 67 13

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Abstract

Objectives:

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

Design

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

Results

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

Conclusion

The implementation of a multidisciplinary clinical pathway and OSS for the management of CTS was safe with positive long-term clinical outcome and high patient satisfaction. However, inclusion of the neurophysiological evaluation in the one-stop visit and the use of resolvable sutures would lead to a more genuine one-stop 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.

Strengts 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

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

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

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

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

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

Material and methods

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

Study design

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

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

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

Participants

A large majority (67%, n=671) of the 1003 patients in the original cohort (2003-2009) completed the follow-up interview and constituted the study population. Of the 671 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 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-variates 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.

Alternatively they received a late day OSS appointment to interfere the least with the flow of the day in case of cancellation. Patient selected for OSS received information about the procedure and an appointment. A diagram of the patient flow can be seen in the supplementary material.

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, which they expressed were most affected. Patients with CTS on both hands who had previously been operated with effect, were offered a new appointment for OSS a minimum of three months later 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 outpatient clinic houses the OSS clinic 1-4 days per month. The clinic accommodates 5-6 procedures per day. The patients are scheduled for their OSS appointment with a time interval of 45-60 minutes depending on the surgeon. Two nurses assist the surgical procedure in: a) getting the patient ready for surgery, b) surgery, c) attending the patient during surgery d) cleaning and preparation for the next procedure and e) providing post-operative information and support to the patient. In routine cases, the patient leaves the outpatient clinic when comfortable after surgery.

The standard surgical procedure was the endoscopic procedure with the single portal Wolf system.[6] The surgery was performed in local 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. Conversion to open surgery was done in cases of 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 neurological deficits. The surgeons were all board certified neurosurgeons with the exception of a few supervised procedures performed by residents.

Outcome measures

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

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 nights 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.

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

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

Statistical analyses

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

Results

Primary outcome

Good long-term outcome at follow-up

The overall average self-reported satisfaction score of the effect of surgery was 9.0 on a 1-10 scale. At time of follow-up, a vast majority of the operated patients had relief of symptoms to a various degree, 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 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**	**> 1 risk factor**
Number of operated hands (n)	*153*	*35*	*107*	*63*	*40*	*164*	*198*	*57*	*51*	*117*	*125*	*9*	*279*
Number of operated patients (n)	*120*	*25*	*75*	*44*	*27*	*117*	*148*	*48*	*36*	*86*	*85*	*7*	*200*
Hands (%) free of any symptom	66	**43** **	62	62	65	**60** *	62	65	61	65	69	78	64
Hands (%) with symptoms	34	**57** **	38	38	35	**40** *	38	35	39	35	31	22	36
Wake-up at nights (%)	8	14	6	14	3	10	5	11	12	9	7	0	9
Constant symptoms (%)	12	**26** *	14	11	15	11	10	**19** *	16	16	10	11	13
Weakness (%)	22	29	25	27	15	23	18	23	20	20	15	11	21
Worsening (%)	18	**34** **	15	19	18	20	21	18	25	**9** *	20	22	18
Paresthesies (%)	19	**49** **	31	32	28	**31** *	24	32	27	26	26	11	28
Pain (wrist) (%)	14	17	10	16	10	13	11	7	12	9	12	0	11
Pain (palm) (%)	7	11	9	13	10	**11** *	7	7	8	7	6	0	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	**9.8** **	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	9.2	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	9.8	8.9

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	Polyneuropathy	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.

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	Converted	Primary open
	n	*n*	*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 **
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 informationon	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).

Table 4. Complications and reoperations.

	No	%
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) and more had residual symptoms other than weakness.

Reduced waiting time and improved patient management

An increased number of patients with *no interest* in surgery were identified after introduction of the telephone interview (21%) compared to no pre-selection (7%). The nurse discharged 12% of the referred patients after the telephone interview (figure 1). Moreover, the telephone interviews reduced the number of cancellations and postponements on the day of surgery and increased the amount of operated patients actually having surgery completed in a single visit from 68% to 86%.

Pre-screening by telephone interview also reduced the waiting time from *referral* to *surgery* from 93 days to 81 days, and the *waiting time* from referral to the patients' first evaluation (telephone interview) from 93 to 31 days, although patient numbers rose with an annual rate of 3.6%. The average waiting time of 31 days for the telephone interview includes waiting time for the group of patients redirected for an EMG. Usually the patients were interviewed within a week of referral or the neurophysiological evaluation.

