ORIGINAL ARTICLE

# Endoscopic carpal tunnel release: experience of surgical outcome in a Chinese population

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**Objective** To review the outcomes of endoscopic carpal tunnel release in a Hong Kong public hospital and identify any predictive factors.

**Design** Retrospective study.

**Setting** Regional hospital with a hand surgery service, Hong Kong.

**Patients** Between January 2001 and December 2007, records of 145 patients (160 carpal tunnel syndromes) having endoscopic release were reviewed. Five major symptom domains (pain, numbness, nocturnal awakening, weakness, and clumsiness) before and after the operation were scrutinised. Functional status was assessed by grading key pinch and hand grip, as well as complications.

**Intervention** Endoscopic carpal tunnel release using the modified Chow's extrabursal technique under intravenous anaesthesia.

**Results** After the 160 procedures performed, 124 (78%) and 132 (83%) of them revealed improvement in terms of numbness and nocturnal awakening, respectively. Also, there were significant improvements in terms of average functional grading of pinch power and grip power. No serious complications due to the surgery were encountered.

**Conclusions** Experience using the Chow's two-portal endoscopic technique for the treatment of carpal tunnel syndrome in the Chinese population was encouraging. It was a safe and effective method for treating carpal tunnel syndrome. We advocate endoscopic surgical intervention for patients with refractory relief of symptoms following conservative management.

## Introduction

Carpal tunnel syndrome is brought about by the development of venular congestion within the synovial membrane of the flexor tendon causing oedema and inflammation.[1] Pressure in the carpal tunnel is increased, leading to chronic entrapment of the median nerve and pain. Repeated shaking of the affected hand to ameliorate these symptoms aggravates the degeneration of the epineurium and endoneurium, thereby impairing axonal transmission.

Surgical treatment of patients with carpal tunnel syndrome continues to be one of the most frequently performed operations for nerve entrapment. Open carpal tunnel release was originally described by Cannon in 1946.[2] Phalen[3] introduced a method for the division of the transverse carpal ligament (TCL) for the first time in 1950. This method has been widely accepted as the usual means of the surgical management for carpal tunnel syndrome. However, certain drawbacks to this approach have been identified. They include pillar pain around the incision site on the transverse ligament, scar tissue tenderness, and delays in returning to activity of daily living, including work. After Okutsu et al[4] introduced endoscopic surgery in 1987, minimally invasive carpal tunnel release has gained popularity and different methods have been reported.

Often-cited advantages of endoscopic decompression are the reduction of post-surgical pain at the incision site; the rapid recovery of key pinch and hand grip, and consequently associated medical and social costs are reduced[5]; and a smaller and aesthetically superior surgical scar. According to some reports however, endoscopic decompression is not without risks and has resulted in skepticism about the safety of this technique. Complications include: incomplete release, and erroneous insertion of the endoscope into Guyon's canal injuring the ulnar nerve or nearby blood vessels.[6] According

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to Kuschner and Lane,[5] injury to nerves and blood vessels were twice as frequent as in open carpal tunnel release.

Nevertheless, a better understanding of the factors predictive of such outcomes following carpal tunnel release can enable both surgeons and patients to make more informed decisions about whether to proceed with surgery, and have more accurate expectations of outcomes. Less favourable outcomes following surgery have been associated with: old age, a long history of carpal tunnel syndrome, thenar atrophy, prolonged distal motor latency, medical co-morbidity (including diabetes mellitus), heavy or repetitive manual work, and exposure to vibrations.[7-11]

This study was a 7-year retrospective review (January 2001 to December 2007) of endoscopic carpal tunnel release in a Chinese cohort. The aim was to present our experience with this technique with respect to outcomes, specifically in regard to safety, efficacy, and associated prognostic factors.

