Results of Endoscopic Carpal Tunnel Release Relative to Surgeon Experience With the Agee Technique

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Purpose To establish the rate of iatrogenic injury after endoscopic carpal tunnel release (ECTR) for a surgeon in the first 2 years of practice; to report the rate of conversion from ECTR to open carpal tunnel release (OCTR), the reason for conversion, and any increase in morbidity found in patients converted to OCTR; and to determine whether the conversion rate decreased with increasing surgeon experience.

Methods We conducted a retrospective review of patients undergoing ECTR by a single surgeon in the first 2 years of practice. Data collected or calculated included symptom relief, rate of conversion to OCTR, reason for conversion, and neurovascular complications. For patients converted to OCTR, we assessed satisfaction and function using the Disabilities of the Arm, Shoulder, and Hand questionnaire. We compared these results for 1 to 6 months, 7 to 12 months, and 12 to 24 months to determine whether a learning curve was present.

Results A total of 278 patients (358 procedures) underwent ECTR. Of these, 12 patients required conversion to OCTR during the index procedure over a 2-year period. In the first 6 months of practice, 8 of 71 ECTRs were converted to OCTR compared to 1 of 72 in the second 6 months. This was a statistically significant decrease ($p = .017$). In year 2, 3 of 215 patients were converted to OCTR. Average Disabilities of the Arm, Shoulder, and Hand score for patients converted from ECTR to OCTR was 9. No patients required repeat surgery for recurrence of carpal tunnel symptoms. We observed no major neurovascular complications.

Conclusions A learning curve for ECTR was present. Rates of conversion significantly diminished with increased surgeon and anesthesia experience. Patients requiring conversion showed no variation in Disabilities of the Arm, Shoulder, and Hand scores from established values after OCTR. Patients may be at a higher risk of conversion to OCTR during the learning curve time period; nevertheless, we found no increased morbidity. *(J Hand Surg 2011;36A:61–64. © 2011 Published by Elsevier Inc. on behalf of the American Society for Surgery of the Hand.)*

Type of study/level of evidence Prognostic III.

Key words Carpal tunnel, surgery, endoscopic, open.

Carpal tunnel syndrome (CTS) is the most frequent compressive neuropathy in the upper extremity, with an incidence of 1 to 3 cases per 1,000 patients per year.[1] Since the 1950s, conventional open carpal tunnel release (OCTR) has been the standard of care for CTS that has failed nonsurgical treatment. Open carpal tunnel release has provided excellent long-term results but has been associated with pillar pain, slow return of pinch strength, and slow return to work.[2–9]

Okutsu et al.[10] described endoscopic carpal tunnel release (ECTR) to provide equivalent decom-

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pression of the median nerve while attempting to diminish the complications associated with OCTR. The early 2-portal technique of ECTR had a high incidence of complications.[11–13] Agee et al.[14] later developed a single incision technique that allowed for visualization of the transverse carpal ligament throughout the procedure. With visualization and increasing surgical experience, the complications associated with ECTR diminished.

In a literature assessment of 80 publications from 1966 to 2001 that reviewed 22,327 cases of ECTR and 5,669 cases of OCTR, the rate of structural damage to nerves, arteries, or tendons in OCTR was 0.49%, whereas in ECTR it was 0.19%. The rate of transient neurapraxias was higher in the ECTR group, 1.45% compared with 0.25%.[15] Several studies have supported that ECTR patients have less postoperative pain, faster return to functional activities, and improved early grip and pinch strength.[9,16–20] These differences were found to normalize at 1 year.[21–23] Endoscopic carpal tunnel release has become an accepted treatment alternative to OCTR. Even in light of the above data, concern has been expressed that results of ECTR are limited by the surgeon's experience.[18,24–29]

This study is a retrospective review of 358 ECTRs performed by a single surgeon in the first 2 years in practice. Our goals were to establish the rate of nerve and vessel injury, the rate of conversion from ECTR to OCTR, and the effect conversion had on patient outcome, and to further define the learning curve associated with ECTR for a single surgeon in the first 2 years of practice. We compared the rate of conversion from OCTR to ECTR for 1 to 6 months, 7 to 12 months, and 12 to 24 months after beginning practice. We evaluated the reason for conversion and whether an increase in morbidity was found in patients converted to OCTR. We hope to identify more clearly whether the results were related to the experience of the surgeon performing ECTR and if during this period there was increased morbidity for the patients.

