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The mini-incision technique for carpal tunnel release using nasal instruments in Chinese patients

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Abstract

Treatment of carpal tunnel syndrome (CTS) remains a challenge for hand surgeons. Carpal tunnel release (CTR) using nasal instruments has the advantages of both endoscopy and open surgery. In this study we aimed to explore the effectiveness of CTR using nasal instruments in Chinese patients.

We present a case series of 49 cases of idiopathic CTS treated with the mini-incision technique using nasal instruments. The average recovery days before return to normal work and complications were recorded. The mean grip strength, pinch strength, and sensation were evaluated. Subjective results were evaluated using the visual analogue scale (VAS), Levine Carpal Tunnel Syndrome Questionnaire (LCTSQ), Disabilities of the Arm, Shoulder, and Hand (DASH), and Medical Outcomes Study (MOS) 36-item short-form health survey (SF-36).

The mean follow-up was 13 months. No return of symptoms or blood vessel injury occurred. The incidence of scar tenderness was only 8.1%, later pillar pain (after 4 weeks) was 18.4%, and average recovery time to return to normal work was 23.7 days. The mean grip strength, pinch strength, and sensation were significantly improved ($P < .001$). The VAS, LCTSQ, and DASH survey postoperative mean scores were lower than the preoperative scores ($P < .001$). SF-36 scores were significantly increased following surgery ($P < .001$).

We conclude that the mini-incision technique for CTR using nasal instruments in Chinese patients is safe, effective, and low cost. It is worthwhile for the technique to be promoted and used.

Abbreviations: 2-PD = 2-point discrimination, BP = bodily pain, CTS = carpal tunnel syndrome, DASH = Disabilities of the Arm, Shoulder, and Hand, ECTR = endoscopic carpal tunnel release, EMG = electromyography, GH = general health, LCTSQ = Levine Carpal Tunnel Syndrome Questionnaire, MH = mental health, MRI = magnetic resonance imaging, NCV = nerve conduction velocity, OCTR = open carpal tunnel release, PF = physical functioning, RE = role-emotional, RP = role-physical, SF = social functioning, SF-36 = Medical Outcomes Study (MOS) 36-item short-form health survey, VAS = visual analogue scale, VT = vitality.

Keywords: carpal tunnel syndrome, mini-incision technique, nasal instruments, subjective evaluation

1. Introduction

Carpal tunnel syndrome (CTS) is a common chronic nerve entrapment syndrome. There are 3 surgical options for treating it: open carpal tunnel release (OCTR), endoscopic carpal tunnel release (ECTR), and the mini-incision for carpal tunnel release (CTR).[1] OCTR is the standard surgery for CTR and has the advantages of lower risk of harming blood vessels, completeness of release, and allowing the performance of parallel treatments on other ailments in the carpal tunnel. However, as the number of patients following up after surgery accumulated, complications were found to be common, often affecting the normal work and life of patients. Typical complications include pillar pain, subcutaneous tumor, scar tenderness, carpal arch broadening, and flexor tendon entrapment. Scar tenderness was found to occur in 19% to 61% of patients.[2–5] Some researchers began trying mini-incision surgery in an attempt to avoid the complications and improve the quality of life of patients. The mini-incision technique has the advantage of leaving a smaller scar, less scar pain and pillar pain, and having a shorter recovery period.[6,7] However, there are also obvious disadvantages: a smaller viewing area and less exposure for examination during the procedure, difficulty getting bleeding to stop, and no possibility of curing other ailments in the carpal tunnel. It can also lead to serious complications such as palmar aponeurosis tear; injury to the median, ulnar, and finger nerves; superficial palmar arterial arch damage; flexor tendon injury; and insufficient decompression.[6,8] To avoid the disadvantages of the mini-incision technique for CTS, the use of endoscopy was introduced. ECTR led to high rates of blood vessel injury and incomplete release.[9,10] Additionally, it required use of a complicated device and was expensive.

The use of nasal instruments can help open a relatively safe space in the intricate and important carpal tunnel area and fully expose the ligamentum carpi transversum. Sever[11] reported that CTR surgery using nasal instruments has the advantages of

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both endoscopy and open surgery, being simple, effective, low cost, and associated with fewer complications. However, in that study, the author only evaluated sensation, pinch, and grip strength without subjective evaluation of the patients. They did not fully assess the effectiveness of CTR surgery under nasal instruments. The subjective evaluation does not often correlate with the objective evaluation. Karnezis[12] thought a patient's subjective evaluation reflected the functional improvement more precisely. Because 3 functionality evaluation tools were used for subjective evaluation in addition to objective evaluation, our study comprehensively evaluated the effectiveness of the mini-incision technique for CTR using nasal instruments for idiopathic CTS in Chinese patients.

