Original Article

Limited incision carpal tunnel release

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Abstract

Background: Carpal tunnel syndrome (CTS) is the most common peripheral entrapment neuropathy. Limited incision techniques for carpal tunnel release are gaining popularity. The main advantages of these techniques are less scar load, less pillar pain, shorter recovery, and return-to-work time. However, the completeness of release, and risk of neurovascular injury are always a concern. We devised a method of limited incision release with two mini-incisions and use of nasal speculum and a probe. We aimed to evaluate the clinical and neurological outcome of this technique.

Materials and Methods: Twenty seven cases (9 male and 18 female, age 28–56 years) of isolated CTS cases were enrolled in the study. A total of 33 hands (six bilateral) underwent limited incision carpal tunnel release. In this study, two mini-incisions were used and release was done with the help of nasal speculum. Evaluation preoperatively and in 6 months and at 1-year postoperatively was done, namely, (a) clinical status examination, (b) motor testing using grip and pinch dynamometer, and (c) neurological outcome measure using nerve conduction study.

Results: All the patients had good clinical and neurological outcome with no recurrence during followup. The first symptom to get relieved was night pains, with a mean of 4.5 days (range 2–14 days). Compared to pain, improvement of sensory symptoms was delayed; the mean duration was 42.8 days (range 30–90 days). Scar tenderness was present only for a mean duration of 9 days (range 7–21 days). The mean duration for patients to resume their daily activities was12 days (range 7–28 days) and to work was 32 days (range 21–90 days). The hand grip showed mean values of 45.12 ± 16.16 g/mm^2 preoperatively, 62.45 ± 18.86 g/mm^2 at 6 months postoperatively, and 74.87 ± 20.35 g/mm^2 at 1-year postoperatively. The key pinch showed mean values of 11.27 ± 3.51 g/mm^2 preoperatively, 20.181 ± 3.94 g/mm^2 at 6 months postoperatively, and 27.96 ± 94.42 g/mm^2 at 1-year postoperatively. The tip pinch showed mean values of 8.88 ± 2.39 g/mm^2 preoperatively, 15.393 ± 3.25 g/mm^2 at 6 months postoperatively, and 19.27 ± 4.81 g/mm^2 at 1-year postoperatively. The palmar pinch showed mean values of 14.42 ± 2.92 g/mm^2 preoperatively, 19.303 ± 3.62 g/mm^2 at 6 months postoperatively, and 22.97 ± 4.08 g/mm^2 at 1-year postoperatively.

Conclusion: Limited incision carpal tunnel release can be considered a feasible alternative to traditional open release and endoscopic release.

Key words: Carpal tunnel syndrome, carpal tunnel release, limited incision, nasal speculum, nerve conduction study
MeSH terms: Carpal tunnel syndrome, minimal access surgical procedures, nerve compression syndrome, speculum, nerve conduction

Introduction

Carpal tunnel syndrome (CTS) is the most common peripheral entrapment neuropathy.[1] The pathophysiology involves a tcombination of mechanical trauma, increased pressure, and ischemic injury to the median nerve within the carpal tunnel.[2] Management strategy is a spectrum between conservative treatment with physiotherapy, steroids, and surgery.

Since the surgical treatment was introduced, carpal tunnel release has been extensively reviewed and many modifications have been suggested with different instruments and incision techniques. Traditional open release has been the standard approach worldwide since Phalen promoted it

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in 1950.[3] Other various techniques proposed are endoscopic release, limited incision releases, and single incision releases (wrist incision technique, midpalmar technique).[4-9] Effectiveness and safety of these various methods still remain controversial. The traditional open release has a few associated incidence of hypertrophic scarring, scar tenderness, pillar pain, and delayed return to work.[7,10-12]

Limited incision method, mini-incision methods, and endoscopic methods all are proposed to be effective for preventing the excessive scar formation, reducing pillar pain, and the early return to work.[13-15] The limited release techniques claim to have most of the advantages of endoscopic release with almost similar end results and lesser learning curve.[16]

The purpose of this prospective study was to look into technique of limited incision carpal release using two mini-incisions and a speculum and to evaluate its effectiveness clinically and neurologically.

