Carpal tunnel syndrome: surgical treatment using the Paine retinaculatome

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The operative technique for the relief of carpal tunnel syndrome has remained controversial. This report presents the results of 445 patients or 577 hands operated on using a transverse technique that varies little from that described by Paine and Polyzois. The patients were followed for 9 months to 3 years. In addition to the data received from follow-up visits, a questionnaire was sent to each patient for evaluation of their results. All surgery was performed under local anesthesia, sometimes with intravenous supplement. Of the 445 patients, 313 had unilateral operations and 132 had bilateral operations at one sitting. Postoperatively, normal hand function was achieved in 59.4% of patients in 1 week or less. Of the 577 hands operated on, 535 (92.7%) exhibited satisfactory results from surgery. No patient required postoperative physical therapy or splinting. There were no injuries to the median nerve or any of its branches.

KEY WORDS • carpal tunnel syndrome • nerve entrapment • retinaculatome

In 1913, Marie and Foix first reported the relationship between the enlargement of the median nerve at the transverse carpal ligament and bilateral thenar atrophy. Learmouth, a surgeon at the Mayo Clinic, performed the first median nerve decompression in 1933, an operation he repeated in 1941. Few reports of carpal tunnel release were published subsequently until Phalen, et al., drew attention to a carpal tunnel syndrome by writing about medial nerve decompression in 1950, 1951, 1957, and several times thereafter. In 1951, Mc Ardle, in a presentation to the Association of British Neurologists, first related acroparesthesias to median nerve compression in the carpal tunnel and recommended division of the flexor retinaculum for relief. Since this procedure gave immediate and permanent relief in most patients, it gradually gained popularity.

There is approximately a 1% incidence of carpal tunnel syndrome in the general population. The incidence approaches 35% in certain subpopulations, such as industrial workers and in individuals whose jobs or hobbies require repetitive wrist and hand movement, or who use vibratory tools. The increasing frequency with which this diagnosis is now made does not reflect an increased incidence of carpal tunnel syndrome, but of a better-informed physician population. Despite this being a common clinical syndrome, the literature is rife with controversy concerning its proper surgical treatment. This report describes a series of 577 hands treated in 445 patients using a modification developed over 30 years ago by Paine and examines the causes of the common complications resulting from carpal tunnel release.

Clinical Material and Methods

A series of 445 patients with carpal tunnel syndrome affecting 577 hands is presented. Follow-up information has been collected on these patients, who represent a subset of carpal tunnel syndrome cases seen by the authors over an 8-year period. The diagnosis was made through a combination of medical history, physical examination, and electromyography (EMG) and nerve conduction velocities (NCV). Prior to the operation, all patients received conservative therapy, consisting of wrist splinting, steroid injections, administration of oral anti-inflammatory agents, and correction of metabolic disorders.

The history of carpal tunnel syndrome consists of nocturnal paresthesias in a median nerve distribution, wrist or hand pain, morning stiffness, intermittent paresthesia associated with certain wrist and hand activities, evolving into constant numbness, and is comparable to the classic clinical presentations cited elsewhere. The time from onset of symptoms to treatment in this series ranged from 2 months to 30 years. Nearly all of the patients had pain and numbness
only in the hand, but it often reached as high as the elbow and, on occasion, up to the shoulders. When pain occurred, it was often described as “excruciating.” Nocturnal paresthesias were present in 528 (91.5%) of the 577 hands and represented the most reliable sign in the history for the diagnosis of carpal tunnel syndrome. Additionally, 99 patients (17.2%), having failed conservative therapy, had associated metabolic problems; thyroid disease, diabetes, and arthritis were the most common, occurring in 76 patients. Cervical disc disease was seen in 14 patients, cancer in eight cases, and polyarteritis, Raynaud’s syndrome, myasthenia, polycythemia vera, and renal disease in one patient each.

The findings on physical examination can be summarized as follows: 303 hands (52.5%) had weakness of the thenar muscles, usually in the abductor pollicis brevis; 141 hands (24.4%) had atrophy in the thenal eminence; and 356 hands (61.7%) had sensory changes in the median nerve distribution. The earliest finding was at the distal aspect of the index finger and the entire median nerve distribution was hypesthesic. Many patients had hyperesthesia rather than loss of sensation. Phalen’s test was positive in 391 hands (67.8%). At presentation, 392 hands (68%) had constant numbness. Tinel’s sign was found to be unreliable and was not used as an indicator of disease.