2. Methods

2.1. Participants

The study was approved by our hospital's Institutional Review Board. Between August 2010 and October 2012, we treated 43 patients (55 hands) with idiopathic carpal syndrome. Of these, 39 were followed up (49 hands). A total of 4 patients dropped out. The mean follow-up period was 13 months (range, 6–15 months). Among the 39 patients, there were 12 men and 27 women with a mean age of 47.2 years (range, 27–49 years). There were 24 affected right hands and 15 left hands. Both hands were affected in 5 patients. The diagnosis was made based on clinical symptoms (median nerve sensory abnormalities, dysesthesia, and night pains), body signs (thenar atrophy, dysfunction of thumb opposition, positive Phalen test, positive Tinel test, and positive carpal tunnel pressure test), positive electromyography (EMG)/ nerve conduction velocity (NCV) test, and exclusion of other ailments with B-scan ultrasonography or magnetic resonance imaging (MRI).

All patients received 1 month of conservative therapy without effective results prior to surgery, and all were receiving CTR surgery for the first time. According to the Hamada classification (Table 1), 12 cases were classified as stage I, 26 as stage II, and 11 as stage III. Grip strength, pinch strength, and 2-point discrimination (2-PD) were tested 1 to 3 days before surgery. Grip and pinch strength were assessed with an E-LINK electronic gripping power device and electronic pinch strength device. Each test was repeated 3 times, and the average value obtained. The 2-PD test was conducted with the patient's eyes closed, and 2 sharp points were used to measure the index finger. All patients completed the visual analogue scale (VAS), Levine Carpal Tunnel Syndrome Questionnaire (LCTSQ), Disabilities of the Arm, Shoulder, and Hand (DASH) score, and Medical Outcomes Study (MOS) 36-item short-form health survey (SF-36).[13]

After the operation, oral methylcobalamin tablets were prescribed (0.5 mg 3 times daily for 1 month). When the patients returned to outpatient clinic 2 weeks, 4 weeks, 8 weeks, 12 weeks, and 6 months after the operation, evaluation of the scar, presence of complications (return of symptoms, blood vessel injury, and pillar pain), and the average recovery days before return to normal work were recorded. Pain was classified by VAS evaluation. When the patients returned to outpatient clinic 6 months after the operation, grip strength, pinch strength, and 2-PD were tested. Patients were also asked to do subjective evaluations by LCTSQ, DASH, and SF-36.

Table 1

Hamada classification (n=49).

Class	Numbness	Thenar atrophy	Dysfunction of thumb pressing	Cases
I	+	−	−	12
II	+	+	−	26
III	+	+	+	11

2.2. Surgical technique

The operations were performed under general anesthesia or brachial plexus block with an upper-arm pneumatic tourniquet. The thumb was passively outspread completely. The incision was made as follows (Fig. 1A): a 1.0 cm longitudinal incision was made distal to the intersection of the third web axis and the completely outspread thumb axis, and then a 1.5 cm transverse incision was made on the volar aspect of the wrist crease between the palmaris longus tendon and the flexor carpi radial tendon. For the first step, the incision was made then the palm aponeurosis was divided by blunt dissection. The distal edge of the flexor retinaculum and the branch of the median nerve were exposed. The second incision was made to expose the proximal edge of the flexor retinaculum and the median nerve trunk. The superficial and deep tissue of the ligamentum carpi transversum was bluntly disassociated (Fig. 1B).

With the wrist hyperextension, a long nasal instrument was inserted proximally from the second incision to the first incision and introduced between the superficial and deep plane of the ligamentum carpi transversum (Figs. 1C and 2A). Due to the nasal instrument's structure, the 2 mirror beaks separate the surrounding structures completely, ensuring the ligamentum carpi transversum was exposed to the operator as clearly as possibly under direct visualization (Fig. 1D). A No. 11 blade was then gently pushed distal to the longitudinal incision in the ligamentum carpi transversum (Figs. 1E and 2B). The surgeon then put his little finger into the tunnel to assess whether the ligament remained blocked and confirmed that the carpal tunnel was completely released. After the tourniquet was released, pressure was applied to the wound for 5 min, and any active bleeding was controlled with electric coagulation. The incisions were closed with interrupted 5-0 nylon sutures, and a pressure bandage was applied. A splint was not used. Active movement of the fingers was attempted on the second postoperative day. The wound dressing was removed after 6 days, and the stitches were removed after 10 to 14 days.