Higher patient satisfaction scores

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

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

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

	No	7.4 [95]	8.2 [69]	0.07
	p-value	***	***	

Level of care		Telephone screening		
		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.

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 given to patients discharged without surgery, might increase patient satisfaction and safety in this subgroup of patients.

Equivalent to others,[3,12] we found a beneficial outcome in the elderly patients. The outcome was not poorer in patients with co-morbidities such as diabetes, excessive use of alcohol and 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.

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

More patients with no interest in surgery were identified through the telephone interview, saving hospital attendance, transport and time off from work for these patients. It may be easier to decline surgery in the telephone than face to face with a surgeon who offers or may even advise surgery. This may particularly be true in one-stop surgery were the whole set-up imply surgery, and the patient may feel a pressure to accept surgery. In the telephone interview the nurse systematically informs the patient and ask the patient for a standpoint regarding surgery and the patient has time to change

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

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

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

Other one-stop clinics also include neurophysiological evaluations. Offering relevant neurophysiological evaluation, home-kits and instructions for suture removals, resolvable stiches along with more strict pre-selection and improved information could provide a more genuine OSS service from the patient perspective and not as in our 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 Questionaire 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

Ethics

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

Competing interests

The authors declare that they have no competing interests.

No authors have any financial or institutional financial interest regarding the content of 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 KFB 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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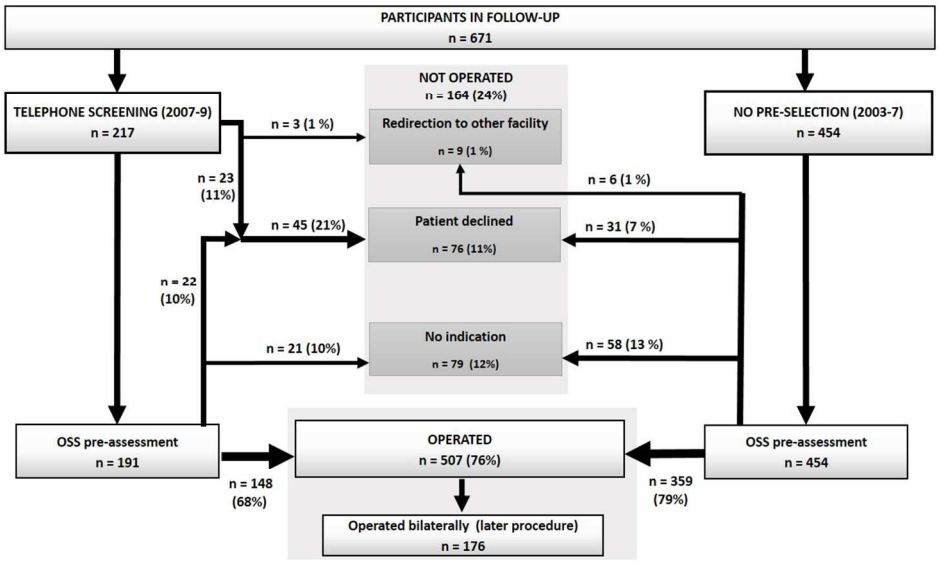

338x190mm (96 x 96 DPI)

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.

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[1]	36	20	56 (6)
Participation in follow-up declined	21	17	38 (4)
Contact was never established[2]	91	54	145 (14)

Numbers (percentages) of patients discharged with or without surgery from the original cohort at time of the follow-up study. [1]In case of language barriers, severe hearing impairment or mental disability. [2]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.

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

Authors

1) Louise Møller Jørgensen[1,2,3], MD Louisemoeller@nru.dk
2) Karin Piil[1,4], MhsN, PhD Karin.piil@regionh.dk
3) Asma Bashir[1], MD ab@asmabashir.dk
4) Morten Bo Larsen[5], MD mblarsen@dadlnet.dk
5) Pamela Santiago Poggenborg[1], MD pspoggenborg@gmail.com
6) Sebastian Bjørck[6], MD drsepsis@gmail.com
7) Kåre Fugleholm, MD, PhD. kaare.fugleholm@regionh.dk

[1]Department of Neurosurgery, University Hospital of Copenhagen, Rigshospitalet, Blegdamsvej 9, 2100 Copenhagen, Denmark

