Surgical Approach and Anesthetic Modality for Carpal Tunnel Release: A Nationwide Database Study With Health Care Cost Implications

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Abstract

Background: Carpal tunnel release (CTR) is commonly performed for carpal tunnel syndrome once conservative treatment has failed. Operative technique and anesthetic modality vary by surgeon preference and patient factors. However, CTR practices and anesthetic trends have, to date, not been described on a nationwide scale in the United States. **Methods:** The PearlDiver Patient Records Database was used to search Current Procedural Terminology codes for elective CTR from 2007 to 2011. Anesthetic modality (eg, general and regional anesthesia vs local anesthesia) and surgical approach (eg, endoscopic vs open) were recorded for this patient population. Cost analysis, patient demographics, regional variation, and annual changes in CTR surgery were evaluated. **Results:** We identified 86 687 patients who underwent carpal tunnel surgery during this 5-year time period. In this patient sample, 80.5% of CTR procedures were performed using general or regional anesthesia, compared with 19.5% of procedures performed using local anesthesia; 83.9% of all CTR were performed in an open fashion, and 16.1% were performed using an endoscopic technique. Endoscopic surgery was on average \$794 more expensive than open surgery, and general or regional anesthesia was \$654 more costly than local anesthesia. **Conclusions:** In the United States, open CTR under local anesthesia is the most cost-effective way to perform a CTR. However, only a small fraction of elective CTR procedures are performed with this technique, representing a potential area for significant health care cost savings. In addition, regional and age variations exist in procedure and anesthetic type utilized.

Keywords: carpal tunnel release, epidemiology, carpal tunnel syndrome, United States

Introduction

Carpal tunnel syndrome (CTS) is present in up to 3% of the general population and is often managed by a team of health care providers, including primary care physicians, physical therapists, and orthopedic surgeons.⁴ There are approximately 400 000 to 600 000 cases annually with an associated health care cost of more than \$2 billion per year.^{6,13} This figure does not include indirect costs such as lost productivity, missed work, and disability payments. The economic impact of those afflicted with CTS may be long-term, with some individuals recovering only half of their pre-condition earnings.⁵ Thus, the economic and financial impact of CTS is significant and should be better understood.

Operative technique and anesthetic modality utilized in carpal tunnel release (CTR) vary by surgeon preference and patient factors. Endoscopic and open CTR techniques have been described with similar results in symptom relief and

functional improvement.^{11,14,18} Endoscopic CTR may be associated with a more rapid return to daily activities and higher patient satisfaction scores, but it is also associated with more complications and a higher reoperation rate for incomplete resolution of symptoms.^{7,18} As such, there is no universally accepted surgical approach for CTR.

In addition, various anesthetic modalities are commonly used during CTR, including general, regional, and local anesthesia. Local anesthesia is associated with shorter operative times, higher patient satisfaction scores, and equivalent functional outcomes.^{8,16} However, regional or general

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Table 1. List of Procedures and Corresponding CPT Codes Excluded From Search Criteria.

Decompression fasciotomy (CPT-24495, CPT-25020, CPT-25023, CPT-25024, CPT-25025)
Arthroplasty (CPT-25332, CPT-25337, CPT-25441, CPT-25442)
Upper Limb Trauma (CPT-25515, CPT-25525, CPT-25526, CPT-25545, CPT-25574, CPT-25575, CPT-25607).

Note. CPT = Current Procedural Terminology.

anesthesia may be preferred if concomitant procedures are planned.¹⁷ There is currently no consensus among surgeons about the optimal anesthetic modality.

The primary goal of this study was to describe and evaluate anesthetic choice and surgical technique trends for patients undergoing CTR. In addition, we explore the cost implications of these nationwide practice trends.

Materials and Methods

The PearlDiver Patient Records Database (PearlDiver, Warsaw, Indiana), a national database of insurance billing records that includes more than 20 million patients from the United Health Group, was utilized in this study. In this database, United Health Group insurance records were retrospectively collected by PearlDiver Inc., an analytics company, and commercially distributed for research purposes. This database was searched using Current Procedural Terminology (CPT) codes for open (CPT-64721) and endoscopic CTR (CPT-29848) in combination with general/regional or local anesthetic types. The database provides data on age, gender, number of procedures performed, geographic region, and hospital charges between 2007 and 2011. Patients with other concurrent fractures or traumatic injuries were excluded (Table 1). The patients were then subdivided into 4 groups: open CTR under general or regional anesthesia, open CTR under local anesthesia, endoscopic CTR under general or regional anesthesia, and endoscopic CTR under local anesthesia. As general and regional anesthesia have the same CPT code when used as the primary anesthetic, it was not possible to separate these modalities in the aforementioned patient groups.