In this study, 89% of the patients had abnormal EMG and NCV. The remaining patients either had a clinical picture consistent with carpal tunnel syndrome but had normal electrical studies, or they simply refused the test.

The follow-up period was from 9 months to 3 years. In addition to postoperative visits, 555 consecutively treated patients were sent a questionnaire and 415 responded. They were asked a series of questions concerning duration of symptoms, presenting complaints, which symptoms had or had not been relieved, and whether they considered that their results were excellent, good, fair, or poor; they were also requested to give reasons why they selected these answers.

Operative Technique

The flexor retinaculum is attached to the pisiform and hook of the hamate bone medially and the tuberosity of the scaphoid and the crest of the trapezium bone laterally. The contents of the tunnel consist of the median nerve, the tendons of the flexor digitorum sublimus, and the flexor digitorum profundus and their synovial sheaths. The long tendon of the palmaris longus passes volar to the retinaculum to become continuous with the palmar aponeurosis fascia. The ulnar nerve and artery lie medial and superficial to the retinaculum, in Guyon’s canal. The palmar cutaneous branch of the median nerve, which innervates the skin over the base of the thenar eminence, arises 1 to 6 cm proximal to the flexor retinaculum to reach the skin. The palmar cutaneous branch of the ulnar nerve also courses superficial to the ligament in a medial direction. The motor branch of the median nerve arises under and distal to the retinaculum and winds around the nerve distal to the ligament to reach the thenar and the lateral two lumbricales muscles.

The incisions used most commonly to divide the ligaments are placed on a curvilineal course on the ulnar side of the thenar crease then cross the wrist parallel to the wrist crease in an effort to avoid damage to the palmar cutaneous branch of the median nerve. The remaining proximal ligament is then divided in a “blind” fashion.

The technique presented here, a slight modification of that used by Paine and Polyzoidis, simply uses a small component of this widely used technique to accomplish the same goal. The Paine retinaculotome has also been slightly modified (Fig. 1). The operation is performed with ×3.5 loupe magnification. Local anesthesia, with or without intravenous sedation, is used because the surgeon can be more sensitive to handling or compression of the nerve. A small transverse incision is made in the distal wrist crease centered on the ulnar side of the palmaris longus tendon. Most dissection is done bluntly to spread and retract tissue rather than to cut it. The flexor retinaculum is exposed, elevated away from the underlying nerve and cut along the course of its fibers about 1.5 cm to expose the median nerve. The

**Fig. 1.** *Upper:* The Paine retinaculotome. The flat portion of the base of the retinaculotome is approximately 2 mm thick. The knife edge extends from the flat portion of the knife in a perpendicular fashion, with the leading edge being the cutting surface which divides the carpal ligament as the retinaculotome is advanced into the palm. The scale is in inches. *Lower:* Artist’s drawing of the retinaculotome being passed into the palm of the hand through a small transverse incision on the ulnar side of the wrist.
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The retinaculum is cut a few millimeters down into the palm and up the wrist to allow easy placement of the retinaculotome. The retinaculotome foot plate is then positioned under the ligament and above the nerve, slightly slanted to the ulnar side about 20°. It is then passed into the palm until no more resistance is felt (Fig. 2). A very characteristic grating sound is produced by division of the ligament. The same procedure is then used to divide the proximal ligament into the forearm. If necessary, several passes are made with the retinaculotome. Bleeding is controlled by bipolar coagulation and gentle compression. The incision is closed with three mattress sutures. A bulky dressing is applied with the fingers free and an ice pack is placed immediately over the palm. The patients are instructed to use the hand as needed and to apply ice for the first 24 hours. The next day, all dressings are removed and replaced with an adhesive bandage dressing. No casts or splints are used, and normal nonstrengthening use of the hand is encouraged starting on the day of surgery. No tenosynovectomy or epineurolysis was performed in these patients and no axillary blocks, Beir blocks, or tourniquets were used. All patients were examined 7 to 10 days postoperatively, and the sutures were removed; the patients were examined again 2 to 3 weeks later. All patients were either seen or contacted by phone 6 months postoperatively and by questionnaire. In those patients who kept their follow-up appointments, routine monitoring continued until the symptoms resolved or stabilized.