## Methods

A clinical diagnosis of carpal tunnel syndrome was established by the presence of three or more of the following findings: a history of recurrent or persistent paresthesias in the median nerve distribution, worsening of symptoms with hand activity, nocturnal awakening with paresthesias, and the presence of a positive Tinel's and/or Phalen's sign on physical examination. A total of 145 patients (160 wrists) subjected to endoscopic carpal tunnel release from 2001 to 2007 were retrospectively reviewed. These patients had received conservative treatment for at least 3 months before the operation. Patients who had undergone prior carpal tunnel surgery and non-Chinese patients were excluded from this series. We obtained socio-demographic, clinical, and work-related data on all the patients. Demographic data extracted included: gender, hand dominance, age, type of work (manual, sedentary, and unemployed), worker's compensation status, diabetes, and any history of tobacco or alcohol use. Concomitant disorders related to diabetes mellitus (central or peripheral neuropathy) were also taken into account. Subjective complaints included the five major domains: pain, numbness, nocturnal awakening by symptoms, weakness, and clumsiness. Physical examination data included the status of the thenar muscle, key pinch, and hand grip. Pinch and grip strength were reported in kilograms. Follow-up data included symptomatic relief, time to return to work, and complications. For surgical outcomes, functional grading of cumulative trauma disorder was evaluated (Table 1). This was assessed by occupational therapists before and after the operation, according to well-established criteria.

Preoperative nerve conduction study data were reviewed. Severity of the median nerve compression was classified as mild, moderate, and severe. Data regarding returning to work were also retrieved. Cohorts were compared by independent sample *t* test, using the Statistical Package for the Social Sciences (Windows version 15.0; SPSS Inc, Chicago [IL], US), with significant differences being defined as a P value of less than 0.05.


## 為華裔病人進行內窺鏡腕管鬆解術的治療效果

**目的** 回顧為華裔病人進行內窺鏡腕管鬆解術的治療效果，並探討相關的預測因子。

**設計** 回顧研究。

**安排** 香港一所提供手外科手術的分區醫院。

**患者** 研究對象為2001年1月至2007年12月期間145位（160病例）患腕管綜合徵並接受內窺鏡鬆解術的病人。評估包括術前和術後的徵兆：痛楚、痲痺、夜間甦醒、乏力及不靈敏情況。手部功能、捏力、握力和併發症則用來評估術後結果。

**療法** 使用周氏改良式的內窺鏡鬆解術，病人均接受靜脈內注射。

**結果** 共160個病例中，發現在痲痺和夜間甦醒方面，分別有124（78%）和132（83%）宗病例於術後得到改善。手部功能、捏力和握力在統計上亦顯著改善。本研究未發現有嚴重併發症。

**結論** 使用周氏雙孔內窺鏡治療腕管綜合徵的華籍患者，效果令人鼓舞。此技術既安全又有效。我們建議為持續出現腕管綜合徵徵兆的病人及早進行內窺鏡術。


TABLE 1. Functional grading of cumulative trauma disorder

| Grading | Description |
|---|---|
| I | • Pain after activity; resolves quickly with rest<br>• No decrease in amount or speed of work<br>• Objective findings usually absent |
| II | • Pain in one site while working<br>• Pain is consistent while working, but resolves when activity stops<br>• Productivity may be mildly affected<br>• May have objective findings |
| III | • Pain in one or more sites while working<br>• Pain persists after activity is stopped<br>• Productivity affected, and multiple breaks may be necessary to continue working<br>• May affect other activities away from work<br>• May have weakness, loss of control and dexterity, tingling, numbness, and/or other objective findings<br>• May have latent or active trigger points |
| IV | • All common uses of hand/upper extremity cause pain which is present in 50 to 75% of the time<br>• May be unable to work or works in limited capacity<br>• May have weakness, loss of control and dexterity, tingling, numbness, trigger points, and/or other objective findings |
| V | • Loss of capacity to use hand because of chronic, unrelenting pain<br>• Usually unable to work<br>• Symptoms may persist indefinitely |