[2]Neurobiology Research Unit, University Hospital of Copenhagen, Rigshospitalet, Blegdamsvej 9, 2100 Copenhagen, Denmark

[3]Faculty of Health and Medical Sciences, University of Copenhagen, Blegdamsvej 3, 2200 Copenhagen, Denmark

[4]The University Hospitals Centre for Health Research (UCSF) and Department of oncology, Blegdamsvej 9, 2100 Copenhagen Ø, Denmark

[5]Department of Orthopedics, Hvidovre Hospital, Kettegård Alle 30, 2650 Hvidovre, Denmark

[6]Department of Orthopedics, Slagelse Hospital, Ingemannsvej 18, 4200 Slagelse, Denmark

Corresponding author Louise Møller Jørgensen, MD

Address Neurobiology Research Unit 6931

University Hospital of Copenhagen

Rigshospitalet

Blegdamsvej 9

2100 Copenhagen

e-mail: louise.moeller@nru.dk

Phone: (+45) 35 45 14 69

Fax: (+45) 35 45 67 13

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Abstract

Objectives

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

Design

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

Results

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

Conclusion

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

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

Strengts 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 were collected retrospectively.
- Data were not collected according to the Boston questionnaire used in many studies.

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 of 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]. One-stop surgery (OSS) may reduce three hospital visits (surgical pre-assessment, surgery, and follow-up) to a single visit. Hence, OSS has a potential to improve patient satisfaction and make the use of health care resources more efficient [3,4].

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

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

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

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

Material and methods

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

Study design

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

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

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

Participants

A large majority (67%, n=671) of the 1003 patients in the original cohort (2003-2009) completed the follow-up interview and constituted the study population. Of the 671 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-variates 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

patients were discharged directly from the telephone interview. In case of atypical presentation, inconclusive nerve conduction studies, pregnancy, history of relevant fractures or severe comorbidities, patients were offered a separate outpatient assessment 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 outcome, 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 outpatient clinic houses the OSS clinic 3-4 days per month. The clinic accommodates 5-6 procedures per day. The patients were scheduled for their OSS appointment with a time interval of 45-60 minutes depending on the surgeon. Two nurses assisted the surgical procedure in: a) getting the patient ready for surgery, b) surgery, c) attending the patient during surgery d) cleaning and preparation for the next procedure and e) providing post-operative information and support to the patient. In routine cases, the patient left the outpatient clinic when comfortable after surgery.

The standard surgical procedure was the endoscopic procedure with the single portal 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 questionaire 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.

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

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

Statistical analyses

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

Results

Primary and secondary outcomes

Good long-term outcome at follow-up

The average self-reported satisfaction score of the effect of surgery was 9.0 on a 1-10 scale. 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 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**	**> 1 risk factor**
Number of operated hands (n)	*153*	*35*	*107*	*63*	*40*	*164*	*198*	*57*	*51*	*117*	*125*	*9*	*279*
Number of operated patients (n)	*120*	*25*	*75*	*44*	*27*	*117*	*148*	*48*	*36*	*86*	*85*	*7*	*200*
Hands (%) free of any symptom	66	**43** **	62	62	65	**60** *	62	65	61	65	69	78	64
Hands (%) with symptoms	34	**57** **	38	38	35	**40** *	38	35	39	35	31	22	36
Wake-up at nights (%)	8	14	6	14	3	10	5	11	12	9	7	0	9
Constant symptoms (%)	12	**26** *	14	11	15	11	10	**19** *	16	16	10	11	13
Weakness (%)	22	29	25	27	15	23	18	23	20	20	15	11	21
Worsening (%)	18	**34** **	15	19	18	20	21	18	25	**9** *	20	22	18
Paresthesies (%)	19	**49** **	31	32	28	**31** *	24	32	27	26	26	11	28
Pain (wrist) (%)	14	17	10	16	10	13	11	7	12	9	12	0	11
Pain (palm) (%)	7	11	9	13	10	**11** *	7	7	8	7	6	0	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	**9.8** **	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	9.2	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	9.8	8.9

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 > 7o 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	Polyneuropathy	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]*
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 informationon	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. 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	%
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.

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

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 are generally resulting in a worse reported outcome than telephone interviews[22,23].

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

Cochrane reviews did not favor the endoscopic technique or the open surgical technique[19,24]. 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[25,26]. 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[25]. 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[25,27]. As in Atherton et al.[28], 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.[29] 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 Questionaire 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 surgical treatment of CTS.

