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Evidence-Based Practice in the Surgical Treatment of Thumb Carpometacarpal Joint Arthritis

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Abstract

Purpose—Thumb carpometacarpal (CMC) arthritis contributes considerably to functional disability in the aging adult U.S. population. Owing to the increasing growth in this segment of our population, its burden on healthcare resources will increase in the future. Variations exist in the degree of complexity and cost among different surgical treatments. We examined the national trends of the surgical treatment of thumb CMC arthritis and hypothesized that current practice patterns are not supported by evidence favoring the simpler trapeziectomy-only procedure.

Methods—Using a random 5%, nationally representative, sample of Medicare fee-for-service beneficiaries diagnosed with thumb CMC arthritis between 2001 and 2010, we used a multinomial logistic regression model to assess the association between patients' characteristics and the surgical treatment. Furthermore, we used surgeons' unique identifiers to examine how their practice preferences have changed over time.

Results—Our findings demonstrated an increasing trend in the utilization of trapeziectomy with ligament reconstruction and tendon interposition (LRTI) from 84% in 2001 to 90% in 2010. Ninety-five percent of surgeons performed only one type of surgical procedure and among those, 93% of surgeons performed only trapeziectomy with LRTI. Compared with 2001, the odds of a patient undergoing thumb CMC arthrodesis or prosthetic arthroplasty slightly increased between 2007 and 2010.

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Conclusions—The majority of hand surgeons in the U.S. use trapeziectomy with LRTI as a surgical treatment of choice for thumb CMC arthritis. Although clinical trials from the UK support the use of the less complex trapeziectomy procedure, US surgeons are still reticent to change their practice in favor LRTI. National comparative studies are still needed to examine the effectiveness of various surgical options for the thumb CMC joint.

Keywords

Evidence-based; osteoarthritis; thumb carpometacarpal; trends; utilization

Introduction

In the United States, up to 8% of men and 25% of women with ages 50 years and older suffer from degenerative arthritis of the thumb carpometacarpal (CMC) joint,¹ with about 20% of affected people requiring some form of treatment (i.e. non-operative or surgical) during their lifetime.^{2,3} The impact of thumb CMC arthritis on U.S. healthcare expenditures will likely increase as the number of people over 60 years of age doubles to approximately 112 million by 2050.^{3,4} The surgical treatment of this debilitating chronic disease has been controversial for decades.⁵ It is also true that measures of health outcomes are not always better where more health services are provided,^{6,7} particularly when there is not strong evidence to document the benefits and harms of the service.⁸ Thus, as our healthcare landscape shifts its focus towards quality and patient-centered care, effectively evolving our practices based on available peer-reviewed published data, where it is available (i.e. an evidence-based approach), has become increasingly important in limiting the misuse of healthcare resources, particularly for our aging population.

The surgical treatment of thumb carpometacarpal (CMC) arthritis has been an ongoing topic of debate among hand surgeons. Davis et al. reintroduced simple trapeziectomy as an effective alternative to trapeziectomy with ligament reconstruction in his 1996 and subsequent studies.^{9–11} A few studies have shown equivalent outcomes among the different surgical treatments of this disease.^{12–14} However, recent data from peer-reviewed non-national level studies suggest that ligament stabilization procedures are still in favor over less complex surgical options.¹⁵ Practice patterns based on factors such as experience and the tradition of techniques learned in training programs,¹⁵ as well as differing views on the quality and generalizability of available evidence may contribute to these observed trends.

Little is known about the recent trends in national practice patterns of the surgical care of thumb CMC arthritis and the factors associated with the trends observed. We examined the national trends in the surgical treatment of thumb CMC arthritis. Our three specific aims were: (1) to examine the national trends in patterns of use of different surgical techniques in the treatment of thumb CMC arthritis, (2) to analyze patient and clinical factors associated with these treatment options, and (3) to investigate hand surgeons' patterns of care over the last decade. We hypothesized that trapeziectomy with ligament reconstruction and tendon interposition (LRTI) is the surgical technique of choice nationally among hand surgeons. Furthermore, we hypothesized that patients' clinical characteristics, such as age and comorbid conditions, are significantly associated with the surgical treatment performed.

