EDITOR'S CHOICE

Early Outcomes of Endoscopic Versus Open Carpal Tunnel Release

Megan R. Miles, MD,* Pragna N. Shetty, MPH,* Kovid Bhayana, BS,† Imran S. Yousaf, DO,* Kavya K. Sanghavi, MPH,*‡ Aviram M. Giladi, MD, MS*

Purpose To compare the short-term outcomes of endoscopic carpal tunnel release (ECTR) and open carpal tunnel release (OCTR), including patient-reported outcomes, pain and satisfaction scores, return to work, and postoperative prescription pain medication use.

Methods We included all patients over 18 years of age undergoing carpal tunnel release at a single hand center between January 2018 and December 2019. The carpal tunnel release method was driven by variations in surgeon practice. Data from patient-reported outcomes measurement information system (PROMIS) questionnaires and brief Michigan hand outcomes questionnaires and data on patient-reported pain levels, satisfaction with care, return to work, and postoperative prescription pain medication use were collected at preoperative visits and the first follow-up visit between postoperative days 7 and 14.

Results We included 678 (586 ECTR and 92 OCTR) patients. The median age was 58 years, and 75% of the patients were women. At early follow up, patients who underwent OCTR reported significantly lower postoperative PROMIS upper-extremity scores than those who underwent ECTR (median, 32 vs 36 points, respectively) but similar postoperative PROMIS pain interference, global physical health, global mental health, and brief Michigan hand outcomes questionnaire scores. The postoperative pain and satisfaction scores were similar between the 2 groups. In multivariable models, patients who underwent OCTR had 62% lower odds of returning to work and 30% greater odds of remaining on a postoperative pain prescription at the first follow-up visit.

Conclusions This study found no evidence suggesting the definitive superiority of 1 surgical technique with regard to clinical outcomes in the early postoperative period. However, OCTR was associated with lower postoperative PROMIS upper-extremity scores of unclear clinical significance, higher odds of remaining on pain medication, and lower odds of returning to work by the first postoperative visit. Endoscopic carpal tunnel release may be preferred in patients who need to return to work within the first 2 weeks after the procedure. *(J Hand Surg Am. 2021;46(10):868–876.*

Type of study/level of evidence Therapeutic IV.

Key words Carpal tunnel release, endoscopic, open release, patient-reported outcomes, return to work.

Additional Material at jhandsurg.org

*From the *Curtis National Hand Center at MedStar Union Memorial Hospital, Baltimore, MD; the †Howard University College of Medicine, Washington, DC; and the ‡MedStar Health Research Institute, Hyattsville, MD.*

Received for publication June 25, 2020; accepted in revised form April 23, 2021.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: Aviram M. Giladi, MD, MS, c/o Anne Mattson, The Curtis National Hand Center, MedStar Union Memorial Hospital, 3333 N. Calvert St., JPB Mezzanine, Baltimore, MD 21218; e-mail: editor@curtishand.com.

0363-5023/21/4610-0004$36.00/0
https://doi.org/10.1016/j.jhsa.2021.04.030

The introduction of endoscopic carpal tunnel release (ECTR) spurred controversy regarding the efficacy, safety, and success of this procedure.[1] However, over time, it has become the technique of choice for many surgeons, with an adequate safety profile and acceptable outcomes. Previous studies have tried to determine which carpal tunnel release (CTR) method, ECTR or open carpal tunnel release (OCTR), is superior by examining their clinical outcomes, including grip and pinch strength, dexterity, and pain, as well as time to return to work and costs per technique.[2–5] Some studies have suggested that ECTR has better short-term results because of improved recovery, less pain, fewer postoperative complications, and greater patient satisfaction, but with much higher costs.[6–10] Other studies have concluded that the short-term benefit of ECTR is negligible, with ECTR and OCTR demonstrating similar outcomes.[11–13] It was initially reported that ECTR is associated with greater risk of nerve injury compared with OCTR, but more recent literature has indicated that the incidence of permanent nerve injury is likely similar (and quite low) for both the techniques.[1,4,7,14–16] The long-term outcomes of both methods have been shown to be comparable.[8,17,18]

The mixed results in the literature comparing the short-term outcomes of ECTR and OCTR may be attributed, in part, to the timing of the studies; most studies were limited to small, prospective randomized controlled trials (RCTs) that were conducted before ECTR became widely used.[8,18–21] From 2003 to 2013, there was a notable increase in the frequency with which ECTR was performed by hand fellowship-trained surgeons in the United States.[22] This can have an impact on clinical outcomes because surgeons become more facile with the procedure with experience.[17,18] Furthermore, more recent studies are limited to meta-analyses that include RCTs with clinically heterogeneous patient populations, variations in the assessment of outcome measures, and discordant outcome measure definitions.[2–4]