MATERIALS AND METHODS

We obtained institutional review board approval for this study. We conducted a retrospective review of all patients undergoing ECTR for CTS by a single hand fellowship–trained surgeon in the first 2 years in practice from October 2007 to September 2009. The surgeon had no experience with ECTR before fellowship but was exposed to ECTR during fellowship training. Patients with prior carpal tunnel release were excluded from the study. All patients with diabetes or an underlying rheumatologic disease were not considered candidates for ECTR and were thus excluded.

We evaluated patients preoperatively and determined the diagnosis of CTS by history and physical examination. All patients undergoing ECTR had a preoperative electromyelogram and nerve conduction studies confirming compression of the median nerve at the level of the transverse carpal ligament. The Micro-Aire uniportal system (Charlottesville, VA) was used in all cases.

Release was performed under local anesthesia with monitored anesthesia care sedation. Approximately 1.5 mL 2% lidocaine was injected into the subcutaneous area directly volar to the incision site proximal to the transverse carpal ligament. A tourniquet was placed just distal to the axilla, the hand was prepared and draped, an Esmarch bandage was used to exsanguinate, and the tourniquet was inflated to 250 mm Hg. The endoscopic release was then performed in the manner previously described by Ruch and Poehling.[24]

We evaluated patients at 2 weeks, 6 weeks, and 6 months after surgical intervention. Data collected included subjective relief of pain and numbness; if conversion to open procedure was required, the reason for conversion; and neurovascular complications. We compared results at 1 to 6 months, 7 to 12 months, and 12 to 24 months after beginning practice to determine whether treatment results were related to the surgeon's experience. We used Fisher's exact test for 2 proportions to determine whether a significant decreased rate of conversion was present.

Indications for conversion from ECTR to OCTR included an inability to obtain clear visualization of the transverse carpal ligament and inadequate anesthesia prohibiting safe completion of ECTR. For patients converted to open procedures, we assessed satisfaction and function using a validated self-assessment questionnaire (Disabilities of the Arm, Shoulder, and Hand [DASH]) at 6-month follow-up.

A total of 278 patients (358 hands) underwent ECTR by a single surgeon over the first 2 years of practice. Unilateral CTR was performed in 278 of 358 cases and bilateral release, both simultaneous and sequential, made up 80 of 358 cases in the study group. There were 76 male and 202 female patients. Thirty-nine patients had associated hand problems, including 17 with trigger finger, 10 with symptomatic ganglions, 7 with cubital tunnel, and 5 with De Quervain's tenosynovitis.

RESULTS

At final follow-up, all patients reported major or complete relief of symptoms, including pain and numbness. No patient required revision carpal tunnel release. A total of 12 patients required conversion to OCTR at time of index surgery over a 2-year period. In the first 6 months, 71 ECTRs were performed. Of these, 8 ECTRs were converted to OCTR. The reason for converting to OCTR included hypertrophic synovium obstructing clear visualization of the transverse carpal ligament for 4, inadequate anesthesia prohibiting safe completion of ECTR for 3, and excessive fogging preventing visualization for 1. In the second 6 months, 72 ECTRs were performed. Of these, 1 was converted to OCTR for inadequate anesthesia prohibiting safe completion of ECTR. This was a statistically significant decrease in conversion rate ($p = .017$). In year 2 of practice, 215 ECTRs were performed. Of these, 3 were converted to OCTR. The reasons for converting to OCTR included inadequate anesthesia prohibiting safe completion of ECTR for 2 and hypertrophic synovium for 1. Average DASH score for patients converted from ECTR to OCTR was 9.1. No patients required repeat surgery for recurrence of CTS.

No major neurovascular complications were present. There was one minor complication of a transient neurapraxia in the long/ring web space that resolved in 3 months with observation. This corresponded to a 0.28% complication rate.

DISCUSSION

There have been multiple retrospective and prospective trials showing successful relief of symptoms and pain with both OCTR and ECTR.[11,18–20,25–27] Some have concluded that results of ECTR depend on the surgeon's level of experience.[11,25–28] This study showed that a learning curve was present when looking at conversion from ECTR to OCTR. In addition, we found that patient safety was never compromised during the learning curve because the rate of nerve injuries and patient outcomes was similar to established values. Consequently, the concern for increased complications during the learning curve was not supported in this study.