List of abbreviations

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

Ethics

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

Competing interests

The authors declare that they have no competing interests.

No authors have any financial or institutional financial interest regarding the content of 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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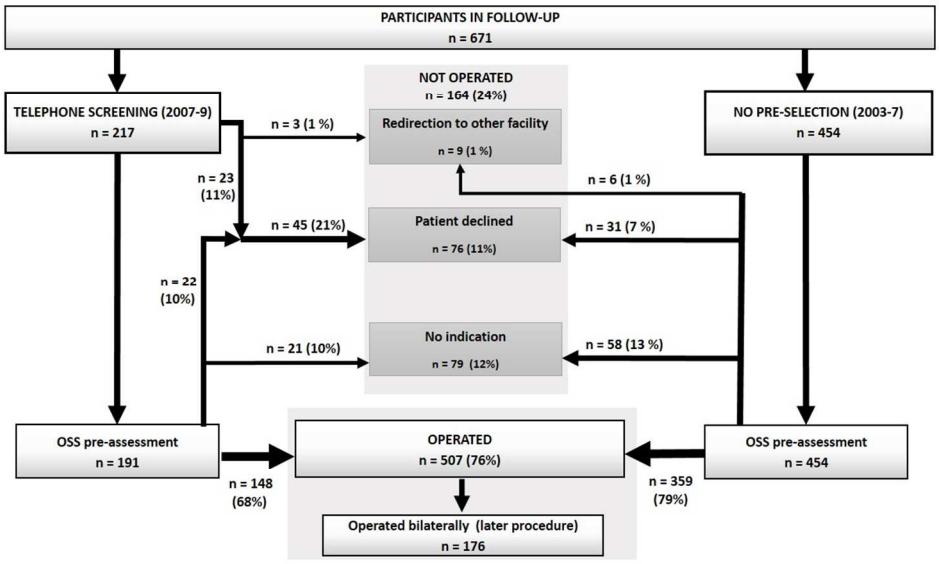
Legends to figure 1

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



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[1]	36	20	56 (6)
Participation in follow-up declined	21	17	38 (4)
Contact was never established[2]	91	54	145 (14)

Numbers (percentages) of patients discharged with or without surgery from the original cohort at time of the follow-up study. [1]In case of language barriers, severe hearing impairment or mental disability. [2]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.

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

Authors

1) Louise Møller Jørgensen[1,2,3], MD Louisemoeller@nru.dk
2) Karin Piil[1,4], MhsN, PhD Karin.piil@regionh.dk
3) Asma Bashir[1], MD ab@asmabashir.dk
4) Morten Bo Larsen[5], MD mblarsen@dadlnet.dk
5) Pamela Santiago Poggenborg[1], MD pspoggenborg@gmail.com
6) Sebastian Bjørck[6], MD drsepsis@gmail.com
7) Kåre Fugleholm, MD, PhD. kaare.fugleholm@regionh.dk

[1]Department of Neurosurgery, University Hospital of Copenhagen, Rigshospitalet, Blegdamsvej 9, 2100 Copenhagen, Denmark

[2]Neurobiology Research Unit, University Hospital of Copenhagen, Rigshospitalet, Blegdamsvej 9, 2100 Copenhagen, Denmark

[3]Faculty of Health and Medical Sciences, University of Copenhagen, Blegdamsvej 3, 2200 Copenhagen, Denmark

[4]The University Hospitals Centre for Health Research (UCSF) and Department of oncology, Blegdamsvej 9, 2100 Copenhagen Ø, Denmark

[5]Department of Orthopedics, Hvidovre Hospital, Kettegård Alle 30, 2650 Hvidovre, Denmark

[6]Department of Orthopedics, Slagelse Hospital, Ingemannsvej 18, 4200 Slagelse, Denmark

Corresponding author Louise Møller Jørgensen, MD

Address Neurobiology Research Unit 6931

University Hospital of Copenhagen

Rigshospitalet

Blegdamsvej 9

2100 Copenhagen

e-mail: louise.moeller@nru.dk

Phone: (+45) 35 45 14 69

Fax: (+45) 35 45 67 13

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Abstract

Objectives

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

Design

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

Results

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

Conclusion

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

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

Strengths and limitations of this study

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

Background

Increasing demands on the health care system call 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 of 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]. One-stop surgery (OSS) may reduce three hospital visits (surgical pre-assessment, surgery, and follow-up) to a single visit. Hence, OSS has a potential to improve patient satisfaction and make the use of health care resources more efficient [3,4].