Although previous studies have compared clinical outcomes, a thorough understanding of patient-reported outcomes (PROs) is incomplete. Few studies have compared PROs in the early postoperative period.[8,12,13] Patient-reported outcomes are increasingly being used as measures of the quality of care and can affect hospital and provider ratings as well as reimbursements.[23] Patient-reported outcomes can also provide physicians with a more complete picture of patients' recovery when used in conjunction with other clinical outcomes to understand the full patient experience.[24] With the increasing usage of ECTR, it is important to determine the difference between the short-term outcomes of ECTR and OCTR. The aim of this study was to compare PROs, pain and satisfaction scores, return to work, and postoperative prescription pain medication use between ECTR and OCTR in the early postoperative period. We hypothesized that ECTR is associated with better PRO scores, lower reported pain, higher satisfaction, earlier return to work, and decreased pain medication use compared with OCTR.

MATERIALS AND METHODS

This was a retrospective, pragmatic observational study that analyzed data collected from patients consenting to data use for research who were seen at our center between January 1, 2018, and December 31, 2019. Preoperative data were collected at clinic visits up to 30 days prior to surgery. Early postoperative data were collected at clinic visits between 7 and 14 days after surgery. We obtained institutional review board approval. Patients were not specifically enrolled in a study at the time of data collection because these data are collected as part of the standard care at our center. Patients were identified using the current procedural terminology codes for CTR: 29848 for ECTR and 64721 (neuroplasty and/or transposition; median nerve at carpal tunnel) for OCTR. Two providers performed OCTR and 9 performed ECTR as their standard practice for elective outpatient CTR. We excluded patients under 18 years of age; those who had undergone multiple carpal tunnel surgeries, CTR revisions, distal radius fracture within 3 months prior to CTR, or any other types of surgery either on the same day or within 3 months before or after CTR, worker's compensation patients, and those who did not complete all PRO questionnaires.

Outcome measures

The patients completed questionnaires using a web-based system (OBERD) at each clinic visit. This included demographics, medical and surgical history, prescription opioid use, and PRO questionnaires. The patients answered questions regarding their history of mental health conditions, including anxiety and/or depression, and history of pain disorders, including fibromyalgia, gout, neuropathy, osteoarthritis, and/or rheumatoid arthritis. At each visit, the PRO questionnaires included the National Institutes of Health's Patient-Reported Outcomes Measurement Information System (PROMIS) global health, v1.2, providing

physical (global physical health [GPH]) and mental (global mental health [GMH]) components, as well as upper extremity (UE) v2.0, and pain interference (PI) v1.1, computer-adaptive testing modules. Higher scores on the PROMIS GPH, GMH, and UE indicate better patient physical health, mental health, and upper-extremity function, respectively. Higher scores on the PROMIS PI indicate worse pain and associated interference when the patients perform daily tasks.[25] The patients also completed the brief Michigan Hand Questionnaire (bMHQ), a validated, short-form, legacy questionnaire that has been shown to thoroughly evaluate patient-reported function, pain, satisfaction, and appearance in patients with upper-extremity illness, with a higher score associated with better hand function and higher patient satisfaction with their upper-extremity function.[26]

The patients self-reported whether they had returned to work. Patients with missing information were identified, and a chart review of their electronic medical record was performed to determine whether patients had been able to return to work, either for modified or full duty. For the analyses, we included patients who reported that they had or had not returned to work; patients who had retired or were unemployed were excluded. The patients reported their occupation at the time of the initial clinic visit. For the analyses, each occupation was coded as either manual labor or nonmanual labor. The patients also self-reported whether they received a postoperative opioid prescription at the time of discharge and whether they continued to use a postoperative opioid prescription at the time of follow-up. The patients reported their pain using a scale from 0 to 10, with 0 indicating no pain at all and 10 indicating the greatest pain imaginable. Patient satisfaction with care was evaluated using 2 questions adapted from the Consumer Assessment of Healthcare Providers and Systems survey, with 1 indicating dissatisfaction and 10 indicating satisfaction with their care. A case with a postoperative infection was defined as any patient who was prescribed an antibiotic commonly used for surgical site infections within the first 14 days after the surgery. This information was obtained from the review of the medical records.

