ENDOSCOPIC CARPAL TUNNEL RELEASE

In Favor

Daniel J. Nagle, MD

THE CONTROVERSY: HISTORICAL PERSPECTIVE

The controversy surrounding endoscopic carpal tunnel release (ECTR) has evolved since Okutsu et al.12 and Chow13 first introduced their techniques in 1987 and 1989. The initial visceral reaction to this new technique has gradually given way to a more rational discussion. The importance of the discussion is grossly reflected in the number of articles appearing in the literature. The number of scientific articles dealing with carpal tunnel surgery has passed from approximately 29 articles per year between the years 1986 and 1988, to 66 articles per year since 1988. Prior to 1989, there were no articles dealing with ECTR. Two years after the first ECTR articles appeared, the number of ECTR and open carpal tunnel release (OCTR) articles began to increase to reach a maximum in 1993 for OCTR and 1994 for ECTR (Fig. 1). Although there are many reasons for the increase in carpal tunnel surgery literature, the parallel growth in the number of OCTR and ECTR papers would suggest that the advent of ECTR was at least in part responsible for this increase. ECTR made us look more critically at a procedure that has been taken for granted for decades.

ECTR is an extension of the philosophy of minimally invasive surgery that is becoming more popular in the United States. This philosophy is based on the assumption that limiting surgical trauma should lead to less postoperative pain and an earlier return to function. Orthopedic colleagues (Desouza, 1838), were the first to perfect endoscopy.14 The orthopedic community was introduced to arthroscopy in 1918 by Takagi of Tokyo.15 He first used a cystoscope to examine cadaver joints. He developed arthroscopes and used them to examine a tuberculous knee in 1920. (It is interesting that ECTR also was first performed by Okutsu, a Japanese surgeon.) His successor, Watanabe, continued to refine the arthroscope and printed an atlas of arthroscopy in 1957.16 Interest in arthroscopy waned, however, because of the poor quality of the arthroscopes. It was not until the late 1960s and early 1970s that North American interest began to increase.17 Maintezem orthopedic surgeons did not immediately embrace this technology. Knee arthroscopy was considered by many to be a triumph of technology over reason. As experience with knee arthroscopy increased, however, it became apparent arthroscopy offered many advantages over arthrotomy. Today, knee arthroscopy is the "standard" modality for the treatment of many knee problems.

Other surgical specialties began using en-
The second source of irritation to many has been the marketing of ECTR. ECTR has come to be associated with the actual device rather than the technique that may or may not be used. The marketing of ECTR has been a major factor in the widespread use of the procedure. The second source of controversy is the data on the actual outcomes of patients treated with ECTR. This data is often presented in a way that is not easy to interpret. The third source of controversy is the use of ECTR in the context of other surgical procedures. The use of ECTR in conjunction with other procedures has been a major point of contention.

Another source of controversy is the financial impact of ECTR on healthcare systems. The cost of ECTR is often higher than that of other surgical procedures, and the long-term effects on patients are not always clear.

The controversy surrounding ECTR has been complex and multifaceted. The first reason for the difficulty in interpreting the data on ECTR is the lack of standardization in the procedures used. The second reason is the lack of long-term follow-up data. The third reason is the lack of large-scale randomized controlled trials. The fourth reason is the lack of consensus regarding the indications for ECTR.

ECTR has been used in a variety of settings, including both acute and chronic conditions. The effectiveness of ECTR in the treatment of acute conditions has been well established. However, the use of ECTR in the treatment of chronic conditions is more controversial. The long-term effects of ECTR on patients with chronic conditions are not always clear.

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used "extrabursal technique." Literature based on procedures completed using the transbursal (original) technique flooded the journals in the early 1990s and colored the perception of ECTR. As we pass the midpoint of this decade, newer studies of the extrabursal Chow technique and reted Agee device have defined more accurately the risks associated with these approaches. (See section on ECTR results.)