Data source

We examined claims data gathered from a 5% random sample of Medicare beneficiaries with thumb CMC arthritis enrolled between January 1, 2001 and December 31, 2010. Specifically, we used Beneficiary Summary files, Medicare Provider and Analysis Review files, Outpatient files, and Carrier files. Claims data include information from the following sources: (1) diagnosis (*International Classification of Diseases, Ninth Revision, Clinical Revision, Clinical Modification [ICD-9-CM]*), (2) procedures (*Current Procedural Terminology 4 [CPT-4]*), and (3) the Healthcare Procedural Coding System. Enrollment data include data identifiers for enrollment in Medicare Managed Care (MMC). Because claims data are available only for beneficiaries with fee-for-service, we excluded patients enrolled in Medicare Managed Care plans from our study. Beneficiary Summary files also include limited demographic information on age, sex, race and ethnicity. Additionally, we used the 2000 Census Bureau data to include ZIP-code-level household income and education in our analytical models. The availability of 10 years of enrollment information and Medicare claims allowed for our trend analysis. Our Institutional Review Board approved the use of de-identified Medicare claims data, and we signed a Data User Agreement with the CMS.

Sample Selection

We defined our study sample based on a similar methodology used by Aliu et al.¹⁵ Briefly, we first searched ICD-9-CM diagnostic codes for thumb CMC arthritis in the Medicare Inpatient, Outpatient, and Carrier files (Figure 1). Using CPT codes, we extracted all patients 65 years of age and older who had received a surgical intervention for this disease. Patients without an ICD-9-CM diagnosis of primary hand osteoarthritis or the manifestations of the disease (e. joint crepitus, arthralgia, degenerative disease of the articular cartilage, and joint instability) were excluded. These exclusions ensured that only patients having documented diagnoses with ICD-9-CM codes and documented treatments with CPT codes were included in our study population. The CPT code used for simple complete trapeziectomy (25210) was noted to be ambiguous, only specifying carpectomy of one bone. In order to compensate for this, we decided to exclude any patients with ICD-9-CM codes for wrist arthritis, carpal fractures, non-unions, and avascular necrosis. Lastly, we excluded patients with an ICD-9-CM diagnosis code for rheumatoid arthritis.

Our cohort included 3,530 patients ages 65 and older who had both a diagnosis of hand osteoarthritis and underwent surgical treatment with one of the following four procedures: (1) partial or complete trapeziectomy with a soft tissue arthroplasty technique (i.e. tendon interposition with or without ligament reconstruction), (2) simple complete trapeziectomy, (3) thumb CMC arthrodesis, and (4) thumb CMC joint prosthetic arthroplasty (Appendix 1). Additionally, 125 of these patients had missing values in the categories of “education” and “household income,” and were subsequently excluded from our regression analysis. The final number of subjects in our regression analysis included 3,405 patients (Figure 1).

We did not analyze the probability of complications after each surgical procedure. Given that certain ICD-9 CM codes used to identify typical complications after thumb CMC surgery may also be used for other conditions, it would be difficult to consider these diagnosis codes as complications related to any specific procedure.

Dependent and Independent Variables

The method of surgical treatment for thumb CMC arthritis was our outcome of interest. We defined three exclusive categories for surgical treatment: (1) partial/complete trapeziectomy with ligament reconstruction and tendon interposition (LRTI) (CPT codes - 25447, 25447 and 20924, 25210 and 20924), (2) simple complete trapeziectomy (CPT code - 25210), and (3) thumb CMC arthrodesis or thumb CMC prosthetic arthroplasty (due to small sample sizes in each of these two procedures, we combined them into one category) (CPT codes - 26841, 26842, 25445).

Our explanatory variables included patient-level characteristics such as age, sex, race/ethnicity, socioeconomic status, number of comorbid conditions, and place of residence (urban versus non-urban cities) (Table 1), which we extracted using Master Beneficiary Summary files. The “age” variable was categorized as 65–74, 75–84, and 85, with the 65–74 age group serving as the reference category. We included the number of comorbid conditions using Medicare Outpatient and Carrier files. We identified all comorbid conditions listed in Elixhauser’s comorbidity index¹⁶ and categorized the “comorbidity” variable as less than two conditions and greater than or equal to two conditions. Rural vs. Urban status was identified by linking ZIP code of each beneficiary’s place of residence to the US Department of Agriculture Rural-Urban Continuum Codes for metropolitan and non-metropolitan counties. In order to include a measure of socioeconomic status, we merged national census data from 2010¹⁷ with the Master Beneficiary Summary File based on patient’s zip code of place of residence; this method is commonly used in the literature to merge zip-code level socioeconomic data with Medicare claims data.¹⁸ We used these two measures as proxies for socioeconomic status of beneficiaries. We categorized zip-code level median household income into three exclusive categories: (1) less than \$25,000, (2) between \$25,000 and \$50,000, and (3) more than \$50,000, with the “between \$25,000 and \$50,000” serving as the reference category. Finally, we included the year of surgical encounter to control for the temporal trend in our model, with 2001 being the reference year.