Statistical analysis

The Shapiro-Wilk test was used to determine the distribution of the data. Differences in continuous data between the groups were analyzed using quantile regression to evaluate the distribution and median values of patient characteristics and outcomes. Differences in categorical data were analyzed using the χ^2 test or Fisher exact test as appropriate.

Bivariate linear regressions were used to assess the relationship between the type of CTR and patient age, PROMIS questionnaire scores, bMHQ scores, and pain and satisfaction scores at the patient's preoperative and first postoperative visits. Bivariate logistic regressions were used to assess the relationship between the type of surgery and patient sex, medical history, likelihood of returning to work, and receiving or remaining on a postoperative opioid prescription at the first follow-up visit. Multivariable linear and logistic regression models were then constructed from conceptual frameworks based on current literature and included any significant results ($P < .05$) from the bivariate analyses to evaluate how PROs, returning to work, and remaining on a postoperative opioid prescription differed by CTR type when controlling for patient demographics and medical history. Adjusted R^2 tests were used to assess the goodness of fit. Statistical significance was set at $P < .05$.

A *post hoc* power calculation using a 2-sided, 2-sample, equal-variance Student *t* test demonstrated that sample sizes of 586 for the ECTR group and 92 for the OCTR group achieve 95% power when the effect size is 0.40 (moderate as defined by Cohen) and the significance level is 0.05.

RESULTS

A total of 809 patients who underwent CTR at our hand center between January 1, 2018, and December 31, 2019, were identified. A total of 131 patients were excluded, leaving 678 patients included in the study. Of the 131 patients who were excluded, 47 had not completed all the PRO questionnaires. The median age of the study sample was 58 years (interquartile range, 51−68 years; range, 22−89 years). Women represented 74.6% of the study sample (n = 437).

The patients were divided into 2 groups: those who underwent ECTR (n = 586) and those who underwent OCTR (n = 92). The group comparative analyses for patient demographics and outcome variables are shown in Table 1. Notably, there was a significant difference in the percentage of postoperative surgical site infections, with a higher percentage in the OCTR group. The bivariate analyses were performed for model selection for the multivariable analyses (Appendix E1 and E2, available online on the *Journal's* website at www.jhandsurg.org).

Table 2 shows the results of the unadjusted bivariate and adjusted multivariable analyses for returning to work. When adjusted for patient

TABLE 1. Comparison of Patient Demographics and Outcome Variables Between Endoscopic CTR and Open CTR

Demographics and Outcome Variables	Endoscopic CTR	Open CTR
Number of patients, n (%)	595 (86.3)	95 (13.7)
Patient age, y, median (IQR)	58 (51–68)	58 (52–67)
Patients < 65 y, n (%)	403 (67.7)	69 (72.5)
Patients ≥ 65 y, n (%)	192 (32.3)	26 (27.5)
Female, n (%)	440 (74.0)	69 (73.0)
Preoperative pain scores, median (IQR)	5 (2–7)	5 (2–8)
Postoperative pain scores, median (IQR)	3 (2–5)	4 (2–7)
Change in pain scores, median (IQR)	−1 (0–3)	−2 (0–4)
Postoperative satisfaction scores, median (IQR)	9.8 (8.0–10)	10 (8.1–10)
Insurance payer status		
Private	259 (44)	37 (39)
Self-pay	0 (0.0)	6 (6.3)
Medicaid	144 (24)	23 (24)
Medicare	183 (31)	26 (28)
Worker's compensation	9 (1.6)	3 (3.2)
Returned to work at 2 weeks, median (IQR)*		
Returned to work, n (%)	209 (41.7)	14 (17.5)
Had not returned to work, n (%)	292 (58.3)	66 (82.5)
N/A (retired or unemployed), n	94	15
Received a postoperative opioid prescription, n (%)*	455 (76.4)	81 (85.6)
Remained on a postoperative opioid prescription, n (%)	82 (18.1)	20 (24.5)
Preoperative PROMIS GPH scores, median (IQR)	42 (37–51)	42 (37–48)
Postoperative PROMIS GPH scores, median (IQR)	48 (40–51)	42 (40–51)
Change in PROMIS GPH scores, median (IQR)	0 (−4 to 4)	0 (0–3)
Preoperative PROMIS GMH scores, median (IQR)	51 (44–56)	53 (48–59)
Postoperative PROMIS GMH scores, median (IQR)	51 (44–56)	51 (44–56)
Change in PROMIS GMH scores, median (IQR)*	0 (−3 to 5)	−2 (−2 to 5)
Preoperative PROMIS UE scores, median (IQR)*	35 (30–40)	28 (25–37)
Postoperative PROMIS UE scores, median (IQR)*	35 (30–38)	28 (24–34)
Change in PROMIS UE scores, median (IQR)*	−1 (−3 to 7)	1 (−4 to 4)
Preoperative PROMIS PI scores, median (IQR)*	60 (54–66)	64 (57–68)
Postoperative PROMIS PI scores, median (IQR)	59 (54–64)	60 (56–66)
Change in PROMIS PI scores, median (IQR)*	−2 (−1 to 7)	−6 (−10 to 1)
Preoperative bMHQ scores, median (IQR)	50 (38–64)	46 (35–58)
Postoperative bMHQ scores, median (IQR)	57 (48–69)	52 (43–61)
Change in bMHQ scores, median (IQR)	2 (−8 to 12)	2 (−2 to 6)
History of mental illness, n (%)	99 (16.7)	18 (18.9)
History of pain disorder, n (%)	109 (18.3)	17 (17.6)
Use of preoperative pain medications, n (%)	303 (51.0)	45 (60.0)
Postoperative surgical site infection, n (%)*	17 (2.9)	4 (4.2)