Nationwide cost implications were assessed using the 2006 census data provided by Jain et al to estimate the total number of CTR performed annually.⁶ It is known that the demographic of the United Health Group patient population does not mimic that of the United States, with 45% of subscribers living in the South. To account for this difference, regional variation in the utilization of CTR was examined as the regression from the expected regional distribution of procedures. The expected regional distribution of a procedure was calculated by multiplying the total number of procedures by the known regional distribution of United Healthcare subscribers, provided by PearlDiver Inc.

Statistically significant differences between the observed and expected regional distributions were determined using chi-square analysis. Chi-square tests were also used to determine statistically significant differences in age and sex. In addition, linear regression was used to assess temporal trends. Statistical significance was set at $P < .05$, with all statistical analysis conducted on STATA software (Version 13.1 MP; StataCorp, College Station, Texas).

Results

After exclusion criteria were applied, a total of 86 687 patients who underwent CTR between 2007 and 2011 were identified. Of the patients identified, 66.4% were females and 33.6% were males. Open CTR performed under general or regional anesthesia accounted for 67.6% of procedures. In contrast, endoscopic surgery using local anesthesia was the least common procedure with only 1687 patients identified, accounting for 1.9% of all CTR procedures (Table 2).

Surgeons in the Midwest performed more open CTR than expected ($P < .001$), while those in the South performed more endoscopic CTR ($P < .001$) (Table 2). CTR was most commonly performed in 50- to 59-year-old patients, accounting for 39% of all procedures. When analyzing age distributions for each procedure, open surgery and general anesthesia were most commonly used in the 30- to 39-year-old age group ($P < .001$).

About 80.5% of all CTR procedures were performed using general or regional anesthesia, compared with 19.5% of procedures performed using local anesthesia (Table 2). Trends in anesthetic modality remained relatively unchanged from 2007 to 2010; however, there was a 4.7% increase in the use of local anesthesia from 2010 to 2011 ($P < .001$) (Figure 1).

During the period examined, there was a strong preference for open procedures, which accounted for 83.9% of all CTRs performed, while only 16.1% were performed endoscopically. However, there was a statistically significant increase in the use of endoscopic surgery for CTR over this time period, from 14.0% of all procedures in 2007 to 18.8% in 2011 ($P < .05$) (Figure 2). Total hospital charges for endoscopic surgery was \$794 more than for open surgery, while general or regional anesthesia was \$654 more than local anesthesia (Figure 3).

Discussion

Open CTR under general or regional anesthesia was the most commonly used approach in our series, accounting for approximately two-thirds of the cases examined. Open CTR under local anesthesia is the least expensive option; however, it was only utilized in 16.3% of cases. If general or regional anesthesia were abandoned in favor of local anesthesia for all open CTR procedures, the total direct

Table 2. Patient Demographics by Surgical Approach and Anesthetic Modality Utilized.

	Open surgery with general or regional anesthesia	Open surgery under local anesthesia	Endoscopic surgery under general or regional anesthesia	Endoscopic surgery under local anesthesia	Significance
n	58 620 (68%)	14 174 (16%)	12 219 (14%)	1 687 (2%)	
Sex					<.0001
Female	39 117 (67%)	8927 (63%)	8401 (67%)	1096 (65%)	
Male	19 503 (33%)	5247 (37%)	3818 (31%)	591 (35%)	
Age					<.0001
<30	1857 (3%)	502 (3%)	429 (3%)	49 (3%)	
30-39	10 342 (18%)	1772 (12%)	1593 (13%)	217 (16%)	
40-49	15 372 (26%)	3717 (27%)	3314 (27%)	464 (26%)	
50-59	22 376 (38%)	5766 (41%)	4990 (41%)	683 (39%)	
60-69	8486 (15%)	2372 (16%)	1865 (16%)	273 (15%)	
≥70	194 (<1%)	45 (<1%)	28 (<1%)	1 (<1%)	
Region					<.001
Midwest	18 854 (32%)	5229 (37%)	2585 (21%)	405 (24%)	
Northeast	5793 (10%)	1286 (9%)	1201 (10%)	167 (10%)	
South	26 289 (45%)	6087 (43%)	6603 (54%)	842 (50%)	
West	7684 (13%)	1572 (11%)	1826 (15%)	273 (16%)	
Year					<.001
2007	12 049 (68%)	3177 (18%)	2078 (12%)	392 (2%)	
2008	11 911 (68%)	2882 (17%)	2330 (13%)	281 (2%)	
2009	11 702 (70%)	2492 (15%)	2385 (14%)	246 (1%)	
2010	11 772 (69%)	2474 (14%)	2576 (15%)	259 (2%)	
2011	11 326 (64%)	3149 (18%)	2850 (16%)	508 (3%)

Figure 1. Temporal trend in the use of general and local anesthesia for carpal tunnel release from 2007 to 2011.