ENDOSCOPIC TECHNIQUES

Multiple ECTR techniques have been developed since 1987. The technique developed by Okatsu et al. has continued to be used by Okatsu in Japan but has not become popular in the United States. Tsai in Louisville is one of the few North Americans using a variation of the Okatsu technique. In fact Tsai and his colleagues have extended the use of the endoscope in proximal and cubital tunnel release (personal communication). Agee’s single-portal technique and Chow’s dual-portal techniques have been used extensively in the United States. Kosnick and Miller and Brown et al. have developed techniques very similar to the Chow technique using similar instruments. Memon has developed a single-portal technique as has Mirza et al. The majority of the literature on ECTR has, however, dealt with the Chow or Agee technique. It is beyond the scope of this article to review each technique; however, each is briefly contrasted in Table 1. (Note: A videotape reviewing the Chow extrabursal technique as well as pertinent anatomy is available in the American Academy of Orthopaedic Surgeons and the American Society for Surgery of the Hand Video Libraries.)

OPEN TECHNIQUES

Open carpal tunnel release techniques range from the "standard" Takagishi approach following the midaxial line of the ring finger, to extensive exposure extending well into the palm and forearm, to transverse incisions at the wrist flexion crease.

In addition to these "classic" OCTR techniques are the "mini" OCTR approaches. Since the introduction of ECTR, many surgeons, in an attempt to avoid scars in the palm, reconsidered their traditional OCTR incisions. Byrani and Downes, Wilson, Lo Verme and Saccone, Bremley, Abouzaid et al. and others have reported "minimal-incision" carpal tunnel release techniques. Pagano and Barratt also use a minimal incision but release the transverse carpal ligament with a Paine retractor alone. All these techniques attempt to expose the transverse carpal ligament without violating the palmar fascia and skin immediately over the ligament, thus avoiding the pain associated with incisions placed across the "heel" of the hand. They attempt to achieve what ECTR accomplishes without the use of video imaging, preserving the magnification of their 2.5× lenses to the 30× magnification of the endoscope.

RESULTS OF ENDOSCOPIC CARPAL TUNNEL RELEASE TECHNIQUES

The many endoscopic and open carpal tunnel release techniques practiced today render accurate comparison of these techniques difficult. Those studies in which a prospective analysis of one ECTR technique is contrasted to a single OCTR technique are probably the

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<th>Table 1. ENDOscopic CARPAL TUNNEL RELEASE TECHNIQUES</th>
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<tr>
<td>Technique</td>
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<tr>
<td>Chow</td>
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<tr>
<td>Okatsu</td>
</tr>
<tr>
<td>Agee</td>
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<tr>
<td>Memon</td>
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<td>Mirza</td>
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most enlightening but are rare. The few such studies that exist are discussed in this section.

The results of a multicenter prospective study of 640 ECTR's was presented to the American Society for Surgery of the Hand in Phoenix, Arizona in 1992 and published in 1996. Approximately 31% of the cases were covered by workers' compensation and 70% were non-workers' compensation cases. Two ECTR techniques were used. Early in the study the original transbursal technique as described by Chow was used. Approximately 12% of the cases were treated using the modified Chow technique or transbursal technique in which the bursa is not entered. The authors noted the rate of conversion from ECTR to OCTR was 1.3% for the modified Chow (extrabursal) technique and 7.8% for the original Chow (transbursal) technique. The study also reported perioperative complications that included 16 occurrences of neuropathia all of which were resolved. One superficial palmar arch was lacertus and the flexor digitorum sublimis of the ring and small fingers were lacertus in one patient. There was one hematoma and four incomplete releases. Late complications included three reflex sympathetic dystrophies. These statistics translate to a complication rate of 3.2% for the modified Chow technique and 11% for the original Chow technique. The conclusion of these authors was that the transbursal or original Chow technique was associated with a higher complication rate. It was also concluded that there is a steep learning curve with this procedure and appropriate training is essential.

Nagle et al. reported their study of 278 carpal tunnel releases using the extrabursal Chow technique. The rate of conversion to OCTR was 0.7%. There were five neuropathias, all of which resolved; and there were no tendon, artery, or nerve lacerations; hematomas; or incomplete releases. There was one reflex sympathetic dystrophy and three stitch abscesses at the proximal portal. This translated to a complication rate of 3.2%, including the three superficial stitch infections without the stitch infections, the complication rate was 2.2%.