IQR, interquartile range; N/A, not applicable.
*Denotes significance at $\alpha = 0.05$.

TABLE 2. Bivariate and Multivariable Logistic Regression Analyses for Return to Work at 2 Weeks (n = 569)

Variable	Bivariate Analysis		Multivariable Analysis	
	β Estimates (95% CI)	*P* Value	β_1 Estimates (95% CI)	*P* Value
Patient age, y	1.0 (0.99−1.0)	.16	1.0 (1.0−1.0)	.10
Patient sex				
Male	Ref		Ref	
Female	0.90 (0.66−1.2)	.52	1.3 (0.73−2.4)	.35
Type of work				
Manual	Ref		Ref	
Not manual	1.3 (0.32−5.3)	.72	1.1 (0.26−4.9)	.87
Postoperative pain scores	0.87 (0.80−0.94)	<.05*	0.73 (0.54−0.96)	<.05*
History of mental illness	0.71 (0.48−1.0)	.08	0.96 (0.51−1.8)	.89
History of pain disorder	1.1 (0.71−1.6)	.77	3.5 (0.28−4.2)	.93
Use of preoperative pain medications	1.1 (0.78−1.7)	.50	0.49 (0.01−4.5)	.52
CTR surgery type				
Endoscopic (n = 492)	Ref		Ref	
Open (n = 77)	0.50 (0.10−0.63)	<.05*	0.38 (0.18−0.79)	<.05*

CI, confidence interval.
*Denotes significance at $\alpha = 0.05$. $R^2 = 0.19$.

demographics, type of work, and medical history, patients who underwent OCTR had 62% lower odds of returning to work by the early postoperative follow-up visit ($P < .05$). The type of work was not significantly associated with return to work, as detected using the bivariate or multivariable analyses.

Although the preliminary percentage comparisons did not show significant differences, in both the bivariate and multivariable analyses the odds of remaining on a postoperative prescription pain medicine were found to be significantly associated with postoperative pain scores and CTR method (Table 3). Controlling for other factors, patients who underwent OCTR had a 30% increased odds of remaining on a postoperative opioid prescription ($P < .05$).

In multivariable analysis, patients undergoing OCTR were predicted to have a statistically significant decrease in the postoperative PROMIS UE scores when controlling for other factors (−3.0; 95% confidence interval, −5.1 to −0.99; $P < .05$; Table 4). This decrease may be smaller than the clinically meaningful difference. Additionally, although we felt that postoperative scores in the early period would be more reflective of the surgical procedure than of other conditions or problems, we also used models, including the preoperative PROMIS UE scores, to control for any preintervention differences. Appendix E3 (available online on the *Journal's* website at www.jhandsurg.org) shows the bivariate and multivariable analyses for the postoperative PROMIS UE scores when the patients' preoperative PROMIS UE scores were incorporated, with the overall results similar. The presence of postoperative infection was found to be associated with a 6.4-point decrease in the PROMIS UE scores in the multivariable analysis ($P < .05$; Table 4).