Statistical Analysis

First, we examined the unadjusted differences in patient characteristics stratified by the three main surgical procedure groups. Chi-squared test and Fisher’s exact test were utilized to identify the differences in categorical variables (age group, sex, race, median household income, education, urban-rural, and number of comorbid conditions) among surgical procedure groups. We used an ANOVA F test to identify the mean difference in education (percentage of college graduates at the zip code level) as a continuous variable among surgical procedure groups (Table 1). We then used a multinomial logistic regression model to examine the association between patient characteristics and the surgical treatment performed (Table 2). We used partial/complete trapeziectomy with LRTI as the reference category. Next, we used physician’s unique identifiers reported in carrier and outpatient claim files to examine the frequency of different procedures (in both ambulatory and outpatient settings) each surgeon has performed. Additionally, we defined the exact procedures performed among surgeons in our cohort who only performed one type of procedure (Figure 2).

Results

Patient Characteristics

Of the 3,530 patients in the study, 3,153 patients (89.3%) over the age of 65 years underwent a partial/complete trapeziectomy with LRTI, 181 patients (5.1%) underwent simple complete trapeziectomy, and 196 patients (5.6%) underwent thumb CMC arthrodesis or prosthetic arthroplasty. Table 1 shows the descriptive statistics of patients' sociodemographic and clinical characteristics, stratified by the three surgical treatment categories. Except for female sex (over the age of 65 years), there were no differences in patients' characteristics among the three surgical treatment groups. More females underwent trapeziectomy with LRTI compared with the other three procedures ($p < 0.01$).

Figure 2 shows the unadjusted trends in utilization of the three surgical treatment categories for thumb CMC arthritis. Between 2001 and 2010, partial/complete trapeziectomy with LRTI was consistently found to be the surgical procedure most utilized. The predominance of partial/complete trapeziectomy with LRTI grew from 84% of all surgical treatment options of thumb CMC arthritis in 2001 to 90% in 2010 ($p < 0.05$).

Adjusted Predictive Probabilities from Regression Analysis

Results from the multinomial logistic regression analysis are summarized in Table 2. Similar to the unadjusted comparisons, female sex (over the age of 65 years) was the only patient factor to have significant association with type of surgical treatment. Compared with their male counterparts, women were less likely to undergo simple complete trapeziectomy (OR=0.49; CI: 0.36–0.69) versus trapeziectomy with LRTI. With few patients undergoing simple complete trapeziectomy and joint arthrodesis or prosthetic arthroplasty in each year, we did not have enough power to examine annual trends in our regression model. Instead, we analyzed ten years of pooled data.

Unadjusted Surgical Trends

Of the 2,966 surgeons who performed thumb CMC procedures for patients in the study sample, 2,758 (93%) surgeons performed only one procedure type in 2010 compared to 2,669 (90%) in 2001 (Figure 3a). Among 2,758 surgeons who performed only one procedure type in 2010, 2,593 (94%) performed partial/complete trapeziectomy with LRTI, 83 (3%) performed simple complete trapeziectomy, 27 (1%) performed thumb CMC arthrodesis, and 55 (2%) performed thumb CMC prosthetic arthroplasty (Figure 3b).

Discussion

Thumb carpometacarpal (CMC) arthritis is a high-prevalence chronic condition that affects a growing segment of the U.S. aging population.^{2,3,19–21} Our study reveals that not only is partial or complete trapeziectomy with ligament reconstruction and tendon interposition (LRTI) the prevailing surgical technique of choice among hand surgeons nationally, there was a consistent upward temporal trend in the utilization of trapeziectomy with LRTI.

Although some studies have demonstrated that trapeziectomy with LRTI offered “no additional benefits” over trapeziectomy alone.^{5,14} trapeziectomy with LRTI still remains the most commonly practiced technique among hand surgeons in the United States.