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

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

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

Material and methods

Study design

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

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

The patient flow from referral to discharge

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 patients were discharged directly from the telephone interview. In case of atypical presentation, inconclusive nerve conduction studies, pregnancy, history of relevant fractures or severe comorbidities, patients were offered a separate outpatient assessment 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.

Patients were also asked whether any of these symptoms were intermittent or continuous.

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.

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

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

Statistical analyses

Data was organized in a relational database. The statistical analyses were performed post-hoc using the SPSS software with multivariate logistic regression analysis analyzed for each symptom independently with the specific (or none) symptom as the dependent and the following predictors: No risk factor, polyneuropathy, diabetes, connective tissue disease, metabolic disorder, arthrosis, symptoms > 3 years, atrophy, excessive use of alcohol, age > 70 and obesity. Each subgroup of patient satisfaction scores (1-10) were tested independently by two-sample t-test between the group of

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

Results

Descriptive statistics of the cohort

A large majority (67%, n=671) of the 1003 patients in the original cohort (2003-2009) completed the follow-up interview and constituted the study population. Of the 671 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 Table I (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-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
Paresthesies (%)	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										
Level of information	7.8	6.6	7.8	7.7	7.7	7.0	6.3	7.7	7.3	6.6
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	Converted	Primary open
	n	*n*	*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 **
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 informationon	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 ($p_{uncorrected}$) 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	%
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 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-

reported satisfaction score of the effect of surgery (8.7) was not reduced as compared to patients not treated for SSI. 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 good long-term symptom relief 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. Consistent with other studies of symptom relief 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 less symptom relief 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, and symptom relief is the strongest predictor of satisfaction as compared to other outcome measures such as improvement of function[9,10]. We demonstrate a good outcome with OSS for CTS in regard to symptom relief and a high self-reported satisfaction scores. Others have demonstrated that patients with more severe symptoms and functional impairment assign higher importance to relief of symptoms[11], which is in line with the higher satisfaction

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

Equivalent to others[3,12], we found good symptom relief in the elderly patients. The symptom relief was not less 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.

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

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 encourages the study participant to reflect and think through responses before answering [22,25]. Self-administered questionnaires generally result in a worse reported outcome than telephone interviews[26,27].

Cochrane reviews did not favor the endoscopic technique or the open surgical technique[19,28]. 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 symptom relief observed in our study with the planned open procedure. As in the study by Beck et al.[18], we did not find a difference in symptom relief between the converted and endoscopic procedure.

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

Conclusions

Increasing demands on the health care system call for exploration of new approaches to patient management. OSS can 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 long-term symptom relief comparable to that of non-OSS patients. We recommend OSS as the standard procedure for surgical treatment of CTS.

List of abbreviations

CTS	Carpal tunnel syndrome
OSS	One-stop surgery

EMG	Electromyography
SSI	Surgical site infections

Ethics

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

Competing interests

The authors declare that they have no competing interests.

No authors have any financial or institutional financial interest regarding the content of 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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Legends to figure 1

Flow chart of all referred patients (n = 671) participating in the follow-up study. The patient was discharged from the clinic without surgery for the following reasons: 1) redirection to another surgical facility, 2) Patient declined surgery and 3) The surgeon did not find an indication to perform carpal tunnel decompression on the referred patient.