Note. The y-axis on the left is for general or regional anesthesia while the y-axis on the right is for local anesthesia.

savings to our health care system would amount to approximately \$2.3 billion over the next decade. These savings would increase to approximately \$3.6 billion per decade if all CTR procedures were also performed in an open fashion.

Recently, health care costs have received a considerable amount of political and media attention as US health care spending continues to increase, reaching \$2.8 trillion in 2012.¹⁵ Based on the findings in this study, the anesthetic choice and surgical approach utilized for CTR represents a

Figure 2. Temporal trends in the surgical technique utilized for carpal tunnel release from 2007 to 2011.

Note. The y-axis on the left is for open surgery while the y-axis on the right is for local anesthesia.

Figure 3. Average hospital charge per procedure type for carpal tunnel release.

potential area for cost savings. Despite the cost-effectiveness of open CTR under local anesthesia, general or regional anesthesia is still the preferred anesthetic choice among most providers.

When comparing the surgical approach utilized for CTR, both endoscopic and open CTR are equally efficacious for symptom relief and functional improvement.^{7,11,18} However, endoscopic CTR has been associated with increased nerve injury, reoperation rate, and recurrence of CTS.^{1,10} Our study demonstrates that open CTR remains the predominant modality used nationally; however, endoscopic release is still used by a substantial number of surgeons, and this trend

increased from 2007 to 2011 despite the increased cost and complication rate.

CTR under local anesthesia can be safely performed in an office-based setting with minor procedure field sterility and no prophylactic antibiotics.⁹ More than 70% of hand surgeons in Canada use local anesthesia for CTR with similar reported outcomes.² In addition to cost savings, local anesthesia is associated with shorter surgical wait times and increased convenience.^{2,3,12} Patients can expect equivalent outcomes, complication rates, and patient satisfaction scores in comparison with general or regional anesthesia.^{8,11,18} Despite these numerous benefits, the use of local

anesthesia for CTR did not change dramatically over the study time period.

Our finding that women are more likely to undergo a CTR, and that the procedure is most commonly performed in the 50 to 59 years age group, is consistent with previously reported literature.⁴ Regionally, open CTR is most common in the Midwest, while endoscopic CTR is more common in the South. Such regional variations may reflect differences in training, patient preference, surgeon choice, or marketing dynamics of that region.

Like other database studies, our study is limited by potential errors in billing coding and sampling bias. Furthermore, utilizing an insurance records database prevents assessment of advanced metrics like functional outcomes. Because there are no distinct CPT codes to differentiate between general and regional anesthesia, these groups could not be analyzed separately. Last, Medicare patients were not included in our database, which limits the conclusions we can make about patients above the age of 65 years. However, our cohort still includes several thousand individuals above the age of 65 years who have Medicare with supplemental private insurance.

The major strength of our study is the sample size of more than 86 000 patients, which is representative of the entire US population. Such large numbers reduces the risk of misrepresentation of specific subgroups and may generalize to the nation at large. Furthermore, this study addresses the hospital charges of various anesthetic and surgical techniques in CTR as well as the practice patterns in utilization, which have previously been unreported in a national cohort.

Conclusion

This cross-sectional study of a large, private insurance database composed of patients throughout the United States provides information on the trends and demographics of patients utilizing various anesthetic types in open or endoscopic CTR. In the present study, we found that the vast majority of procedures are performed in an open technique under general or regional anesthesia. In the current era of cost-conscious, evidence-based medicine, the underutilization of local anesthesia for CTR in the United States represents a potential area for significant health care cost savings.

Ethical Approval

As this study utilized the PearlDiver database, which contains de-identified and publicly disseminated insurance records, this study did not require institutional review board review or informed consent at our institution.

Statement of Human and Animal Rights

The article does not contain studies with human or animal subjects.

Statement of Informed Consent

As this study utilized the PearlDiver database, which contains de-identified and publicly disseminated insurance records, this study did not require institutional review board review or informed consent at our institution.

Declaration of Conflicting Interests

JCW reports nonfinancial support from the North American Spine Society, nonfinancial support from the Cervical Spine Research Society, personal fees from the AO Spine/AO Foundation, and other support from DepuySynthes, outside the submitted work.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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