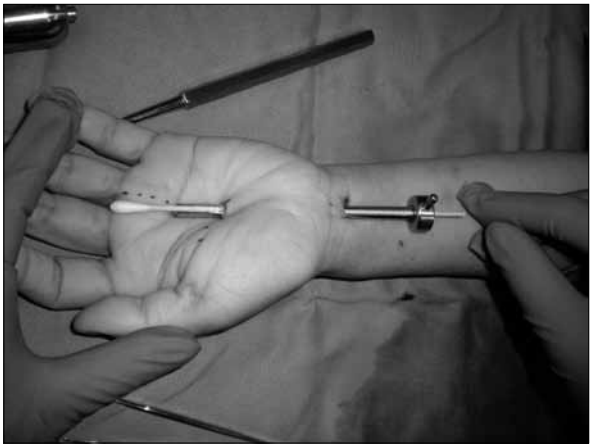

FIG 1. Cotton wool stick was inserted through the slotted cannula to free the fatty tissue away from the operative site

### Surgical technique

Endoscopic carpal tunnel release was performed with the modified Chow's extrabursal technique. The patient was placed in the supine position on the operating table, with the involved arm in 90-degree abduction and the hand placed on a hand table. A heparin block was set at the dorsum of the involved hand. The tourniquet was then inflated to 250 mm Hg; 40 mL of 0.5% lignocaine was injected into the involved limb through the heparin block. Then the heparin block was removed and the hand was prepared and draped in the usual fashion. Specific instrumentation for the procedure was the ECTRA system (Smith and Nephew, Incorporation, Andover [MA], US). It consisted of a short 4.0 mm x 30º video endoscope, a slotted cannula, a rigid obturator, a curved blunt dissector, a self-retaining retractor, a hand holder, a probe, a palmar arch suppressor, a probe knife, a retrograde knife, and a triangular knife. The palmaris longus was used as a guide for placement of the proximal portal. A 1-cm transverse incision at the proximal flexor wrist crease was made for the entry portal site. Dissection along the ulnar side of the palmaris longus kept the superficial palmar branch of the median nerve at a safe distance from the instruments. If the palmaris longus did not exist, a distance of about 16 mm radial to the radial aspect of the os pisiform was used as a guide.[12] This distance placed the proximal portal radial to the radial edge of Guyon's canal and ulnar to the superficial palmar branch of the median nerve. From this point, a second line was drawn proximally 0.5 cm. A third line was then drawn from the proximal end of the second line radially 1 cm; this was the entry point of the incision. The patient's thumb (the exit portal) was placed in full abduction. A line was drawn across the palm from the distal border of the thumb to the approximate centre of the palm. A second line was drawn from the web between the middle and ring fingers to meet the first line, formed a right angle. A line bisecting this right angle was extended approximately 1 cm proximal from the vertex, which served to establish the site of incision of the exit portal. The superficial palmar arch was located at least 10 mm distal to the distal margin of the TCL, with a fat pad that was always found between them.[12] This anatomic configuration makes the 'fat drop sign' a useful guide for the placement of the distal margin of the TCL. Identification of this fat pad and determination of its proximal border comprised a useful sign for avoiding injury to the superficial palmar arch. Synovial adhesions usually covered the inner surface of the transverse ligament, and these needed to be removed for clear endoscopic identification of the transverse fibres before the ligament was cut. These adhesion or fibres needed to be carefully identified and palpated with a probe. After introducing the cannula, a cotton wool stick was passed through the cannula several times, with the aim of clearing any adhesions or fat away from the TCL (Fig 1). It was crucial to see the inner surface of the TCL and feel the characteristic 'washboard effect'. The instrument had to be withdrawn if there was lack of the recognition of the transverse fibres.

For the carpal tunnel release, dissection ensued within 0.5 to 1 cm distal to the TCL, to avoid injury to the superficial palmar arch and the superficial palmar communication between the median and ulnar nerves (the Berrettini branch).[13] In the more common extraligamentous course for the thenar motor branch (encountered in 92% of patients), injury could be avoided by incising along the longitudinal third web space line (Fig 1) with a safe margin of nearly 7 mm. The surgeon nevertheless had to look for anatomical variants of the transligamentous course (occurring in 8% of subjects), in which case the thenar branch was at significantly greater risk of iatrogenic injury.[14] During the procedure, the transverse fibres had to be seen clearly before any dissection of the ligament. If any tubular structure was encountered during the procedure, the cannula was rotated slightly, with the aim of ruling out the possibility of cutting a nerve or vessel.