Materials and Methods

32 cases of limited incision carpal tunnel release operated between January 2013 and December 2014 were included in study. All the patients were called for followup at 6 months and 1 year. After obtaining the ethical committee clearance, all the idiopathic CTS patients who gave informed consent for this method of surgery were included in the study. They were diagnosed and evaluated in the Department of Neurology with nerve conduction study (NCS) and then referred to the Plastic Surgery Department for surgery. Five were excluded from the study since they were lost to followup (two patients did not turn up at 6-month followup and other three patients did not return for 1-year followup). Thus, 27 cases were included of which 6 cases had bilateral CTS, hence total of 33 hands. Female preponderance was seen with 19 females and 8 males. The mean age of presentation was 52.22 years (range 38–64 years). They were operated with limited incision technique by a single surgeon in the department. The patients were admitted a day before surgery and postsurgery kept for observation for 1 day.

NCS was done as a part of neurological evaluation both preoperatively and postoperatively at 6 months and 1 year to document nerve recovery status.

In NCS, parameters such as distal motor and sensory latencies and motor and sensory amplitudes' sensory conduction velocities of the median nerves across the carpal tunnel and all along course of median nerve were measured. Whenever additional information was needed, comparative study of motor conduction velocity and distal motor latency (DML) in the median and ulnar nerves in the same hand was done. Multiple compression neuropathies were ruled out. NCS was graded as per the American Association of Electrodiagnostic Medicine (AAEM) criteria.[17,18]

Operative procedure

The patients were operated either in general anesthesia or regional anesthesia under tourniquet. Brachial block was preferred; however, general anesthesia was given to patients who did not consent for block. The wrist was kept in extension.

Skin marking was done as shown in Figure 1. Vertical line was drawn from the third interdigital space to wrist crease on the palm; horizontal line was drawn joining the radial aspect of thumb to styloid process (Kaplan cardinal line). Then, the proximal incision site was marked with 1 cm horizontal line on the wrist crease at base of the vertical line, and distal incision site was 1 cm vertical line ulnar to the site of intersection of the vertical line and the horizontal line [Figure 1].

The proximal incision was made, skin and subcutaneous tissue were cut, and ligament was visualized. A probe is passed deep to tunnel and felt at the distal marking on the palm to make a distal incision and then taken out. We cannot palpate the probe in between the distal and proximal end. A plane created superficial to ligament using blunt scissors [Figure 2]. In all our dissection, we used nasal speculum which introduced from proximal incision up to the distal incision. The whole retinaculum including the palmar fascia could be visualized and cut under vision [Figure 3]. The probe is felt subcutaneously between the incisions only if the ligament is completely cut [Figure 4]. This method minimizes the collateral damage and also guarantees completeness of the release.

Postoperatively, no splints are given to these patients. They were discharged on the next day of surgery. Patients were

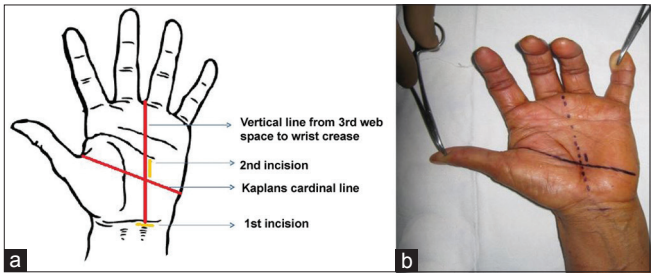

Figure 1: (a) Line diagram (b) Photograph of patient's hand showing skin markings: Vertical line drawn from third interdigital space to wrist crease on palm, horizontal line drawn joining the radial aspect of thumb to styloid process (Kaplan cardinal line). The proximal incision site marked with 1 cm horizontal line on the wrist crease at base of the vertical line, distal incision site is 1 cm vertical line ulnar to the site of intersection of vertical line and the horizontal line