Okatsu et al. reviewed 51 ECTR's in 1988 and reported no nerve or arterial injuries. More recently, the same authors reported the results of 39 ECTR's in which they noted no complications and resolution of all sensory disturbances within an average of 20 weeks. Resnick and Miller reported their results in 1991 of a study of 75 cases that compared the transbursal and extrabursal approaches. Their only complication was noted with the transbursal approach and consisted of one partial median nerve laceration and six ulnar neuropathias.

Brown et al. reported their results comparing the single-portal approach (140 cases) to a dual-portal approach (152 cases). They noted the average duration of operative symptoms was approximately 15 days with either technique, and the average return-to-work time was between 15 and 17 days. The complication rate was 6% for the single-portal procedure and 5% for the dual-portal. There were no iatrogenic vascular or nerve injuries in either series. They did note, however, five "transient paraesthesias" with the two-portal technique prior to the use of "customized" instruments. One case of reflex sympathetic dystrophy (RSD) was noted with each technique. Two cases using the single-portal approach had to be converted to an OCTR and they concluded that the single-portal approach is more difficult than the dual-portal approach.

Brown et al. reported on a prospective, randomized, multicenter study comparing ECTR to OCTR. The endoscopic technique was a dual-portal extrabursal approach. There were 85 OCTR's and 81 ECTR's. They reported no complications using the OCTR approach, but reported four complications using the ECTR approach. These included a partial laceration of the superficial palmar arch, a digital nerve and an ulnar nerve neuropathia, and one hematoma. They stated the relief of pain and paraesthesias was similar with both techniques. Eighty-four percent of the patients who had OCTR and 89% of the patients with ECTR were satisfied. The return of sensation and motor strength was the same in both groups. The OCTR patients complained of more scar tenderness and their median return-to-work time was 26 days as opposed to 14 days for the patients who underwent ECTR.

Palmer and his co-authors, in a single-center, prospective study of 211 carpal tunnel releases, compared the results of carpal tunnel releases carried out with the Chow, Agee, and open techniques. They noted no difference in the time to resolution of paraesthesias
or nocturnal pain among the different release methods. ECTR techniques, however, lead to a more rapid recovery of pinch and grip strength and wrist range of motion, and less mid-palm tenderness. They noted no intragenic injuries with any of the techniques.

Scott et al. 

reported his experience with 215 ECTRs using the modified Chow technique. He stated that 211 patients “did well” whereas two patients developed mild RSD and two other patients were not relieved of their symptoms. No neurovascular or tendon injuries were noted in the 211 cases.

Both et al. of London, Ontario, in a prospective, single-center, study, performed 165 ECTRs using the modified Chow technique and noted a 94% success rate. There were no neurovascular complications or RSD. There were four complications including: one incomplete release, one flexor tenosynovitis, one hematoma, and one cellulitis.

Fried et al. reviewed the results of 1400 ECTRs performed using a modification of the Chow technique. They noted two partial lateralizations of the superficial palmar arch (0.14%) and one injury to the third common digital nerve (0.07%); all structures were repaired. These authors stated that these three patients recovered well in spite of these complications. They also noted an incidence of RSD of 0.28%. Sixty-three patients underwent an OCTR on one side and an ECTR on the other. Of these patients, 51 (86%) preferred the ECTR, 6 had no opinion, and 3 (5%) preferred the OCTR.

Chow reviewed his first 1754 cases and noted no permanent neurovascular injuries. He did report two transient ulnar nerve palsies, which recovered spontaneously, and one incomplete release for a complication rate of 0.26%. He also recorded three (0.26%) recurrences.

Mekel et al. presented at the American Academy of Orthopaedic Surgeons in 1994 the results of a questionnaire that was sent to participants in the Chow Endoscopic Carpal Tunnel Release Courses. The questionnaire queried the surgeons as to their results using the dual-portal ECTR technique. Data were collected on 10,624 cases of which 30% were carried out using the original transbasal approach and 70% using the extrabasal approach. The complication rate was 4.8% for the original Chow approach and 1.2% for the extrabasal approach. The complications were, however, serious and included median, ulnar, and digital nerve lacerations and tendon and artery injuries (Table 2).