## Results

### Demographics

A total of 145 Chinese patients (160 hands) undergoing endoscopic carpal tunnel release during the 7-year period were reviewed; 15 individuals had bilateral procedures. There were 129 females and 16 males. The right hand was dominant in 144 and the left in 1. The mean age of the cohort was 53 years (range, 25-81 years). Work status was defined as unemployed or retired in 83, employed in an occupation involving sedentary work in 41, and employed in an occupation involving manual labour in 36. Two patients had filed worker's compensation claims, one of whom was

TABLE 2. Demographics of the 160 hands that underwent endoscopic carpal tunnel release

| Characteristics | No. of hands (or otherwise specified) |
|---|---|
| Sex | |
| Female | 144 |
| Male | 16 |
| Age (years) | |
| Mean | 53 |
| Median | 50 |
| Range | 25-81 |
| Smoking status | |
| Smokers | 6 |
| Non-smokers | 154 |
| Drinking status | |
| Alcoholic | 2 |
| Non-alcoholic | 158 |
| Hand dominance | |
| Right-handed | 159 |
| Left-handed | 1 |
| Worker's compensation status | |
| Worker's compensation | 2 |
| Non-worker's compensation | 158 |
| Employment type | |
| Labourer | 36 |
| Sedentary | 41 |
| Retired/unemployed | 83 |

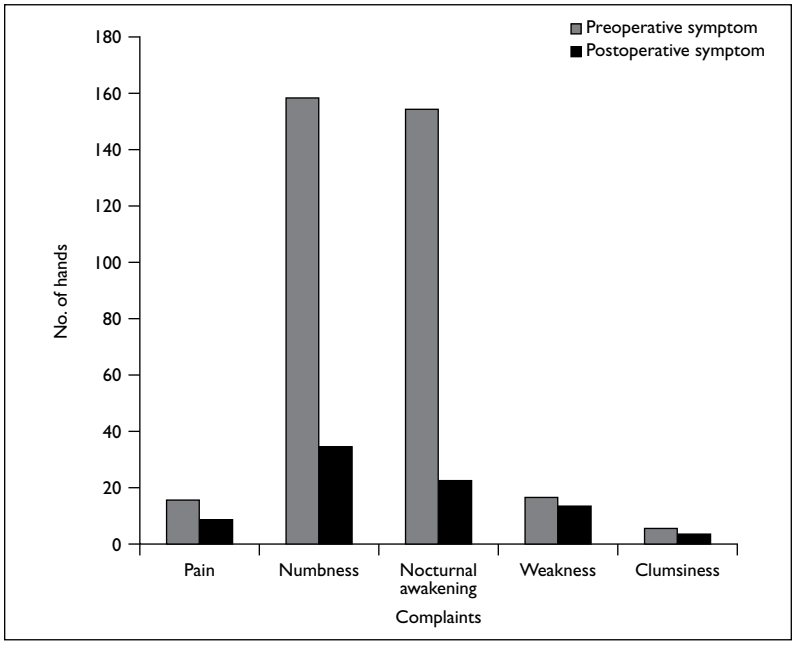


FIG 2. Subjective complaints by patients before and after endoscopic carpal tunnel release (n=160 hands)

TABLE 3. Pre- and post-operative functional grading using scores for cumulative trauma disorder, key pinch, and hand grip

| Functional grading | Mean (standard deviation) | |
|---|---|---|
| | Preoperative | Postoperative |
| Cumulative trauma disorder | 2.1 (0.4) | 1.2 (0.5)* |
| Key pinch (kg) | 4.3 (1.7) | 5.4 (2.0)* |
| Hand grip (kg) | 17.6 (7.2) | 20.8 (7.3)* |

* Statistically significant difference (P<0.05) when compared with preoperative value

a cleaner and the other a construction site worker. Patient demographics are summarised in Table 2. Eleven patients were diabetic. Five patients suffered from concomitant cervical radiculopathy. All of them had definite clinical signs of carpal tunnel syndrome. Six patients claimed to be smokers, and two were alcoholic.