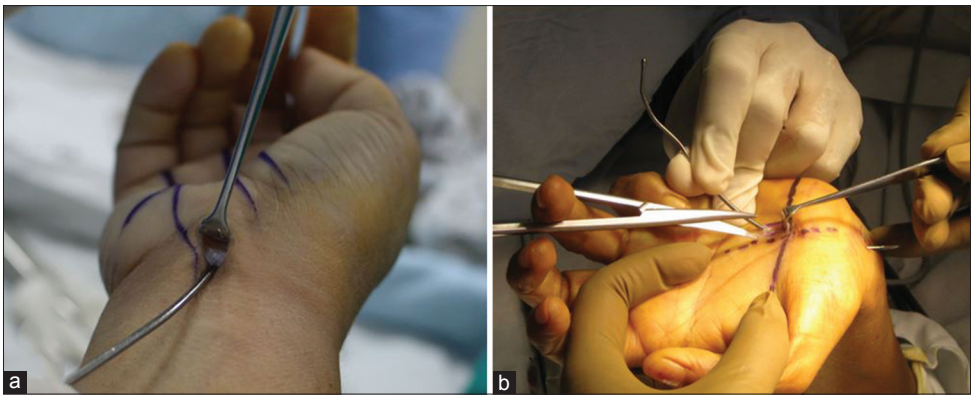

Figure 2: Peroperative photograph showing (a) Proximal incision and visualization of flexor retinaculum proximal end. Passing probe below the retinaculum to feel it at distal incision site. (b) Distal incision given after palpating the probe. Planes created superficial to ligament using blunt scissors

Figure 3: Peroperative photograph showing nasal speculum introduced from proximal incision up to the distal incision, and the whole retinaculum including the palmar fascia is cut under vision

encouraged to carry on light daily activities as soon as possible after 2 days.

Outcome measurements: Clinical and neurological

The patient proforma included symptoms such as duration of night time pain, tingling sensation, scar tenderness, pillar pain, duration of return to daily activities, and duration of return to work. The motor tests which included measurement of hand grip, key pinch, tip pinch, and palmar pinch were performed with a Jamar dynamometer and a Sheehan pinch-meter. Neurological outcome was measured by NCS.

Complications of surgery and recovery including neurovascular injuries and wound infection were recorded immediately after surgery and at each followup visit.

The data were analyzed using Statistical Package for the Social Sciences-Version 22.0 (2013; IBM Corp., Armonk, NY, USA). We compared preoperative and 6 month and 1-year postoperative mean scores of each section using Student's *t*-test and then compared preoperative and postoperative scores by means of ANOVA. *Post hoc* test was applied for repeated measures. Significance was set at $P \leq 0.05$, with 95% confidence interval.

Results

Clinical outcome

The first symptom to get relieved was night pains, with a mean of 4.5 days (range 2–14 days). Compared to pain, improvement of sensory symptoms was delayed; the mean duration was 42.8 days (range 30–90 days). Scar tenderness was seen present only for a mean duration of 9 days (range 7–21 days). The mean duration for patients to resume their daily activities was12 days (range 7–28 days) and to work was 32 days (range 21–90 days).

In the followup period, it was noted that a total of 3 hands had features of pillar pain at 6 months followup (9%). However, these patients subsequently showed resolution of these symptoms at 1-year followup. None of our patients endured any complication in the form of sensory changes and neuromuscular weakness. The scar was inconspicuous in all the patients [Figure 5].