2.3. Statistical analyses

Data were statistically analyzed using SPSS version 22.0 (IBM Corp, Armonk, NY). The results are shown as mean ± standard deviation. Statistical analyses were performed using a paired t test. The significance level for all analyses was defined as $P < .05$.

3. Results

3.1. Questionnaire outcomes

Most patients reported complete disappearance of wrist pain and some reported significant relief following surgery. Significant differences between the pre- and postoperative periods were

Figure 1. (A) The incision design: A 1.0 cm longitudinal incision was made distal to the intersection of the third web axis and the outspread thumb axis, then a 1.5 cm transverse incision was made on the volar aspect of the wrist crease between the palmaris longus tendon and the flexor carpi radial tendon. (B) The proximal edge of the flexor retinaculum was exposed in the second incision, and the ligamentum carpi transversum was bluntly disassociated. (C) With the wrist hyperextension, a long nasal instrument was inserted proximally from the second incision to the first incision between the superficial and deep plane of the ligamentum carpi transversum. (D) The 2 mirror beaks separated the surrounding structures completely, exposing the ligamentum carpi transversum to the operator as clearly as possibly under direct visualization. (E) A No. 11 blade was gently pushed distally to longitudinally incise the ligamentum carpi transversum.

observed in VAS, LCTSQ, DASH, and SF-36 ($P < .001$). The VAS pre- and postoperative scores were 4.5 and 0.5, respectively. The scores of the LCTSQ, DASH, and SF-36 are shown in Table 2. The postoperative Levine score was significantly lower than the preoperative score for both sides (Levine Symptom Score and Levine Function Score), which indicated that postoperative symptoms and function were greatly improved according to the patients' own judgment. The DASH survey showed that postoperative scores were significantly lower in total score and in all 4 categories (intricate activities, heavy physical activities, arm power usage, and confidence), with confidence showing the most change. The postoperative SF-36 scores were increased in 8 perspectives, especially role-emotional (RE), role-physical (RP), and bodily pain (BP). These results indicate that the patients felt significant improvement in all aspects.

3.2. Clinical outcomes

Table 3 shows the results of grip, pinch strength, and 2-PD. Significant differences between the pre- and postoperative periods were observed in grip, pinch strength, and 2-PD ($P < .001$). The mean time to return to normal work was 23.7 days (range, 7–38 days).

3.3. Complications

No cases had a return of pain due to incomplete release or nerve/blood vessel damage. Of the 49 hands, 45 had a small scar without pain to touch and 4 had an apparent scar with light pain. The incidence of pain was 8.1%. Pillar pain occurred in 21 hands. In 4 hands pillar pain lasted for 4 to 8 weeks, in 2 hands for 9 to 12 weeks, and in 3 hands for longer than 6 months. The early