DISCUSSION

This study compares the short-term outcomes of ECTR with those of OCTR in a large patient cohort with individual-level PROs. We found that OCTR, compared with ECTR, was associated with lower odds of returning to work, higher odds of remaining on an opioid medication by the first postoperative visit, and lower postoperative PROMIS UE scores of unclear clinical importance. We found no difference in the postoperative bMHQ, PROMIS PI, GPH, GMH, pain, or satisfaction scores, and the statistically significant difference between the PROMIS UE scores was below the currently available published levels for the minimal clinically important difference of that questionnaire.[27−29]

Across various studies, the long-term outcomes of ECTR and OCTR have generally been found to be equivalent. The PROMIS and bMHQ scores have not been previously compared between ECTR and OCTR

TABLE 3. Bivariate and Multivariable Logistic Regression Analyses for Remaining on a Postoperative Pain Prescription at 2 Weeks (n = 678)

Variable	Bivariate Analysis		Multivariable Analysis	
	β Estimates (95% CI)	*P* Value	β_1 Estimates (95% CI)	*P* Value
Patient age, y	0.99 (0.97−1.0)	.54	0.99 (0.95−1.0)	.77
Patient sex				
Male	Ref		Ref	
Female	1.7 (0.90−3.3)	.10	3.6 (0.68−19)	.13
Postoperative pain scores	1.4 (1.2−1.6)	<.05*	1.3 (1.0−1.7)	<.05*
History of mental illness	0.98 (0.46−2.1)	.96	0.18 (0.02−1.5)	.11
History of pain disorder	1.0 (0.50−2.0)	.99	0.73 (0.19−2.7)	.64
Use of preoperative pain medications	2.2 (1.1−4.2)	<.05*	1.9 (0.54−6.4)	.33
CTR surgery type				
Endoscopic	Ref		Ref	
Open	1.4 (1.0−3.0)	<.05*	1.3 (1.2−5.4)	<.05*

CI, confidence interval.
*Denotes significance at $\alpha = 0.05$. $R^2 = 0.13$.

patients. A few studies have reported Boston carpal tunnel questionnaire (BCTQ) symptom severity scale and functional status scale scores, with some finding no difference in the BCTQ-symptom severity scale and BCTQ-functional status scale scores, whereas 1 study found ECTR to be associated with lower BCTQ-symptom severity scale and BCTQ-functional status scale scores (improved symptom severity and physical function) within the first 2 weeks after the surgery.[8,12,13] We found no difference in the postoperative bMHQ, PROMIS PI, GPH, and GMH scores between the groups. We did find that patients who underwent ECTR had higher postoperative PROMIS UE scores at the first follow-up visit compared with those who underwent OCTR; however, although it has not been clearly established as to whether the 3-point difference in the postoperative PROMIS UE scores is clinically relevant, it is lower than the currently available and reported minimal clinically important difference for PROMIS UE after CTR.[27−29] The persistent conflicting results of the comparison of PRO scores between ECTR and OCTR patients suggests that both the techniques provide overall similar short-term clinical outcomes, with no meaningful differences.

There is conflicting evidence supporting earlier return to work following ECTR. A meta-analysis by Sayegh and Strauch[4] found that ECTR is associated with earlier return to work, contradicting a 2004 meta-analysis by Thoma et al,[30] which showed no significant difference between the 2 techniques. The Cochrane collaboration evaluated 14 studies addressing return to work or activities of daily living, of which 8 studies favored ECTR, 5 showed no difference, and 1 favored OCTR.[5] We found that patients undergoing OCTR had 62% lower odds of returning to work by the first postoperative visit. Depression, anxiety, chronic pain disorders, the use of opioid medications after the surgery, and the type of work have been shown to be associated with a delay in return to work; however, there was no statistically significant difference in the history of mental health challenges or pain disorder, use of preoperative pain medication, or type of work within our cohort to explain the difference in return to work between ECTR and OCTR patients.[31−33] Moreover, in this study of nonworkers' compensation patients, the CTR method continued to have a significant effect on return to work when controlling for these factors in the bivariate and multivariable analyses. Our results indicate that ECTR may be preferred in patients who need to return to work within the first 2 weeks after the surgery. However, this may not be applicable to patients with heightened risks or concerns for wound breakdown or in those who do not have an option of modified duty while they still manage early postoperative pain and other limitations. Previous research has demonstrated that a preoperative discussion of a patient's postoperative expectations is an important determinant of return to work in patients undergoing OCTR.[33] Although we did not evaluate this in our study, preoperative

TABLE 4. Bivariate and Multivariable Linear Regression Analyses for Postoperative PROMIS UE Scores (n = 678)