<table>
<thead>
<tr>
<th>Technique (Chow)</th>
<th>Cases</th>
<th>Nerve Injury (%)</th>
<th>Vessel Injury (%)</th>
<th>Tendon Injury (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transbasal</td>
<td>5756</td>
<td>123 (3.2)</td>
<td>27 (0.7)</td>
<td>15 (0.5)</td>
</tr>
<tr>
<td>Extrabasal</td>
<td>4868</td>
<td>32 (0.7)</td>
<td>27 (0.5)</td>
<td>0 (0)</td>
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Table 2. COMPLICATIONS SEEN IN 10,624 DUAL-PORTAL ECTRS

Menas reported his early results using his single-portal technique in 1994. He studied his first 100 cases and noted no permanent neurovascular injuries although four neuropraxies were suspected and spontaneously resolved. There were no tendon or artery injuries. Seven patients developed pillar pain. Of the twelve patients who underwent an OCTR on one side and an ECTR on the other, nine preferred the ECTR. Complete relief of symptoms was noted in 94% of the patients. This compares well with an 83% resolution of symptoms noted for OCTR by Gelberman et al.

Agee et al. in their most recent review of his technique, looked specifically at complications associated with the use of the retinaculum. Agee carpal tunnel release system. Data from 63 centers around the world were studied. The results of 4199 procedures were analyzed. The results were two (0.2%) long-lasting neurovascular injuries. One was related to the transsection with a scalpel of the palmar cutaneous nerve at the time of creation of the initial wrist incision. The other was thought to be the result of transection of a communicating branch between the median and ulnar nerves. There were no vascular or tendon injuries, one case of RSD, and one suture infection. Twenty-six cases were converted to OCTR (2.5%) and two cases were converted to an alternate ECTR technique (0.2%).

Another single-portal ECTR technique recently has been introduced by Mirza et al. (see Table 2). This technique proceeds from distal to proximal after identifying the palmar neurovascular structures. In their first 40 cases, Mirza et al. noted two neuropraxies of the third common digital nerves and a 20% laceration of the median nerve (repaired at the time of surgery). There was also one inconstant release. The subsequent 248 cases were carried out without incident. Eight (3%) cases were converted to OCTR.
Finally, Radebeck and Delhanty reviewed the results of 322 ECTRs performed by one surgeon using the Agee technique. Three cases (0.9%) were converted to an OCTR and all but one patient (99.5%) reported improvement of their symptoms. There were four complications (1.2%), including an injury to the palmar cutaneous branch of the median nerve, one transient radial sensory neuropathy (not device related), one aggravation of preexisting Reynaud's disease, and one tenosynovitis.

Those studies represent the results of nearly 17,000 ECTRs. The complication rates average approximately 1.6%. The incidence of neurovascular complications and RSD is even lower. These studies performed later in the evolution of ECTR (i.e., performed using the extrabursal Chow technique or the second-generation Agee device) and with larger cohorts demonstrate lower complication rates.

**RESULTS OF OPEN CARPAL TUNNEL RELEASE**

More than 3000 articles have been written on carpal tunnel syndrome since 1964. Among these articles have been several dealing with the complications associated with OCTR. Pelikon reported on 212 cases in 1966 and noted one superficial infection and one RSD. Ariyan and Watson in 1977, studied the results of 429 open carpal tunnel releases and found a 1.4% complication rate (seven infections, one hematoma, and four recurrences).

MacDonald et al. reported in 1978 on 186 cases in which they had an 8% complication rate. Lichtman et al. in 1979, reported on 186 cases in which they had a 1% complication rate. It should be noted that in the study by MacDonald et al., the complications existed prior to the referral to MacDonald and colleagues. MacDonald et al. reported a 8% incidence of injury to the palmar cutaneous branch of the median nerve whereas Lichtman et al. reported a 2% incidence. Lichtman et al. pointed out that these were neuropraxies. Dow and Brown pointed out numerous anomalous origins and routes of the palmar cutaneous branch of the median nerve, including branches crossing to the ulnar aspect of the palm. Siegel et al. reported a case of such an ulna directed branch. Their finding and a review of the literature led them to conclude that there is no truly ‘safe’ approach to the median nerve.

In the series by MacDonald et al., there is a 1% incidence of injury to the superficial palmar arch and a 0.5% incidence of neuroapraxia. MacDonald et al. reported a 2.1% incidence of reflex sympathetic dystrophy whereas Lichtman et al. reported a 0% incidence. In MacDonald et al.'s series, there was a 2.5% incidence of hypertrophic scars, a 0.5% incidence of tendon adhesions, and a 2% incidence of bowstringing.