Motor tests

The hand grip showed mean values of 45.12 ± 16.16 g/mm^2 preoperatively, 62.45 ± 18.86 g/mm^2 at 6 months postoperatively, and 74.87 ± 20.35 g/mm^2 at 1-year postoperatively. The key pinch showed mean values of 11.27 ± 3.51 g/mm^2 preoperatively, 20.181 ± 3.94 g/mm^2 at 6 months postoperatively, and 27.96 ± 94.42 g/mm^2 at 1-year postoperatively. The tip pinch showed mean values of 8.88 ± 2.39 g/mm^2 preoperatively, 15.393 ± 3.25 g/mm^2 at 6 months postoperatively, and 19.27 ± 4.81 g/mm^2 at 1-year postoperatively. The palmar pinch showed mean values of 14.42 ± 2.92 g/mm^2 preoperatively, 19.303 ± 3.62 g/mm^2 at 6 months postoperatively, and 22.97 ± 4.08 g/mm^2 at

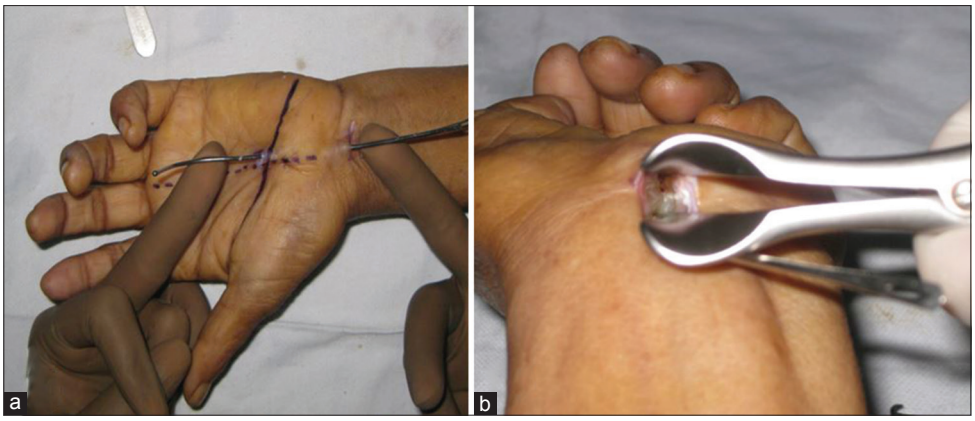

Figure 4: Peroperative photograph showing (a) Probe is palpated between the proximal and distal ends. It can be palpated only if ligament and fascia are completely cut. (b) Visualization of completeness of carpal tunnel through the speculum

Figure 5: Postoperative clinical photograph showing inconspicuous scar

1-year postoperatively. All the motor tests showed statistically significant improvement with $P < 0.05$ [Table 1].

Neurological outcome

The CTS patients were classified according to the AAEM criteria based on NCS findings. Twenty one cases had severe CTS and 12 had moderate CTS.

On motor evaluating motor response, DML ranged from 5.6 to 10.4 milliseconds (ms), M-amp ranged from 1.4 to 4.8 mV, and Motor conduction velocity ranged from 22.9 to 52.0. Sensory responses were absent in 25 hands. When sensory responses could be elicited, the DSL ranged from 0.6 to 1.9 ms, the S-amp ranged from 6 to 13.2 mV, and the SCV ranged from 12 to 22 m/s.

Improvement in DML, M-amp, DSL, S-amp, and SCV had occurred 6 months after surgery. One-year followup also showed further improvement that was statistically significant. All the 25 hands which had absent sensory response showed improvement by 6 months. The mean changes in these parameters at 6 months and 1-year postoperatively are detailed in Table 2 along with statistical evaluations of these parameters with comparison.

Discussion

CTS is the most common entrapment neuropathy.[1] The standard means for diagnosing CTS is NCS along with the classical presenting symptoms. The gold standard treatment for CTS in cases of severe CTS and failed conservative management cases has been surgical release.[19-21] The surgeries described in literature for CTS can be classified into endoscopic and nonendoscopic methods of carpal tunnel release. Nonendoscopic release procedures comprise traditional release, limited incision release, and mini-incision release.[4-9]

Traditional open carpal release method still remains the standard and most common approach since its introduction by Mackinnon.[3] This approach has been said to have a few complications such as scar tenderness, pillar pain, increased duration to return to work, and longer scar which may be considered unaesthetic by a few surgeons.[7,10-12]

The advantages cited with endoscopic release over open method are decreased postoperative morbidity, early return to work, aesthetic scar. Still there are complications documented such as laceration of the superficial palmar arc, median nerve transection, injuries of digital nerves, vessels, and insufficient release of the carpal tunnel.[22-24] The metaanalysis by Thomas *et al*. which compared two techniques of open and endoscopic surgery showed that endoscopic technique had less pain in the incision site and better improvement in grasping objects at 12 weeks, but there was three times greater likelihood of nerve damage than the open surgery group.[25] There are also concerns regarding duration of surgery, cost of surgery, equipment cost, and surgical training required.