Variable	Bivariate Analysis		Multivariable Analysis	
	β Estimates (95% CI)	*P* Value	β_1 estimates (95% CI)	*P* Value
Patient age, y	0.03 (−0.01 to 0.07)	.19	0.01 (−0.74 to 0.76)	.96
Patient sex				
Male	Ref		Ref	
Female	−3.9 (−5.2 to 0.69)	.15	−2.2 (−4.3 to 1.6)	.33
Type of work				
Manual	Ref		Ref	
Not manual	−3.9 (−10 to 0.21)	.19	−2.9 (−4.6 to 4.4)	.43
History of mental illness	−3.1 (−4.5 to −1.6)	<.05*	−1.6 (−2.0 to −1.3)	<.05*
History of pain disorder	−1.4 (−2.9 to 0.02)	<.05*	0.11 (−3.1 to 0.35)	.94
Use of preoperative pain medications	−3.1(−4.5 to −1.7)	<.05*	−2.8 (−4.0 to −1.5)	<.05*
Postoperative infection	−3.1 (−15 to 9.2)	.62	−6.4 (−12 to −0.93)	<.05*
CTR surgery type				
Endoscopic	Ref		Ref	
Open	−3.8 (−7.1 to −0.42)	<.05*	−3.0 (−5.1 to −0.99)	<.05*

CI, confidence interval.
*Denotes significance at $\alpha = 0.05$. $R^2 = 0.16$.

counseling likely remains a critical part of patient education for these patients.

Although some claim that ECTR offers lower morbidity and quicker recovery from surgery, including less immediate postoperative pain, we found no difference in the postoperative satisfaction or pain scores within the first 2 postoperative weeks.[34] Our results differ from those described by Trumble et al,[8] who found that patient satisfaction is greater in the ECTR group at the 2-week postoperative visit. Previous studies comparing these techniques conflict on whether ECTR is associated with improved pain relief in the early postoperative period.[12,13,17,20,35,36] However, we did see an increased likelihood of remaining on opioids after OCTR. The comparison of postoperative opioid pain medication use between ECTR and OCTR patients is not well described in the literature, and it certainly is important to acknowledge that many patients do not require any opioids for recovery from OCTR or ECTR.[35,37] A previous RCT found no difference in the number of narcotic pills consumed between ECTR and OCTR patients at the 2-week postoperative visit.[15] A more recent RCT investigated the difference in narcotic pill consumption in the first 5 days after ECTR and OCTR and found no difference in the mean total number of narcotic pills consumed between patients undergoing the 2 surgical techniques.[21] We found that patients who underwent OCTR were 1.3 times more likely to remain on a postoperative opioid prescription at their first postoperative visit compared with those who underwent ECTR. In our cohort, the postoperative pain scores were relatively low, ranging from 2 to 7, regardless of the CTR method. This supports the ongoing question of whether opioid pain medication should be prescribed following CTR at all. Indeed, 1 study found no difference in the average number of total pills consumed by patients prescribed either oxycodone or a non-narcotic medication in the first 5 days following ECTR or OCTR, and the patients agreed that the provided medication was strong enough.[30] If narcotics are to be prescribed after the surgery, it is paramount to consider the risk of prolonged opioid use, especially after OCTR.

The difference in the incidence of postoperative infections following OCTR and ECTR has been inconsistently reported in the literature, with an overall low rate of surgical site infection after CTR.[7,11,13,17,38,39] However, a surgical site infection can have an impact on early recovery and should be considered when comparing postoperative outcomes. We found a significantly higher percentage of surgical site infections among those who underwent OCTR compared with those who underwent ECTR (4.2% vs. 1.7%; $P < .05$). Furthermore, the presence of postoperative infection was found to be associated with significantly lower PROMIS UE scores.

However, the presence of postoperative infection demonstrated collinearity with return to work and remaining on a postoperative opioid prescription, precluding inclusion in the bivariate and multivariable analyses.

We acknowledge the limitations of this study. Although the overall participant enrollment was high, there was a large discrepancy in the number of participants in each cohort. However, there was a sufficient number of patients who underwent OCTR to adequately compare the 2 surgical techniques. The reasoning behind a surgeon's decision to proceed with OCTR or ECTR for each patient was unknown, potentially introducing a selection bias. Furthermore, preoperative counseling was not standardized among the surgeons who participated in the study, potentially influencing postoperative expectations and perceived outcomes. Additionally, the opioid prescribed and the CTR approach (ie, open vs mini-open incision) was not standardized. Although we did account for job type when comparing return to work data, the type of work (manual vs nonmanual labor) was determined retrospectively by coding the patient-reported occupation. Furthermore, whether the return was to full duty or modified duty was not analyzed. Notably, we excluded workers' compensation patients, making it unclear whether our results can be generalized to that important patient population. We focused on comparing the postoperative outcome scores rather than on the change in the scores because we believe that the preoperative scores in CTR patients more likely reflect carpal tunnel symptomatology, whereas the postoperative scores in the early postoperative period more likely reflect the surgical procedure. Although we focused on the postoperative outcome scores, we recognize that the preoperative scores and reporting may have varied. Indeed, we found that preoperative PROMIS UE scores are significantly associated with postoperative PROMIS UE scores; however, our other results did not change notably because the CTR method continued to have a statistically significant impact on the postoperative scores when controlling for preoperative scores, although this impact was perhaps not clinically relevant. Finally, the study results reflect the standard daily care at a busy hand center with a high volume of CTR patients. Although this may have limited the generalizability, it still provides an insight into the patient outcomes during the early period after CTR using a pragmatic observational approach.

