

Socioeconomic Status Affects Pre- and Postoperative Two-point Discrimination in Patients with Carpal Tunnel Syndrome

Gautham Prabhakar, MD*
 Abdullah Ghali, MD†
 David Momtaz, BS, MPH*
 Ryan Rose, MD*

Background: Carpal tunnel release is a life-changing procedure within hand surgery. Multiple factors may have an impact on the outcome following surgery.

Methods: In this retrospective cohort study, we reviewed all patients who underwent carpal tunnel release in our institutional database from 2018 to 2020. We included patients with a minimum of 6-week follow-up. Patient demographics were identified, including insurance status and comorbidities. Patients were categorized as “improved” or “not improved” based on two-point test differences. Results were analyzed using the Fisher exact test. We ran a logistic regression model to analyze the relationship between income status (operationalized by having Medicaid/Carelink) and preoperative scores, and inferential statistics were computed with appropriate *t* tests.

Results: Of the 125 patients who met the inclusion criteria, 47 (37.6%) had Medicaid or Carelink, and 79 (62.4%) had commercial insurance. Medicaid/Carelink patients presented with worse two-point discrimination on initial presentation ($P < 0.001$). Compared to commercial insurance, Medicaid/Carelink patients were less likely to show improvement in postoperative two-point discrimination ($P < 0.001$). Male patients were also less likely to show improvement. Race, ethnicity, medical comorbidities, and age were not shown to have a significant effect on improvement in two-point discrimination.

Conclusions: Although medical comorbidities did not have a significant effect on postoperative two-point, patients with low-income status (Medicaid/Carelink) may have a less predictable outcome. These socioeconomic considerations are critical in appropriately risk stratifying surgical candidates, and counseling patients in whom tactile acuity may be less predictable. (*Plast Reconstr Surg Glob Open* 2022;10:e4389; doi: 10.1097/GOX.0000000000004389; Published online 8 July 2022.)

INTRODUCTION

Carpal tunnel syndrome (CTS) is a common peripheral neuropathy, affecting approximately 3.8% of the general population and up to 7.8% of the working population.^{1,2} Many risk factors have been associated with CTS, including diabetes, rheumatoid arthritis, obesity, and several socioeconomic factors.^{3,4} Furthermore, some of these socioeconomic factors, such as marital status, income level, migrant status, and receipt of social assistance, have

been linked to poorer surgical and patient-reported outcome measures.^{5–8}

Studies evaluating socioeconomic factors and quantitative measures of symptom severity in CTS, such as two-point discrimination (2PD), are limited. High 2PD measure sensibility can be a sign of decreased hand function.⁹ The primary objective of the current study was to determine whether medical comorbidities and insurance status affect postoperative 2PD following carpal tunnel release (CTR). The authors hypothesize that patients with governmental insurance (such as Medicaid or Carelink) are less likely to clinically improve and have worse 2PD scores.

MATERIALS AND METHODS

This study was approved by the institutional review board of our institution. We performed a retrospective review of all patients from 2018 to 2020 who underwent

From the *Department of Orthopaedics, UT Health San Antonio, San Antonio, Tex; and †Department of Orthopedics, Baylor College of Medicine, Houston, Tex.

Received for publication December 20, 2021; accepted May 4, 2022.

Copyright © 2022 The Authors. Published by Wolters Kluwer Health, Inc. on behalf of The American Society of Plastic Surgeons. This is an open-access article distributed under the terms of the [Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 \(CCBY-NC-ND\)](#), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

DOI: 10.1097/GOX.0000000000004389

Disclosure: The authors have no financial interest to declare in relation to the content of this article.

mini-open CTR surgery in our level 1 university trauma center institutional database. Patients were identified using International Classification of Diseases 9 and 10 codes for CTR. A total of 182 patients were identified, and their medical record numbers were used to extract age, demographics, gender, ethnicity, race, zip code, insurance status, and surgical date. A research team in the department of orthopedic surgery individually reviewed and verified each data point. The hospital staff collected all the demographic and clinical variables. The 2DP discrimination measurement was routinely tested in all patients with CTS by the same certified board hand surgeon, the senior author, preoperatively and at 6 weeks and 3 months in the postoperative period. A research team, including hospital staff and residents from the orthopedic surgery department, was instructed to make the extraction of retrospective data from patient charts. [Figure 1](#) shows the inclusion flowchart for the study.