Deep infection would appear to be a rare occurrence after OCTR, with Hahnesen et al. reporting a 0.4% incidence. Caruotto et al. however, reported a case in which extensive palmar necrosis occurred as a result of a post-ECTR infection.

Recurrence of carpal tunnel syndrome symptoms after a successful OCTR has not been reviewed critically by many authors. Ariyan and Watson are among the few authors who looked at this phenomenon and noted a 9.3% rate of recurrence.

While Murphy et al. have reported the occurrence of neurovascular injury during ECTR, Lilly and Magner reported the severance of the motor branch of the median nerve during OCTR. Caruotto et al. have reported a case of complete laceration of the median nerve during an ECTR.

Incomplete release of the transverse carpal ligament has been noted after OCTR. Langholz and Lichtenstein noted incomplete release of the transverse carpal ligament in 21 of 28 cases requiring reexploration after OCTR.

Palm and Tearson surveyed the members of the American Society for Surgery of the Hand with regard to the members' experience with OCTR and ECTR. The results of that survey are summarized in Table 3. This survey of "qualified" surgeons clearly demonstrates that OCTR is associated with significant complications.

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<thead>
<tr>
<th>Table 3. COMPLICATIONS OF ECTR AND OCTR</th>
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<tr>
<td><strong>Complication</strong></td>
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<td>----------------------------------------</td>
</tr>
<tr>
<td>Median nerve</td>
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<tr>
<td>Palmar cutaneous branch</td>
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<td>Ulnar nerve</td>
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<td>Digital nerve</td>
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<td>Tendon</td>
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<td>Superficial arch</td>
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<td>Ulnar artery</td>
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RETURN TO WORK

Several studies have reported on the difference in return-to-work times between workers’ compensation cases and non-workers’ compensation cases. Agee et al. noted little difference in the time to return to work between OCTR and ECTR in those patients covered by workers’ compensation (71 days for those treated with ECTR, 78 days for those treated with OCTR). They did, however, appreciate a significant difference between OCTR and ECTR when the return-to-work times were compared for patients not covered by workers’ compensation. The ECTR group returned to work on average 16.5 days after surgery as opposed to 45.3 days for the OCTR group.

The multicenter ECTR study cited earlier, as well as the study by Nagle et al. reported an average time to return to work of between 57 and 65 days for workers’ compensation cases as opposed to 21 to 22 days for non-workers’ compensation cases. Both these studies work on to assess whether or not there was a difference between the workers’ compensation and non-workers’ compensation groups according to the work classification. These studies concluded regardless of the type of work performed, the workers’ compensation patients return to work on average later than did the non-workers’ compensation patients.

Further corroborating this trend are the results reported by Chow in which, at 4 weeks, 63% of the workers’ compensation patients were back to work as opposed to 90% of the non-workers’ compensation patients.

Palmar et al. demonstrated that ECTR led to a more rapid return to work for patients covered by workers’ compensation than did OCTR (Table 4). They estimated that the more rapid return to work of these workers treated with ECTR would save the state close to $5,000,000.

Feinstein noted that non-workers’ compensation patients returned to work an average of 17 days after their ECTR as opposed to 34 days for workers’ compensation patients. Keer and associates recently have noted the time to return to work for workers’ compensation cases is independent of the carpal tunnel release technique used.

Nancollas et al. also noted that with OCTR, 42% of the workers’ compensation patients had a slower initial improvement. Their statistics show the average time to return to work for a workers’ compensation patient after an OCTR was 8.4 months as opposed to 1.7 months for non-workers’ compensation cases.

Roth et al. in their study of 108 ECTR cases noted the mean time to return to work was 36.4 days for workers’ compensation cases and 79.5 days for non-workers’ compensation patients.

Higgs et al. retrospectively compared the work status of 113 patients who had undergone OCTR and were covered by workers’ compensation with that of 53 patients who also underwent OCTR but who were not covered by workers’ compensation. The time to return to work after the OCTR was 3 weeks for the non-workers’ compensation patients as compared to 12 weeks for the workers’ compensation patients.