Table 1: Comparison of motor parameters before and after surgery

Parameters	Time of measurements (mean±SD)			*P* (significant test)		
	Preoperative	6 months postoperative	1 year postoperative	Preoperative versus 6 months postoperative	6 months postoperative versus 1 year postoperative	Preoperative versus 1 year postoperative
Hand grip (g/mm^2)	45.12±16.16	62.45±18.86	74.87±20.35	0.001	0.023	<0.001
Key pinch (g/mm^2)	11.27±3.51	20.181±3.94	27.96±94.42	<0.001	<0.001	<0.001
Tip pinch (g/mm^2)	8.88±2.39	15.393±3.25	19.27±4.81	<0.001	<0.001	<0.001
Palmar pinch (g/mm^2)	14.42±2.92	19.303±3.62	22.97±4.08	<0.001	<0.001	<0.001

SD=Standard deviation

Table 2: Comparison of electrophysiologic parameters before and after surgery

Time of measurement	Parameters					
	Mean±SD			*P* (significant test)		
	Preoperatively	6 months postoperatively	1 year postoperatively	Preoperative versus 6 months postoperatively	6 months postoperatively versus 1 year postoperatively	Preoperatively versus 1 year postoperatively
DML	8.36±1.36	4.52±0.45	3.62±0.27	<0.001	<0.001	<0.001
MA	2.45±0.78	5.42±0.73	6.48±0.51	<0.001	<0.001	<0.001
MCV	36.55±7.18	47.12±4.82	56.77±3.46	<0.001	<0.001	<0.001
DSL	1.11±0.46	2.98±0.51	3.71±0.31	<0.001	<0.001	<0.001
SA	9.43±2.45	25.54±7.59	47.73±5.11	<0.001	<0.001	<0.001
SCV	18.12±4.61	43.88±3.24	51.78±4.96	<0.001	<0.001	<0.001

DML=Distal motor latency (in ms), MA=Motor amplitude (in mV), DSL=Distal sensory latency (in ms), SA=Sensory amplitude (in μV), SCV=Sensory conduction velocity (in ms), SD=Standard deviation, MCV=Motor conduction velocity

Limited incision release surgeries came into picture when it was introduced in 1993 as two-incision method and later modified into a single incision method in 1994.[6,26] They have also evolved; there are many new instruments and techniques designed for this purpose. Instruments such as retinaculotome by Paine and Polyzoidis,[27] probe channel by Durandeau,[28] special scalpel with transillumination by Lee and Strickland,[7] and special knife by Avci and Sayli[4] were described and reported to have good results with a few complications. These techniques are comparable in terms of reduced postoperative pain, quicker recovery, time of return to work, recovery of grip strength, and complication rate.[29,30] These methods were also considered to be easier to perform and safer than the endoscopic method and do not require special equipment.[7]

The major concern of these limited incisions has always been the risk of nerve damage due to (a) limited visualization and (b) transligamentous variation. However, if properly performed with good knowledge of anatomy and instrumentation, these complications can be minimized.