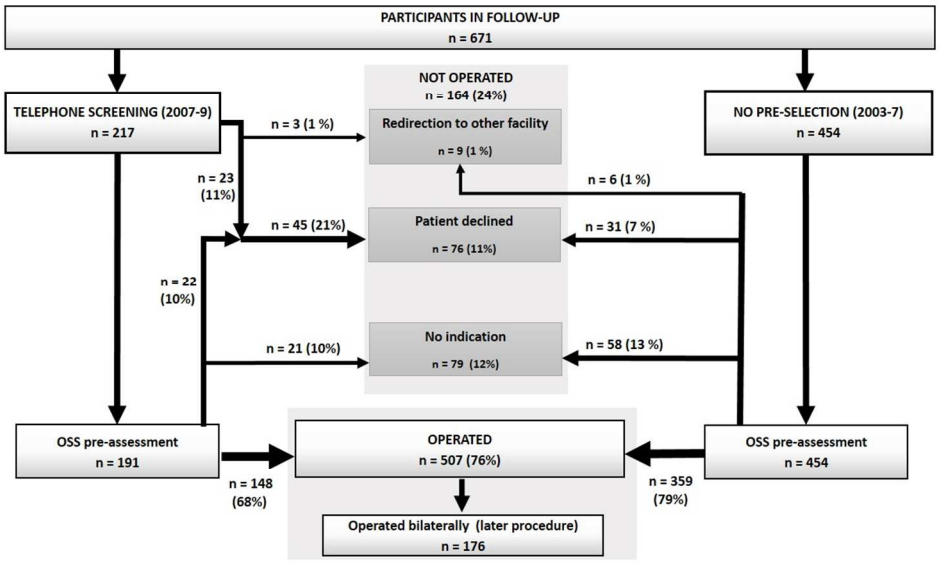

Table I. Cohort and participants in the follow-up study

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[1]	36	20	56 (6)
Participation in follow-up declined	21	17	38 (4)
Contact was never established[2]	91	54	145 (14)

Numbers (percentages) of patients discharged with or without surgery from the original cohort at time of the follow-up study. [1]In case of language barriers, severe hearing impairment or mental disability. [2]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.

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

Authors

1) Louise Møller Jørgensen[1,2,3], MD Louisemoeller@nru.dk
2) Karin Piil[1,4], MhsN, PhD Karin.piil@regionh.dk
3) Asma Bashir[1], MD ab@asmabashir.dk
4) Morten Bo Larsen[5], MD mblarsen@dadlnet.dk
5) Pamela Santiago Poggenborg[1], MD pspoggenborg@gmail.com
6) Sebastian Bjørck[6], MD drsepsis@gmail.com
7) Kåre Fugleholm, MD, PhD. kaare.fugleholm@regionh.dk

[1]Department of Neurosurgery, University Hospital of Copenhagen, Rigshospitalet, Blegdamsvej 9, 2100 Copenhagen, Denmark

[2]Neurobiology Research Unit, University Hospital of Copenhagen, Rigshospitalet, Blegdamsvej 9, 2100 Copenhagen, Denmark

[3]Faculty of Health and Medical Sciences, University of Copenhagen, Blegdamsvej 3, 2200 Copenhagen, Denmark

[4]The University Hospitals Centre for Health Research (UCSF) and Department of oncology, Blegdamsvej 9, 2100 Copenhagen Ø, Denmark

[5]Department of Orthopedics, Hvidovre Hospital, Kettegård Alle 30, 2650 Hvidovre, Denmark

[6]Department of Orthopedics, Slagelse Hospital, Ingemannsvej 18, 4200 Slagelse, Denmark

Corresponding author Louise Møller Jørgensen, MD

Address Neurobiology Research Unit 6931

University Hospital of Copenhagen

Rigshospitalet

Blegdamsvej 9

2100 Copenhagen

e-mail: louise.moeller@nru.dk

Phone: (+45) 35 45 14 69

Fax: (+45) 35 45 67 13

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Abstract

Objectives

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

Design

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

Results

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

Conclusion

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

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

Strengths and limitations of this study

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

Background

Increasing demands on the health care system call 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 of 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]. One-stop surgery (OSS) may reduce three hospital visits (surgical pre-assessment, surgery, and follow-up) to a single visit. Hence, OSS has a potential to improve patient satisfaction and make the use of health care resources more efficient [3,4].

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

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

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

Material and methods

Study design

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

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

The patient flow from referral to discharge

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 patients were discharged directly from the telephone interview. In case of atypical presentation, inconclusive nerve conduction studies, pregnancy, history of relevant fractures or severe comorbidities, patients were offered a separate outpatient assessment 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.

Patients were also asked whether any of these symptoms were intermittent or continuous.

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.