It is clear from this review of the currently available literature that the return to work issue remains unresolved. Some studies have suggested that ECTR, in fact, does lead to an earlier return to work, whereas others have suggested that it does not, at least with regard to workers’ compensation cases. All the studies agree that, in patients not influenced by secondary gain, ECTR does, in fact, allow an earlier return to normal activities. It is naive to suppose a surgical technique will accelerate the slow postsurgical recovery noted in workers’ compensation patients.

<table>
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<tr>
<th>Table 4: RETURN TO WORK (DAYS AFTER PROCEDURE)</th>
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<td>Technique</td>
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<td>Chow</td>
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<td>OCTR</td>
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WC = Workers’ compensation cases; NWC = non-workers’ compensation cases.


DISCUSSION

That ECTR relieves the majority of patients suffering with carpal tunnel syndrome of their symptoms is supported by the literature presented in this article. But what about the science behind the technique? Ahlve et al., using pre- and postoperative MR imaging,
have demonstrated that the volume of the carpal tunnel increases after ECTR just as it does after spontaneous carpal tunnel release. Furthermore, their data indicate that the loss of Guyon canal changes from triangular to round after both carpal tunnel release techniques. These findings are further corroborated by the work of Kato et al. In their study, they also performed pre- and postoperative MRI imaging evaluation of the carpal tunnel and found that the cross-sectional area of the carpal tunnel increased by an average of 33% after ECTR.

Hamenaka et al. have measured the intra-carpal tunnel pressure before and during ECTR and demonstrated a definite "decompression" of the carpal tunnel after ECTR, with the intra-carpal tunnel pressure returning to normal levels. Based on these studies, it would appear that ECTR does indeed decompress the carpal tunnel.

One can argue that ECTR techniques do not permit complete visualization of the carpal canal and, therefore, congenital anomalies will not be found and corrected. Certainly not all patients will be candidates for ECTR. If something is "not quite right" at the outset of the procedure (i.e., an abnormally positioned muscle at the wrist), the endoscopic technique should be converted to an open procedure. In the majority of cases, however (in our series, 99.3%), an ECTR can be completed. The endoscopic decompression of the carpal tunnel creates enough volume to accommodate the congenital anomaly and decompress the median nerve. If the anomaly were the de novo cause of the carpal tunnel syndrome, one would expect to see carpal tunnel syndrome in infants and children. Carpal tunnel syndrome, however, is rarely seen in children. Furthermore, if one assumes an estimated incidence of congenital anomalies in the carpal tunnel region of between 10% to 12%, one would expect to see a failure rate nearly equal to the incidence of the anomalies. This is not seen.

Many of us become accustomed to performing external neurolysis of the median nerve during OCTR. It made us feel good to release the constriction of the median nerve. Obviously, neurolysis cannot be done during an ECTR. Mackinnon et al. and Goberman et al. have, however, demonstrated that internal neurolysis is not beneficial in carpal tunnel syndrome surgery. It would, therefore, appear that the fact that neurolysis cannot be performed during ECTR is not a drawback and may actually be saving the median nerve from unnecessary trauma.

Several studies have shown patients to be more comfortable after ECTR as compared with OCTR. Critics of ECTR state the risks associated with ECTR are not outweighed by this increased postoperative comfort. If the risks associated with ECTR were indeed greater than those associated with OCTR, no one would advocate this procedure. The literature presented in this article (17,000 ECTR cases); however, does not support this hypothesis. Assuming ECTR and OCTR have similar outcomes and complications (neither technique being completely benign) it would seem appropriate to provide our patients with relief of their carpal tunnel symptoms with the least invasive and least painful technique possible, ECTR.

SUMMARY

The many studies presented in this article demonstrate that ECTR is not a procedure to be taken lightly. It is a demanding surgical exercise that requires exacting knowledge of the anatomy of the hand. It is not something that should be carried out by the surgeon who does an occasional carpal tunnel release. For those who do not meet these criteria, OCTR remains the procedure of choice. For those surgeons who are well trained and aware of the anatomy of the hand, however, ECTR allows them to provide their patients with a safe, predictable solution to their carpal tunnel syndrome that will allow them a rapid return to normal activities.

Further studies, however, will be required to see how well ECTR holds up to the test of time. Long-term studies currently are underway and should be available in the not-too-distant future.

ACKNOWLEDGMENTS

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