## Subjective complaints

A total of 89 patients reported complaints related to the right hand and 71 to the left hand. Numbness and nocturnal symptoms were the most common presenting complaints, with 159 and 155 instances, respectively. Hand weakness was reported in 17 patients, hand pain in 16, and clumsiness in 6. The average functional grading of cumulative trauma disorder was 2.1 (range, 1-3) [Fig 2].

## Physical examination findings

Patients were subjected to median nerve compression testing and specifically assessed pre- and post-operatively for evidence of thenar atrophy, and pinch and grip strength. We graded thenar atrophy according to the bulk and contour of the thenar eminence; mild-to-moderate atrophy consisted of a degree of flattening of the thenar eminence, whilst severe atrophy entailed excavation along the proximal radial border of its eminence. Among the 160 involved hands, 132 entailed no muscle wasting, while 26 and 2 cases had mild and moderate thenar muscle atrophy, respectively. Regarding these 160 hands, complete data for the review of the key pinch and hand grip power were available for 104. Their mean preoperative key pinch and hand grip strengths were 4.3 kg and 17.6 kg, respectively (Table 3).

## Nerve conduction studies

In all, 45 hands had preoperative nerve conduction studies, which were performed if there was doubt about the diagnosis of carpal tunnel syndrome. We classified the neurophysiological severity of carpal tunnel syndrome into three grades: mild entailed abnormal distal motor latency; moderate entailed abnormal digit/wrist distal sensory conduction velocity and abnormal distal motor latency; severe entailed absence of sensory response and abnormal distal motor latency. Twenty-one hands had a mild degree of median nerve compression, whereas 20 and 4 had moderate and severe degrees of compression, respectively.

### Outcomes of endoscopic carpal tunnel release

The patients were evaluated by surgeons and occupational therapists. The assessment at 6 months after operation was taken into account. In all, 109 (68%) of the hands had complete resolution of symptoms after the operation. Moreover, 78% (n=124) and 83% (n=132) had improvement in terms of numbness and nocturnal awakening, respectively. Improvement of pain was noted in 44% of the hands. Only 18% and 33% of the hands improved in terms of weakness and clumsiness, respectively. The average functional grading of cumulative trauma disorder improved from 2.1 to 1.2, which was statistically significant (P<0.05).

Average key pinch power improved from 4.3 to 5.4 kg and average hand grip power improved from 17.6 to 20.8 kg, both of which were statistically significant (P<0.05). Regarding the 26 hands with mild thenar muscle wasting, in terms of the muscle bulk and subjective assessment, seven showed some improvement after the operation, while one revealed deterioration. Eighteen (69%) of the hands showed no improvement at all. Regarding the two hands with moderate thenar muscle wasting, only one revealed some improvement after the operation.

The average operating time for these procedures was 30 (range, 10-55) minutes and the average time to return to work was 18 (range, 14-100) days.

### Complications

Overall, 128 (80%) of the procedures gave rise to no complications. Twenty-nine (18%) were associated with self-limiting pillar pain that did not disturb daily living. Three (2%) had a subsequent open carpal tunnel release 3, 4, and 6 months after the initial endoscopic operation. All these three hands were found to have undergone incomplete TCL release; in two instances the incomplete release had occurred at the distal part of the carpal ligament. The remaining hand had incomplete release along the whole ligament. After the open release, symptoms were alleviated in all three hands.

### Correlation

For the correlation, although the functional grading of cumulative trauma disorder was higher in unemployed or retired patients (as opposed to sedentary workers or manual labourers), these differences were not statistically significant. We divided the patients into two age-groups, those younger than 40 years, and those aged 40 years or more. The average postoperative functional grading was higher in the younger group, but the difference was not statistically significant (P>0.05). Other factors (gender, duration of symptoms, diabetes, smoking and drinking status) did not correlate significantly with surgical outcomes. For hands with and without thenar muscle wasting, both enjoyed significant improvements in functional grading. The respective average functional grading of hands with and without thenar muscle wasting was 2.4 and 2.1 preoperatively, and 1.6 and 1.2 postoperatively; both differences being statistically significant.