Fig. 2. Artist's drawing of a transverse section of the wrist at the distal wrist crease showing the position of the retinaculotome as the ligament is divided. The median nerve is the black structure above the flexor tendons in the carpal tunnel.

Results

Over 555 consecutive patients were sent questionnaires, but only 445 patients completed and returned their form. The results were determined by the patient's response to the questionnaire and whether the preoperative symptoms had been relieved.

Nocturnal paresthesias, which had been present in 91% of the patients preoperatively, were completely relieved in 520 (90.1%) of the 577 hands. Improved hand function was reported in 481 (83.4%) of the 577 hands. When patients were asked how soon postoperatively they were able to use their hands in a comfortable fashion, 343 (59.4%) of 577 hands were in regular use within 1 week. Since many of our patients were either retired or unemployed, only 251 patients responded to the question concerning "return to work." Of these, 131 (52.2%) reported having returned to work in less than 1 week after surgery (34 of these patients had undergone bilateral carpal tunnel release at a single sitting) and 182 patients (72.5%) were back to work in less than 3 weeks (42 (23%) of whom had a bilateral carpal tunnel release at one sitting). These results were accomplished without postoperative physical therapy or splinting. These data include patients with a wide variety of jobs: teachers, typists, carpenters, meat cutters, and other production workers.

The 445 patients responding to the questionnaire reported that 472 hands (81.8%) had good to excellent results from surgery. However, based on the questions regarding relief of nocturnal paresthesias, pain or numbness, and improvement in hand function, 535 hands (92.7%) exhibited satisfactory results from surgery. Of the operations that failed, four hands were known to have undergone reoperation; two were improved after the second operation, and two were unchanged. It was believed that the reason for initial failure in the two that improved after the second operation was incomplete division of the ligament at the first operation.

There were no injuries to the median nerve or any of its branches in this series. There was one case of reflex sympathetic dystrophy, which responded to sympathetic block. There were no postoperative hematomas in the surgical bed, but eight hands developed superficial infections that responded to oral antibiotics.

Discussion

Pathogenesis

Carpal tunnel syndrome has been reported to be associated with a number of systemic and metabolic disorders, including diabetes mellitus, hypothyroidism, rheumatic diseases, acromegaly, amyloidosis, multiple myeloma, long-term renal dialysis, tumors of the wrist, and unusual anatomical variations. It can also be of a primary familial variety. By far the most commonly encountered cause is acquired and usually related to repetitive wrist and hand activity. The common denominator in the development of carpal
tunnel syndrome is the cross-sectional diameter of the carpal tunnel itself.\textsuperscript{2,3,4,5} Anything that decreases the size of the tunnel can compromise its contents,\textsuperscript{6,7,8,9,10,11,12,13,14,15,16,17} making the phrase “carpal tunnel stenosis” appealing. The metabolic disorders rarely cause isolated carpal tunnel syndrome. Patients with isolated carpal tunnel syndrome, normal ulnar latencies, and a physical examination and medical history not suspicious of peripheral neuropathy do not warrant laboratory study.\textsuperscript{5}

Management and Complications

The medical management of carpal tunnel syndrome has been widely reported and the role of wrist splinting, steroid injections, rest, oral anti-inflammatory agents, and correction of metabolic disorders is well documented.\textsuperscript{10,11,12,13,14,15,16,17} The surgical management of carpal tunnel syndrome has been debated widely in the literature. Complications of surgery have been attributed primarily to the type of incision rather than to the experience and skill of the surgeon.\textsuperscript{4,7,16,17} The necessity for doing anything but simple division of the transverse ligament in the majority of patients has been investigated. Physiological studies of the nerve during carpal tunnel release and anatomical studies have shown that extensive dissection and internal neurolysis do more harm than good, apart from marginally better results in patients with extensive thenar muscle atrophy.\textsuperscript{4,6,9,10,11,12,13,14,15,16,17}