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

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

Statistical analyses

Data was organized in a relational database. The statistical analyses were performed post-hoc using the SPSS software with multivariate logistic regression analysis analyzed for each symptom independently with the specific (or none) symptom as the dependent and the following predictors: No risk factor, polyneuropathy, diabetes, connective tissue disease, metabolic disorder, arthrosis, symptoms > 3 years, atrophy, excessive use of alcohol, age > 70 and obesity. Each subgroup of patient satisfaction scores (1-10) were tested independently by two-sample t-test between the group of

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

Results

Descriptive statistics of the cohort

A large majority (67%, n=671) of the 1003 patients in the original cohort (2003-2009) completed the follow-up interview and constituted the study population. Of the 671 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 Table I (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-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
Paresthesies (%)	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										
Level of information	7.8	6.6	7.8	7.7	7.7	7.0	6.3	7.7	7.3	6.6
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	Converted	Primary open
	n	*n*	*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 **
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 informationon	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 ($p_{uncorrected}$) 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	%
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 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-

reported satisfaction score of the effect of surgery (8.7) was not reduced as compared to patients not treated for SSI. 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, provide good long-term symptom relief 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. Consistent with other studies of symptom relief 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 less symptom relief 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, and symptom relief is the strongest predictor of satisfaction as compared to other outcome measures such as improvement of function[9,10]. We demonstrate a good outcome with OSS for CTS in regard to symptom relief and high self-reported satisfaction scores. Others have demonstrated that patients with more severe symptoms and functional impairment assign higher importance to relief of symptoms[11], which is in line with the higher satisfaction

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

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

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

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 encourages the study participant to reflect and think

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

Cochrane reviews did not favor the endoscopic technique or the open surgical technique[19,28]. 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 symptom relief observed in our study with the planned open procedure. As in the study by Beck et al.[18], we did not find a difference in symptom relief between the converted and endoscopic procedure.

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

Conclusions

Increasing demands on the health care system call for exploration of new approaches to patient management. OSS can 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 long-term symptom relief comparable to that of non-OSS patients. We recommend OSS as the standard procedure for surgical treatment of CTS.

List of abbreviations

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

Ethics

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

Competing interests

The authors declare that they have no competing interests.

No authors have any financial or institutional financial interest regarding the content of 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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Legends to figure 1

Flow chart of all referred patients (n = 671) participating in the follow-up study. The patient was discharged from the clinic without surgery for the following reasons: 1) redirection to another surgical facility, 2) Patient declined surgery and 3) The surgeon did not find an indication to perform carpal tunnel decompression on the referred patient.

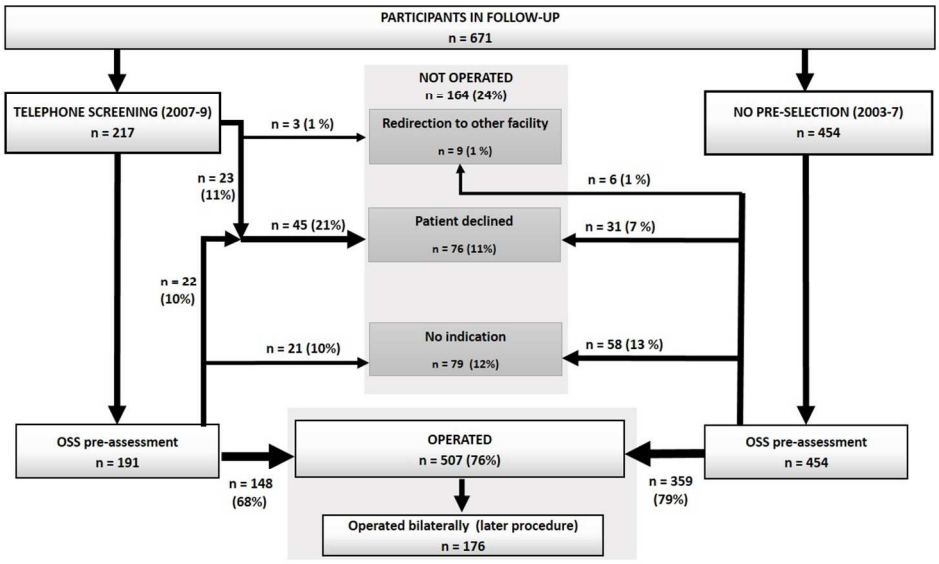

Table I. Cohort and participants in the follow-up study

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[1]	36	20	56 (6)
Participation in follow-up declined	21	17	38 (4)
Contact was never established[2]	91	54	145 (14)

Numbers (percentages) of patients discharged with or without surgery from the original cohort at time of the follow-up study. [1]In case of language barriers, severe hearing impairment or mental disability. [2]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

*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.