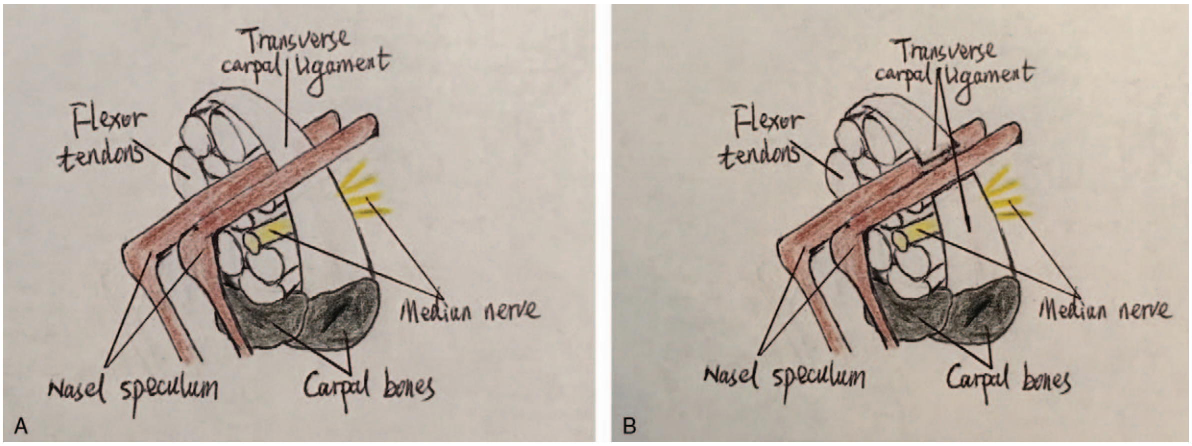

Figure 2. (A) The nasal instrument was inserted between the superficial and deep plane of the ligamentum carpi transversum at the ulnar side of median nerve. (B) The ligamentum carpi transversum was severed longitudinally in the middle of the 2 mirror beaks of nasal instrument.

occurrence rate of pillar pain (within 4 weeks) was 42.9%, and the later occurrence rate (after 4 weeks) was only 18.4%.

4. Discussion

The most serious complications of the mini-incision technique for CTR were nerve/blood vessel damage and incomplete release.[14] Zyluk[8] studied the literature and found that the incidence of nerve/blood vessel damage and incomplete release using the single mini-incision technique was 4.3% and using the double mini-incision technique in 1.3%. To reduce the incidence of such grave complications, special surgical devices such as a carpal tunnel knife, a transverse carpal ligament cutter, and a cutter with a lighting source are used in many cases of mini-incision CTR.[15,16] Abouzahr[17] was the first surgeon to try using nasal instruments as supplemental devices in mini-incision CTR on cadavers. The key was the special structure of the nasal instrument. The shape of the nasal instrument fit the passage in the carpal tunnel, and the 2 mirror beaks could hold the ligamentum carpi transversum. The hinge expansion made the 2 mirror beaks to separate, which let the surgeon see the ligamentum carpi transversum and the structure around it clearly. The results showed the ligamentum carpi transversum in all specimens were completely released; however, there was 1 case of superficial palmar arch injury. It is possible this occurred because the operator did a single mini-incision without fully protecting the vessels and nerves at the distal end of carpal tunnel. In our study, there were no cases of damage to vessels and nerves or of incomplete release. From our study we made the following observations:

1. Two incisions are necessary. The palm incision should be made on the ulnar side to avoid injuring the recurrent branch of the median nerve.
2. It was quite difficult to insert the nasal instruments into the carpal tunnel. We suggest adjusting the curve of the instruments according to the carpal tunnel curve to make it easy to insert and avoid injury to the median nerve and the ramus cutaneus palmaris.
3. The wrist joint must be in extreme dorsiflexion and a light touch must be used when the nasal instrument is inserted.

Wong[16] reported the incidence of pillar pain was 53% and 30% within 8 weeks for ECTR and mini-incision CTR, respectively, while the incidence in traditional OCTR was even higher. Our results showed a low incidence of scar pain and pillar pain. The incidence of scar pain was 8.1%. In the early phase

Table 2

LCTSQ, DASH, and SF-36 evaluation score before and after surgery in the patients with mini-incision technique ($\bar{x}\pm s$, n=49).

	Preoperative	Postoperative
LCTSQ		
Levine Symptom Score	3.27±0.19	1.39±0.47*
Levine Function Score	2.53±0.56	1.18±0.30**
DASH		
Total score	29.21±13.03	8.49±16.04*
Intricate activities	2.24±0.18	1.21±0.45*
Heavy physical activities	2.59±1.53	1.19±0.51*
Arm power usage	2.51±1.09	1.45±0.75*
Confidence	3.46±0.12	1.22±0.69**
SF-36		
PF	71.7±17.1	85.9±15.1*
RP	20.2±9.2	71.9±32.1**
RE	15.9±7.2	76.7±35.6**
BP	47.2±17.2	67.3±20.7**
VT	54.1±12.7	68.5±21.6*
GH	49.2±12.5	59.6±18.3*
MH	46.5±18.0	65.8±17.3*
SF	60.3±18.2	79.8±17.2*

BP = bodily pain, DASH = Disabilities of the Arm, Shoulder, and Hand, GH = general health, LCTSQ = Levine Carpal Tunnel Syndrome Questionnaire, MH = mental health, PF = physical functioning, RE = role-emotional, RP = role-physical, SF = social functioning, SF-36 = Medical Outcomes Study (MOS) 36-item short-form health survey, VT = vitality.
* $P<.001$.
** $P<.0001$.