If the primary problem is stenosis of the carpal tunnel, the operation should be designed to release the nerve with the least amount of trauma to the nerve. Anatomical analyses of the approaches necessary to accomplish this goal have varied widely, including a transverse incision and longitudinal incisions that extend from the palm up the forearm. The surgical approaches are aimed at complete division of the ligament without injuring the recurrent motor, palmar cutaneous, and digital branches of the nerve or the ulnar artery. The palmar cutaneous branch arises from the median nerve on the radial side of the palmaris longus tendon, and an incision on the ulnar side of this tendon should avoid injury to it. Although injury to the motor branch is postulated in many articles, it is surprisingly rare, regardless of the technique used, as is true for other potential complications.\textsuperscript{15,16,17,18,19,20,21} Complications, such as reflex sympathetic dystrophy, joint stiffness, bowstringing of the flexor tendons, and inadequate division of the ligament, are reported equally, regardless of the technique used.\textsuperscript{17,18,21}

At least two of our failures were due to incomplete division of the ligament. To avoid this problem, it is important to continue advancing the retinaculotomy until resistance is lost. Cutting the ligament creates a very characteristic grating sound that persists throughout the cut. The resistance to the blade is also consistent along the length of the ligament. The grating and resistance cease simultaneously. The distance required to pass the retinaculotomy varies slightly from patient to patient; thus, attention to these details will insure adequate division of the retinaculum.

Recently, we have started using a small hemostat to confirm division of the ligament. After cutting the retinaculum, the hemostat is introduced into the carpal tunnel and opened widely. There should be no resistance to this maneuver either distally into the palm, or proximally into the forearm.

Analysis of Results

The results of this study compare favorably with those of others. In a review of 214 patients operated on for carpal tunnel syndrome, Graham\textsuperscript{12} found that 75% had complete symptomatic relief. In a study of 100 patients treated surgically, Kulick, et al.,\textsuperscript{15} reported that 25% had persistent paresthesias of the median nerve at the time of “long-term follow-up.” Macdonald, et al.,\textsuperscript{17} studied both longitudinal and transverse incisions in 186 patients and found that 34 (18.2%) had experienced complications of surgery. In a series reported by Semple and Cargill\textsuperscript{12} in 1969, only 75% had symptomatic relief following surgery using a longitudinal incision. These results are similar to those of Graham using the same technique. Paine and Polyzoidis\textsuperscript{21} and others\textsuperscript{5,12,13} have reported 90% or greater relief of symptoms using various techniques for carpal tunnel syndrome. As stated by Phalen,\textsuperscript{20} however, “the type of incision used is of little importance, provided the incision does not cross the distal flexion crease of the wrist at a right angle.”

It was clear both from our experience with the open technique and from the literature, that these patients had an easier postoperative course than is reported with the open technique.\textsuperscript{18,19} Patients can use their hands on the day of surgery, and 24 hours later have only a bandage strip on the wound. There is little interruption in routine daily hand usage, allowing bilateral procedures to be performed at the same sitting. This reduces time lost from work and the costs involved. Almost three-quarters of our employed patients returned to work by 3 weeks after surgery.

Conclusions

The authors have used a technique that varies slightly from that used by Paine and Polyzoidis.\textsuperscript{21} We believe that this technique encompasses beneficial aspects of other techniques while avoiding many of the complications cited above. We have analyzed our results objectively by allowing the patients to determine their outcome in the form of a questionnaire. A review of each case revealed greater than a 92% success rate without a single injury to the median nerve or any of its branches in over 577 consecutive hands. We have also re-explored 24 hands originally treated with a longitudinally oriented exposure, and all were improved by the present technique.

We submit that this technique is anatomically sound and judging by the results of our cases and those of Paine and Polyzoidis,\textsuperscript{21} that a modified transverse incision is an efficient, safe, and effective way to treat carpal tunnel syndrome. The patients regain full use of
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the hand faster than with a more extensive surgical procedure, avoid postoperative splinting and the need for physical therapy, and do not experience the feared complications that threaten others who undergo a transverse type of incision.

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