In a study of 50 hands from 25 adult cadavers in an Indian population, this different variant was found in only 9.09% of cases.[31] A meta-analysis by Henry *et al*. has documented it to be 11.3% (in 3918 hands).[32] We in our experience of open release and limited incision release have not come across this variant. The reason could be that the vertical incision is made ulnar to the third web. The motor branch is radial to this line.[33]

We have used the limited incision technique with two mini-incisions along with the use of nasal speculum for carpal tunnel release. Patient evaluation was carried out with clinical examination, motor tests, and NCS. It is a matter of debate in medical literature as to which is the reliable method for outcome measure after CTS surgery. Options available are (a) clinical signs, (b) motor tests - grip strength, pinch strength measurements, (c) outcome questionnaires - DASH, MHQ, PEM, BCTQ (BCTQ or Levine questionnaire is CTS specific questionnaire), and (d) electrophysiological studies.

The clinical examination findings such as Phalen's or Tinel's sign have been shown to have limited value in determining whether a patient is a candidate for surgery. Motor tests have low sensitivity and specificity. The questionnaires are subjective. The use of NCS along with these clinical presentations and findings is considered the standard means of diagnosis for CTS.[34] Hence, NCS was preferred to questionnaire in our study.

In the present study, all the patients were relieved of symptoms at followup of 6 months and no recurrence by 1 year. Most patients were able to resume their daily activities by 10–12 days. At 6 months followup, the scar tenderness was not present, but incidence of pillar pain was 9%, which was resolved at 1-year followup. This is close to that of the endoscopic technique and other minimal palmar incision techniques. One of the reasons is because of reduced destruction of skin, subcutaneous tissue, and palmar fascia

and the preservation of the fascia convergence between the thenar and hypothenar muscles.[35] The scar visible is small similar to endoscopic release. It incorporates all advantages of endoscopic release with added advantage being simple, short duration, and low cost. This method reduces the pain and discomfort noticed in traditional release along the scar during routine desk work [Figure 6]. The motor function measured using grip and pinch strength showed significant improvement. Traditional release cuts the interthenar fascia which has been postulated to cause decrease in grip strength. This is avoided in limited incision release, thereby preserving grip and pinch strength.[36] Neurological outcome through NCS also revealed that all patients at 6 months had significant neurological recovery compared to preoperative levels. At 1-year followup, they further improved if not to normal levels. We found our technique of limited incision release with two mini-incisions and using the probe and nasal speculum very effective. Reasons could be: (a) Cutting the ligament between the blades of nasal speculum under vision the collateral damage is minimal (b) Added assurance of complete release by palpating the probe subcutaneously [Figure 4].

The limitations of the study are that it is not a comparative study between different techniques, hence, cannot comment on which is better method. There were a limited number of patients and the data on preoperative status were obtained retrospectively. It has a learning curve and needs expertise to execute. Once mastered, it can be executed to achieve the desired result.

Randomized controlled trial can be done comparing all the different techniques using a reliable outcome measure in terms of a questionnaire and electrophysiological measurement. In limited incision release surgery, the apprehension is the limited exposure leading to incomplete release and damage to surrounding structures, and there can be cadaveric studies to look out if this collateral damage risk is real.

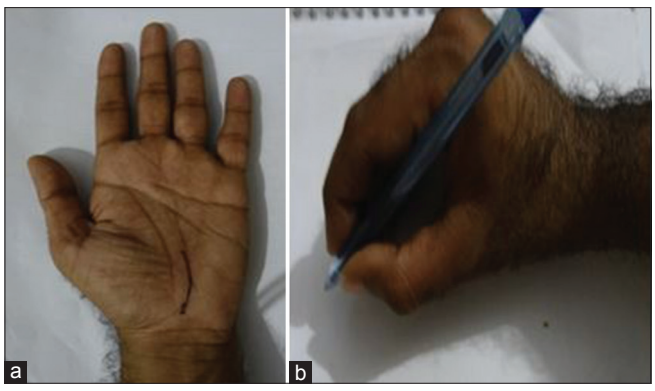

Figure 6: Clinical photographs showing (a) Marking of traditional carpal tunnel release incision. (b) The scar that comes in contact to the surface in people who have "Desk" job

Conclusion

Limited incision carpal tunnel release with two mini-incisions with the use of nasal speculum and probe can be considered a feasible, safe alternative to traditional open release and endoscopic release with good clinical and neurological outcome.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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