Table 3

Objective index before and after surgery in the patients with mini-incision technique ($\bar{x}\pm s$, n=49).

	Gripping power, g/mm^2	Pinch strength, g/mm^2	Two-point epicritic sensibility, mm
Preoperative	16.4±7.6	4.5±1.9	7±2
Postoperative	24.2±6.1*	6.4±2.4*	3±1*

* $P<.001$.

(within 4 weeks), the incidence of pillar pain was 42.9% and in the later phase (after 4 weeks), it was 18.4%. Moreover, grip strength, pinch strength, and 2-PD were significantly improved. Therefore, based on analysis of the incidence of grave complications and objective evaluation, we concluded that mini-incision CTR using nasal instruments is safe and effective for treating CTS.

The methods of evaluating the effectiveness of CTR surgery are an objective evaluation by the surgeon (such as grip strength, pinch strength, 2-PD, and nerve conduction speed) or a subjective evaluation by the patient (mainly using subjective function evaluation forms). At present, most researchers evaluate the effectiveness according to objective function evaluations. Dogan[18] thought that using objective function evaluations alone did not accurately assess the severity of the patient's symptoms and their impact on work and daily life because a doctor's review was often different than the patient's own experience. Karnezis[12] reported that subjective evaluations better reflect the changes in symptoms and function before and after surgery for CTS. Amirfeyz[19] also thought that subjective evaluations were the best way to evaluate the symptoms and function of the patients with CTS. Our results show that for LCTSQ the symptoms score was higher than the function score and in DASH the confidence score was the highest, indicating that patients cared more about the physiological and psychological discomfort caused by the disease than the function of the affected wrist. The objective evaluation only reflects the recovery of function in the doctor's judgment and does reflect the functional recovery as judged by the patient or the physical and emotional changes the patient feels before and after surgery. For these reasons, we believe subjective evaluation is an indispensable part of evaluating the effectiveness of mini-incision surgery for CTR using nasal instruments.

LCTSQ is a well-targeted tool for evaluating the effectiveness of surgery for CTS. However, due to the nature of subjectivity, deviation is likely to occur as patients can easily be influenced and react to hints. In our research, we applied the DASH and the SF-36 at the same time to evaluate the function of the arm and the overall health situation of the patients. Using multiple different questionnaires made the results more reliable and effective.[20] The BP values in the VAS, LCTSQ, DASH, and SF-36 unanimously reflected a significant reduction in pain, and the LCTSQ, DASH, and SF-36 all unanimously showed a positive effect on the entire body after recovery of the affected wrist, and psychological influence was the most obvious.

We have had some experience with conventional OCTR. In a previous study we had the results of OCTR (WJ, MD, unpublished data, May 2013). We also reported the results of the patients' subjective evaluation.[21] In general, the results of grip, pinch strength, 2-PD, and the subjective evaluation were similar, however, it appears that the mini-incision technique is associated with less scar and pillar pain, and recovery time was shorter. With conventional OCTR, the incidence of scar pain and late pillar pain were 34.6% and 23.1%, respectively, and the average recovery time to work was 59 days. With the mini-incision technique, the incidence of scar pain and later pillar pain were only 8.1% and 18.4%, respectively, and average recovery time to work was 23.7 days.

Some limitations of this study should be noted. First, the superficial and deep tissues of the ligamentum carpi transversum must be separated bluntly before the nasal instrument is inserted, which may have led to a high incidence of early pillar pain (42.9%). Second, the carpal tunnel is curved while the mirror beaks of the nasal instrument are straight. Inserting the nasal instrument into the carpal tunnel is not easy. A modified nasal instrument in which the 2 mirror beaks curve to fit more easily into the carpal tunnel might have even better results. Third, the incision for the mini-incision technique is small. Only the amputation of the ligamentum carpi transversum can be carried out, so synovectomy and carpal tunnel exploration cannot be done with the mini-incision technique. Therefore, the usefulness of the mini-incision technique is narrower than that of OCTR and ECTR.

Using a combination of subjective and objective evaluation, we showed the mini-incision technique for CTR using nasal instruments was practical, safe, and effective in Chinese patients.

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