## Discussion

Previous retrospective and prospective comparative studies in patients treated with endoscopic carpal tunnel release demonstrated earlier recovery of pinch and grip strength, earlier return to full work status, as well as less postoperative pain and scarring.[15,16] However, controversy still exists as to the safety of the endoscopic approach. Some authors claimed an increased risk of tendon laceration, incomplete release, and damage to neurovascular structures.[5,6] To address this controversy, we retrospectively reviewed our 7-year experience in a Chinese cohort of patients with carpal tunnel syndrome. Our study revealed reproducible, subjective, and objective success, with an acceptably low complication rate. The most commonly reported symptoms were numbness and nocturnal awakening, which improved in 78% and 83% of the hands, respectively. However, only 18% and 33% of the hands enjoyed improvement in weakness and clumsiness, respectively, which indicates that motor deficit (a late effect of the long-term compressive neuropathy) might not be readily reversible. After the operation, there were statistically significant improvements in terms of the postoperative functional grading of the cumulative trauma disorder, pinch and grip strength. Regarding the five patients with concomitant cervical radiculopathy, they all enjoyed improvement in terms of the numbness and nocturnal awakening. However, due to the small number of cases, it was difficult to draw any conclusion regarding residual symptoms. Nevertheless, our results suggest that endoscopic carpal tunnel release is an effective and safe approach for treating patients with carpal tunnel syndrome.

As noted by previous authors, patients with more advanced disease (presenting with weakness and muscle atrophy) had less favourable surgical outcomes.[7] Our study showed that after the operation, weakness and clumsiness responded less favourably than sensory symptoms. Nevertheless, whether or not thenar muscle wasting was present, there was a significant improvement of functional grading after the operation. Patients were not excluded based on the advanced state of their disease. There were 28 hands (amounting to 18%) that had mild or moderate thenar muscle wasting preoperatively. When obtaining informed consent, they were all cautioned to expect longer and possibly incomplete

neurological recovery.

Reports of unrelieved or recurrent symptoms after carpal tunnel release may be due to incomplete release of the TCL, fibrous proliferation, scarring within the tunnel, entrapped palmar cutaneous nerve, reflex sympathetic dystrophy, or a painful scar. Recent report showed a similar incidence of incomplete TCL release (about 1%) after both endoscopic and open carpal tunnel release.[17] Palmar and Toivonen[6] compared complications ensuing after endoscopic and open release, and reported that the former had a lower rate of median palmar cutaneous nerve injury and neuroma formation, but a higher rate of ulnar nerve, superficial palmar arch, and flexor tendon injuries. However, their data demonstrated similar rates of median nerve laceration. Thus, both surgical approaches have the potential for complications, whilst the open approach is not necessarily safer. In our study, 18% of the hands endured acceptable pillar pain and three (2%) underwent subsequent open carpal tunnel surgery to deal with incomplete release of the ligament. The open releases were performed 3, 4, and 6 months after the initial endoscopic release. Our series resulted in no serious complications (laceration of nerves, vessels, or tendons). The three patients with incomplete tunnel release were all related to the surgical technique; two entailed incomplete release at the distal parts of the carpal ligament and one along the whole ligament. These cases signified the importance of the 'fat drop sign', which requires that special attention be paid to the distal part of the ligament while incising it.

Several limitations of the current study must be acknowledged. The key predictor variables were self-reported and potentially vulnerable to bias. There were incomplete data with respect to assessment of key pinch and grip power. Furthermore, we could not comment on whether nerve conduction abnormalities were independent predictors of outcome, since nerve conduction tests were not performed on all hands.

From a research perspective, clinical trials are required to address whether operating on patients earlier in the course of the functional decline associated with carpal tunnel syndrome may improve outcomes.

## Conclusion

The results of our 7-year experience using the modified Chow's two-portal endoscopic technique for the treatment of carpal tunnel syndrome are presented. Most patients improved in terms of numbness and nocturnal awakening. The rate of complications from this procedure was low. Our results suggest that endoscopic carpal tunnel release using the modified Chow's technique is a safe and effective approach for decompressing the carpal tunnel.

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