Owing to physician and financial difficulties that are associated with clinical trials, to this date, only two randomized controlled trials have been completed comparing trapeziectomy to trapeziectomy with LRTI.^{11,22} Additionally, the majority of studies on this topic have been of low quality, and criticized for their inadequate study size, poorly defined primary outcome measures, extensive bias and confounders, and short length of follow-up.^{5,14} For instance, in a recent randomized controlled trial (RCT) by Davis et al., no significant difference in clinical outcome measures (e.g. pain, DASH scores, and pinch) were found between patients who underwent trapeziectomy alone and trapeziectomy with LRTI. However, this study was underpowered and only provided results with one-year follow-up.¹¹

Patient-reported outcomes (PROs) offer unique insights into patients’ functional and psychosocial health states, elements that are otherwise difficult to ascertain with standard outcome measures.^{23,24} Surgeons’ interpretation of available evidence may be highly dependent on factors relating to the quality and validity of peer-reviewed studies. Consequently, our observed trends may be a reflection of the paucity and poor quality of available evidence or the collective wisdom of the surgical community.

Between 2007 and 2010, we noticed an increase in the odds of undergoing either thumb CMC arthrodesis or prosthetic arthroplasty. One possible explanation for this may be driven by consumer demand given the initial successes and promising results of particular implant designs, such as the Artelon® spacer implant.^{25–28} It is also plausible that the continued interest in new prosthetic materials and the eminence of partial/complete trapeziectomy with LRTI was based on the entrenched rationale of preventing metacarpal instability,^{10,22,30–35} which does not favor simple trapeziectomy. Additionally, in the case of arthrodesis there wasn’t adequate evidence to compare this intervention to LRTI. Furthermore, the addition of prosthetic arthroplasty, and the increase in its utilization, may have been the result of higher physician reimbursement rates associated with the additional ligament reconstruction compared with simple trapeziectomy.³⁶

There are limitations associated with using administrative databases. Given that our study only utilized a 5% sample, the trends found in our study may not be representative of the larger percentage of practicing hand surgeons in the U.S. Additionally, administrative data lack certain clinical information such as severity of disease, e.g. the Eaton-Glickel classification, which can influence treatment choices.³⁷ Moreover, with only a few patients undergoing simple complete trapeziectomy and joint arthrodesis or prosthetic arthroplasty in each year, we did not have enough power to examine annual trends in our regression model. Instead, we presented unadjusted trends between 2001 and 2010, and analyzed ten years of pooled data in our regression model. Also of note is that we categorized trapeziectomy with tendon interposition as both partial and complete trapeziectomy. Furthermore, given the lack of standardization and consistency in the coding of these procedures, our results may not be an accurate reflection of actual practice patterns among hand surgeons. For instance, the ICD-9-CM codes for “wrist arthritis” may have been used synonymously with “thumb CMC

arthritis.” Thus, those with “wrist arthritis” who underwent a “carpectomy of one bone” may have been needlessly excluded. The study patient population was 65 years and older, which does not take into account the younger, more active, population where certain procedures, such as thumb CMC arthrodesis, may be used in higher capacity. However, previous studies with state-level data did not show that age was a significant factor in treatment type.¹⁵ Finally, Medicare claims data do not include claims data related to beneficiaries with any of the MMC plans; about 30% of Medicare beneficiaries choose a MMC plan. In this study, we were able to examine Medicare beneficiaries with FFS plans and thus, our results are only generalizable to Medicare patients with FFS plans.

Our nationally representative study reveals that partial/complete trapeziectomy with ligament reconstruction and tendon interposition is the most common surgical technique of choice among hand surgeons. Although available peer-reviewed evidence does not indicate superiority of trapeziectomy with LRTI over trapeziectomy alone, many of these studies have serious shortcomings. Further national comparative studies, which use better controls, outcome measures, and safeguards against confounding, are needed to examine the value of the different additions to trapeziectomy.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Flow chart for defining our study cohort using 2001–2010 Medicare claims data

Figure 2. Percentage of surgeons performing each of the four types of surgical treatments for thumb carpometacarpal (CMC) arthritis (Source: The 2001–2010 Medicare claims data)

Figure 3.

a: Percentage of surgeons performing one, two, or three procedure types per year (Source: The 2001–2010 Medicare claims data)

b: Percentage of surgeons performing only one procedure type - either (1) partial/complete trapeziectomy with ligament reconstruction and tendon interposition, (2) simple complete trapeziectomy, (3) thumb carpometacarpal arthrodesis, or (4) thumb carpometacarpal prosthetic arthroplasty per year (Source: The 2001–2010 Medicare claims data)