This study found no evidence suggesting the definitive superiority of 1 surgical technique with regard to the overall clinical outcomes in the early postoperative period. Patients undergoing ECTR were predicted to have higher PROMIS UE scores, but the between-group differences were below the currently available minimal clinically important difference values and perhaps not clinically meaningful. However, ECTR patients were predicted to experience less persistent opioid use compared with OCTR patients. Additionally, ECTR patients were predicted to have greater odds of returning to work by the first postoperative visit, indicating that ECTR may be preferred in patients who need to return to work within the first 2 weeks.

REFERENCES

1. Shin EK. Endoscopic versus open carpal tunnel release. *Curr Rev Musculoskelet Med*. 2019;12(4):509–514.
2. Kohanzadeh S, Herrera FA, Dobke M. Outcomes of open and endoscopic carpal tunnel release: a meta-analysis. *Hand*. 2012;7(3):247–251.
3. Zuo D, Zhou Z, Wang H, et al. Endoscopic versus open carpal tunnel release for idiopathic carpal tunnel syndrome: a meta-analysis of randomized controlled trials. *J Orthop Surg Res*. 2015;10(1):1–3.
4. Sayegh ET, Strauch RJ. Open versus endoscopic carpal tunnel release: a meta-analysis of randomized controlled trials. *Clin Orthop Relat Res*. 2015;473(3):1120–1132.
5. Scholten RJ, van der Molen AM, Uitdehaag BM, Bouter LM, de Vet HC. Surgical treatment options for carpal tunnel syndrome. *Cochrane Database Syst Rev*. 2007;2007(4):CD003905.
6. Michelotti B, Romanowsky D, Hauck RM. Prospective, randomized evaluation of endoscopic versus open carpal tunnel release in bilateral carpal tunnel syndrome: an interim analysis. *Ann Plast Surg*. 2014;73(Suppl 2):S157–S160.
7. Devana SK, Jensen AR, Yamaguchi KT, et al. Trends and complications in open versus endoscopic carpal tunnel release in private payer and Medicare patient populations. *Hand (N Y)*. 2019;14(4):455–461.
8. 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 Am*. 2002;84(7):1107–1115.
9. Kazmers NH, Presson AP, Xu Y, Howenstein A, Tyser AR. Cost implications of varying the surgical technique, surgical setting, and anesthesia type for carpal tunnel release surgery. *J Hand Surg Am*. 2018;43(11):971.e1–977.e1.
10. Koehler DM, Balakrishnan R, Lawler EA, Shah AS. Endoscopic versus open carpal tunnel release: a detailed analysis using time-driven activity-based costing at an academic medical center. *J Hand Surg Am*. 2019;44(1):62.e1–62.e9.
11. 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: randomised controlled trial. *BMJ*. 2006;332(7556):1473.
12. MacDermid JC, Richards RS, Roth JH, Ross DC, King GJ. Endoscopic versus open carpal tunnel release: a randomized trial. *J Hand Surg Am*. 2003;28(3):475–480.
13. Saw NL, Jones S, Shepstone L, Meyer M, Chapman PG, Logan AM. Early outcome and cost-effectiveness of endoscopic versus open carpal tunnel release: a randomized prospective trial. *J Hand Surg Am*. 2003;28(5):444–449.
14. Vasiliadis HS, Nikolakopoulou A, Shrier I, et al. Endoscopic and open release similarly safe for the treatment of carpal tunnel syndrome. A systematic review and meta-analysis. *PLoS One*. 2015;10(12):e0143683.