The rate of conversion from ECTR to OCTR decreased significantly over the first year, which indicated that a learning curve was present. The rate of conversion in the first 6 months was 11.3% compared to 1.4% in the second 6 months, a statistically significant decrease. The reason for conversion was related to an inability to obtain clear visualization of the transverse carpal ligament in 5 cases and inadequate anesthesia prohibiting safe completion of ECTR in 6 cases. The decreased conversion rate can be attributed to increased familiarity with the procedure by both the surgeon and the anesthesia staff. As the surgeon became more facile with the procedure, an inability to obtain clear visualization became a less likely source of conversion to OCTR.

Excessive local anesthesia infiltration can cause visualization difficulties with ECTR, and subsequently a high level of monitored anesthesia care sedation is required. In the first 6 months, many of the anesthesia personnel were not comfortable providing the level of sedation necessary to complete the procedure. As our anesthesia team became more comfortable with the procedure, the rate of conversion resulting from inadequate anesthesia decreased from 3 of 71 in the first 6 months to 3 of 287 in the following 18 months. This points out that there is a learning curve not only for the physician, but also for the anesthesia team when a new procedure is introduced. Our study fails to provide quantitative data regarding the costs associated with the learning curve time period. Future investigations could be directed to this end. In a qualitative sense, substantial costs were incurred.

During the learning curve, a higher rate of conversion to OCTR was present but no increased morbidity to the patient was found. No patient had a major nerve or tendon injury. One patient had a transient neurapraxia in the long/ring web space. These data are consistent with published rates for major and minor injury during ECTR.[15] Schmelzer et al.[29] reported on a 13-year experience with the Agee technique encompassing a total of 753 cases. The overall complication rate was 1%. The authors did not address rate of conversion from ECTR to OCTR or the effect of conversion on patient outcome.

In this study, all patients reported complete relief of pain and complete or marked improvement in numbness. We found that patients converted from ECTR to OCTR had no difference in symptom relief, pain relief, or complications. Patients converted to OCTR were found to have an average DASH score of 9.1 at 6 months. This compares favorably to mean DASH scores of 19.7 and 21.5 at 6 months after unilateral and bilateral primary OCTR, respectively, reported by Kotsis and Chung.[30] No patients required repeat surgery for recurrence of CTS. This demonstrates that during the learning curve, patients converted to OCTR have outcomes equivalent to established values. This affirms previous literature stating that ECTR provides a high rate of success for patients with CTS, with low rates of complication and symptom recurrence.

Limitations of our study include performance of all procedures by a single surgeon; therefore, results may not be typical across the spectrum of surgeons. Second, we reviewed complication data retrospectively, and therefore our final numbers depended on the accuracy of documentation. Strengths of this article include a large cohort of patients in the first 2 years of practice, which allowed a statistically significant difference to be determined. Third, all patients were treated by a single surgeon with standard methodology, surgical protocol, and postoperative care. Finally, our data were from an institution with detailed electronic medical records, which made the data easily verifiable.