Table 1

Characteristics of Patients in the Study Sample

	Trapeziectomy with Soft-Tissue Arthroplasty n = 3153 [89.3%]	Simple Complete Trapeziectomy n = 181 [5.1%]	CMC Joint Arthrodesis and Prosthetic CMC Joint Arthroplasty n = 196 [5.6%]	p value
Age (years)	72.1	72.6	72.1	0.50
65–74 (70%)	2193 (69.5%)	120 (66.3%)	141 (71.9%)	0.77
75–84 (28%)	882 (28.0%)	57 (31.5%)	52 (26.5%)	
85+ (2%)	78 (2.5%)	4 (2.2%)	3 (1.5%)	
Sex				
Female (79%)	2533 (80.3%)	120 (66.3%)	153 (78.1%)	<0.01
Race				
White (96.8%)	3055 (96.9%)	171 (94.5%)	192 (98.0%)	0.21
Black (2%)	60 (1.9%)	7 (3.9%)	3 (1.5%)	
Hispanic (0.3%)	8 (0.3%)	2 (1.1%)	0 (0%)	
Other (0.9%)	30 (1.0%)	1 (0.6%)	1 (0.5%)	
Education				
College Graduated %	32.3%	31.7%	31.4%	0.65
Median household income				
<\$25 K (5%)	176 (5.6%)	9 (5.0%)	7 (3.6%)	0.81
\$25 – \$50 K (65%)	2035 (64.5%)	116 (64.1%)	130 (66.3%)	
>50 K (30%)	942 (29.9%)	56 (30.9%)	59 (30.1%)	
Urban-Rural				
Urban (97%)	3096 (97.3%)	180 (99.5%)	191 (97.5%)	0.22
SES				
Low (14%)	407 (13.4%)	34 (19.5%)	28 (14.7%)	0.19
Midium (28%)	863 (28.4%)	43 (24.7%)	57 (30.0%)	
High (58%)	1771 (58.2%)	97 (55.8%)	105 (55.3%)	
Comorbidity (2) (48%)	1534 (48.7%)	78 (43.1%)	97 (49.5%)	0.33

* Data are n and %. Proportions are related to the columns; the columns for each variable add to 100%.

* Education: 125 missing; Socioeconomic Status (SES): 125 missing

* P values are from Chi-square test or Fisher's exact test for the association between the indicated categorical variables and three surgical procedure groups, or ANOVA F test for the mean difference of continuous variables among three surgical procedure groups.

Table 2

Adjusted Odds Ratio of Performing Simple Complete Trapeziectomy, CMC Joint Arthrodesis and Prosthetic Arthroplasty Versus Trapeziectomy with Soft-Tissue Arthroplasty

Effect	Simple Complete Trapeziectomy		CMC Joint Arthrodesis and Prosthetic Arthroplasty	
	OR	CI	OR	CI
Age:				
65–74	1.00	Reference Group	1.00	Reference Group
75–84	1.15	0.824–1.612	0.97	0.696–1.356
85+	0.94	0.335–2.645	0.58	0.180–1.893
Sex:				
Male	1.00	Reference Group	1.00	Reference Group
Female	0.49 *	0.357–0.693	0.82	0.576–1.174
Race/Ethnicity:				
White	1.00	Reference Group	1.00	Reference Group
Nonwhite (Others) ^a	1.09	0.769–1.550	1.07	0.749–1.525
Education ^b	0.51	0.135–1.923	0.49	0.133–1.815
Income ^c :				
Low Income	0.57	0.137–2.382	0.21	0.030–1.598
Middle Income	1.00	Reference Group	1.00	Reference Group
High Income	1.17	0.774–1.773	1.17	0.779–1.753
Geographic Area:				
Urban	1.00	Reference Group	1.00	Reference Group
Rural	0.22	0.029–1.565	0.96	0.379–2.447
Comorbidity:				
Having 1 or no condition	1.00	Reference Group	1.00	Reference Group
Having between 2 and 4 conditions	0.78	0.571–1.072	1.03	0.758–1.387
Having more than 4 conditions	0.75	0.230–2.447	1.49	0.624–3.576
N Total=3,405	174		190	

Source: Medicare claims data between 2001 and 2010

Note: Odds ratios are determined from multinomial logistic regression models, comparing patients who underwent simple complete trapeziectomy and patients who underwent CMC joint arthrodesis or prosthetic arthroplasty with patients who underwent trapeziectomy with soft-tissue arthroplasty.

* Statistically significant at 95% confidence interval.

^a Nonwhite group represents African-Americans, Hispanic, and other minority groups. Because of small sample size, we grouped them all together.

^b Education is measured by percentage of college educated individuals at the zip-code level of patients' place of residence.

^c Income is measured based on median income at the zip-code level of patients' place of residence. Accordingly, median income less than \$25,000 was defined low income (the reference category), income between \$25,000 and \$50,000 was defined middle income, and income more than \$50,000 was defined high income.