15. Benson LS, Bare AA, Nagle DJ, Harder VS, Williams CS, Visotsky JL. Complications of endoscopic and open carpal tunnel release. *Arthroscopy*. 2006;22(9):919–924.
16. Frankel H, Sperry J, Kaplan L. Risk factors for pressure ulcer development in a best practice surgical intensive care unit. *Am Surg*. 2007;73(12):1215–1217.
17. Larsen MB, Sørensen AI, Crone KL, Weis T, Boeckstyns ME. Carpal tunnel release: a randomized comparison of three surgical methods. *J Hand Surg Eur*. 2013;38(6):646–650.
18. Dumontier C, Sokolow C, Leclercq C, Chauvin P. Early results of conventional versus two-portal endoscopic carpal tunnel release: a prospective study. *J Hand Surg Br*. 1995;20(5):658–662.
19. Brown RA, Gelberman RH, Seiler JG, et al. Carpal tunnel release. A prospective, randomized assessment of open and endoscopic methods. *J Bone Joint Surg Am*. 1993;75(9):1265–1275.
20. Erdmann MW. Endoscopic carpal tunnel decompress. *J Hand Surg Am*. 1994;19(1):5–13.
21. Jacobsen MB, Rahme H. A prospective, randomized study with an independent observer comparing open carpal tunnel release with endoscopic carpal tunnel release. *J Hand Surg Br*. 1996;21(2):202–204.
22. Smetana BS, Zhou X, Hurwitz S, Kamath GV, Patterson JM. Effects of hand fellowship training on rates of endoscopic and open carpal tunnel release. *J Hand Surg Am*. 2016;41(4):e53–e58.
23. Gagnier JJ. Patient reported outcomes in orthopaedics. *J Orthop Res*. 2017;35(10):2098–2108.
24. Giladi AM. Measuring outcomes in hand surgery. *Clin Plast Surg*. 2013;40(2):313–322.
25. National Institute on Aging. Patient-Reported Outcomes Measurement Information System (PROMIS). Accessed March 10, 2020. https://www.nia.nih.gov/research/resource/patient-reported-outcomes-measurement-information-system-promis
26. Waljee JF, Kim HM, Burns PB, Chung KC. Development of a brief, 12-item version of the michigan hand questionnaire. *Plast Reconstr Surg*. 2011;128(1):208–220.
27. Bernstein DN, Houck JR, Mahmood B, Hammert WC. Minimal clinically important differences for PROMIS physical function, upper extremity, and pain interference in carpal tunnel release using region-and condition-specific PROM tools. *J Hand Surg Am*. 2019;44(8):635–640.
28. Kazmers NH, Hung M, Bounsanga J, Voss MW, Howenstein A, Tyser AR. Minimal clinically important difference after carpal tunnel release using the PROMIS platform. *J Hand Surg Am*. 2019;44(11):947–953.
29. Terwee CB. Estimating minimal clinically important differences and minimal detectable change. *J Hand Surg Am*. 2019;44(12):e1.
30. Thoma A, Veltri K, Haines T, Duku E. A meta-analysis of randomized controlled trials comparing endoscopic and open carpal tunnel decompression. *Plast Reconstr Surg*. 2004;114(5):1137–1146.
31. Katz JN, Keller RB, Fossel AH, et al. Predictors of return to work following carpal tunnel release. *Am J Ind Med*. 1997;31(1):85–91.
32. Kho JY, Gaspar MP, Kane PM, Jacoby SM, Shin EK. Prognostic variables for patient return-to-work interval following carpal tunnel release in a workers' compensation population. *Hand (N Y)*. 2017;12(3):246–251.
33. Cowan J, Makanji H, Mudgal C, Jupiter J, Ring D. Determinants of return to work after carpal tunnel release. *J Hand Surg Am*. 2012;37(1):18–27.
34. 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 Am*. 1992;17(6):987–995.
35. Ilyas AM, Miller AJ, Graham JG, Matzon JL. Pain management after carpal tunnel release surgery: a prospective randomized double-blinded trial comparing acetaminophen, ibuprofen, and oxycodone. *J Hand Surg Am*. 2018;43(10):913–919.
36. Wong KC, Hung LK, Ho PC, Wong JM. Carpal tunnel release. A prospective, randomised study of endoscopic versus limited-open methods. *J Bone Joint Surg Br*. 2003;85(6):863–868.
37. Miller A, Kim N, Zmistowski B, Ilyas AM, Matzon JL. Postoperative pain management following carpal tunnel release: a prospective cohort evaluation. *Hand (N Y)*. 2017;12(6):541–545.
38. Calotta NA, Lopez J, Deune EG. Improved surgical outcomes with endoscopic carpal tunnel release in patients with severe median neuropathy. *Hand (N Y)*. 2017;12(3):252–257.
39. Karl JW, Gancarczyk SM, Strauch RJ. Complications of carpal tunnel release. *Orthop Clin North Am*. 2016;47(2):425–433.