REFERENCES

1. American Academy of Orthopaedic Surgeons Work Group Panel. Clinical guidelines on diagnosis of carpal tunnel syndrome. Available at www.aaos.org/research/guidelines/CTS_guideline.pdf. Accessed Aug 15, 2010.
2. Nathan PA, Meadows KD, Istvan JA. Predictors of carpal tunnel syndrome: an 11-year study of industrial workers. J Hand Surg 2002;27A:644–651.
3. Palmer KT, Harris EC, Coggon D. Carpal tunnel syndrome and its relation to occupation: a systematic literature review. Occup Med 2007;57:57–66.
4. Cseuz KA, Thomas JE, Lambert EH, Love JG, Lipscomb PR. Long-term results of operation for carpal tunnel syndrome. Mayo Clin Proc 1966;41:232–241.
5. Gellman H, Kan D, Gee V, Kuschner SH, Botte MJ. Analysis of pinch and grip strength after carpal tunnel release. J Hand Surg 1989;14A:863–864.
6. Kulick MI, Gordillo G, Javidi T, Kilgore ES, Newmayer WL. Long-term analysis of patients having surgical treatment for carpal tunnel syndrome. J Hand Surg 1986;11A:59–66.
7. Kuschner SH, Brien WW, Johnson D, Gellman H. Complications associated with carpal tunnel release. Orthop Rev 1991;20:346–352.
8. Semple JC, Cargill AO. Carpal tunnel syndrome. Results of surgical decompression. Lancet 1969;1:918–919.
9. Mackenzie DJ, Hainer R, Wheatley MJ. Early recovery after endoscopic vs. short-incision open carpal tunnel release. Ann Plast Surg 2000;44:601–604.
10. Okutsu I, Ninomiya S, Takatori Y, Ugawa Y. Endoscopic management of carpal tunnel syndrome. Arthroscopy 1989;5:11.
11. Nath RK, Mackinnon SE, Weeks PM. Ulnar nerve transection as a complication of two-portal endoscopic carpal tunnel release: a case report. J Hand Surg 1993;18A:896–898.
12. Murphy RX, Jennings JF, Wukich DK. Major neurovascular complications of endoscopic carpal tunnel release. J Hand Surg 1994; 19A:114–118.
13. Scoggin JF, Whipple TL. A potential complication of endoscopic carpal tunnel release. Arthroscopy 1992;8:363–365.
14. Agee JM, McCarroll HR, Tortosa RD, Berry DA, Szabo RM, Peimer CA. Endoscopic release of the carpal tunnel: a randomized prospective multicenter study. J Hand Surg 1992;17A:987–995.
15. Benson LS, Bare AA, Nagle DJ, Harder VS, Williams CS, Visotsky JL. Complications of endoscopic and open carpal tunnel release. Arthroscopy 2006;22:919–924.
16. Trumble TE, Diao E, Abrams RA, Gilbert-Anderson MM. Single-portal endoscopic carpal tunnel release compared with open release: a prospective, randomized trial. J Bone Joint Surg 2002;84A:1107–1115.
17. Abrams R. Endoscopic versus open carpal tunnel release. J Hand Surg 2009;34A:535–539.
18. Brown RA, Gelberman RH, Seiler JG, Abranhamsson SO, Weiland AJ, Urbaniak JR, et al. Carpal tunnel release: a prospective randomized assessment of open and endoscopic methods. J Bone Joint Surg 1993;75A:1265–1275.
19. Palmer DH, Paulson JC, Lane-Larsen CL, Peulen VK, Olson JD. Endoscopic carpal tunnel release: a comparison of two techniques with open release. Arthroscopy 1993;9:498–508.
20. Agee JM, Peimer CH, Pyrek JD, Walsh WE. Endoscopic carpal tunnel release: a prospective study of complications and surgical experience. J Hand Surg 1995;20A:165–171.
21. Ferdinand RD, MacLean JB. Endoscopic versus open carpal tunnel release in bilateral carpal tunnel syndrome. J Bone Joint Surg 2002; 84B:375–379.
22. Atroshi I, Larsson GU, Ornstein E, Hofer M, Johnsson R, Ranstam J. Outcomes of endoscopic surgery compared with open surgery for carpal tunnel syndrome among employed patients: randomized controlled trial. BMJ 2006;332:1463–1464.
23. MacDermid JC, Richards RS, Roth JH, Ross DC, King GJW. Endoscopic versus open carpal tunnel release: a randomized trial. J Hand Surg 2003;28A:475–480.
24. Ruch DS, Poehling GG. Endoscopic carpal tunnel release: the Agee technique. Hand Clin 1996;12:299–303.
25. Serra L, Panagiotopoulos K, Bucciero A, Mehrabi FK, Pescatore G, Santagelo M, et al. Endoscopic release in carpal tunnel syndrome: analysis of clinical results in 200 cases. Minim Invas Neurosurg 2003;46:11–15.
26. Feinstein PA. Endoscopic carpal tunnel release in a community-based series. J Hand Surg 1993;18A:451–454.
27. VanHeest A, Waters P, Simmons B, Schwartz JT. A cadaveric study of the single-portal endoscopic carpal tunnel release. J Hand Surg 1995;20A:363–366.
28. Brown MG, Keyser B, Rothenberg ES. Endoscopic carpal tunnel release. J Hand Surg 1992;17A:1009–1011.
29. Schmelzer RE, Rocca GJD, Caplin DA. Endoscopic carpal tunnel release: a review of 753 cases in 486 patients. Plast Reconstr Surg 2006;117:177–185.
30. Kotsis SV, Chung KC. Responsiveness of the Michigan Hand Outcomes Questionnaire and the Disabilities of the Arm Shoulder and Hand questionnaire in carpal tunnel surgery. J Hand Surg 2005;30A: 81–86.