Patients who did not have pre- and postoperative 2PD scores were excluded from the study. The remaining 125 patients were categorized based on their insurance status. If a patient had a negative measurement by subtracting their postoperative 2PD score from the preoperative score, they were labeled as “improved.” Otherwise, patients with the same or increased score difference were labeled as “not improved.” Statistical analysis compared proportions of insurance status, medical comorbidities, smoking status, age, and demographics between the improved and not improved cohorts. Fisher exact test was used to elucidate significance.

Logistic regression dependent variables were first analyzed to make certain that little to no multicollinearity was seen and that the assumption of independence of observations was observed. Furthermore, linearity of independent variables and log odds was observed. No significant interactions were seen between independent variables. A multiple linear regression model was assessed to ensure that its assumptions were met. The data were observed to show a linear relationship between the independent variables and preoperative 2PD. Furthermore, residuals were then assessed for normal distribution, and no multicollinearity

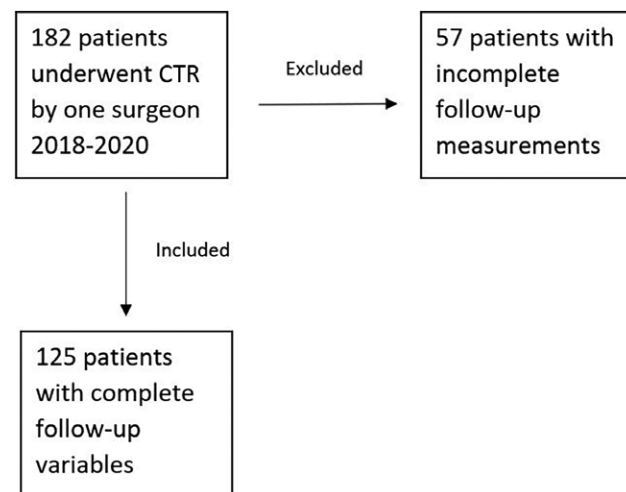


Fig. 1. Patient inclusion flowchart.

Takeaways

Question: What is the impact of socioeconomic status on postoperative two-point discrimination following carpal tunnel release?

Findings: Patients with lower socioeconomic status are less likely to show improvement in postoperative two-point discrimination.

Meaning: Socioeconomic considerations are critical in appropriately risk stratifying surgical candidates and counseling patients in whom tactile acuity may be less predictable.

was observed. The data showed homoscedasticity. Finally, all variables in regression models were first run separately to ensure that no artifact *P* values were present and that all effect sizes were reported honestly and not overinflated due to interaction.

The collected variables were then analyzed using commercially available software packages. Microsoft Excel was used to sort the data and perform preliminary analysis. International Business Machines Statistical Package for the Social Sciences suite was used to run analysis of variance, logistic regressions, and Fisher exact tests, as well as several cross tabulations and descriptive statistics. Regression models were run with having Carelink and/or Medicaid acting as an independent variable and two-point preoperative score as the dependent variable. Carelink and/or Medicaid enrollment was also run as an independent variable with improvement in follow-up two-point score as dependent variable. For both models, race, ethnicity, presence of comorbidities, and age were controlled for. Results and *P* values for this analysis can also be found in the Results section. Confidence intervals (CIs) were set at 95% with a *P* value of 0.05 being considered statistically significant.

RESULTS

Patient demographics and characteristics are shown in [Table 1](#). Mean age was 59.35 with the youngest patient being 50 and the oldest 80. A series of conditions, such as smoking, hypertension, and diabetes, were marked as a comorbidity. A total of 47 patients had either Carelink or Medicaid, and 78 patients had commercial insurance, accounting for 37.6% and 62.4%, respectively. These findings are outlined in [Tables 1](#) and [2](#).

Patients on either Medicaid or Carelink presented with worse 2PD on initial presentation ($P < 0.001$). A multivariable linear regression was run. Our analysis showed an average difference of 6.54 points between the two groups (95% CI, 5.7–7.39). That is, those on Medicaid or Carelink had a preoperative two-point that was 6.54 points worse than those in the commercial insurance group even when we controlled for age, gender, race, ethnicity, and known comorbidities. A comparison of means is presented in [Table 3](#). Next, a multivariable logistic regression was run with improvement as the dependent variable and insurance status as the independent variable, we controlled for age, gender, race, ethnicity, and known comorbidities.

Table 1. Demographic Information on Sample, including Descriptive Statistics

Demographic	N (%)
Not improved	37 (29)
Improved	88 (71)
No comorbidity	44 (35)
Comorbidity present	81 (65)
No Medicaid	108 (86)
Medicaid	17 (14)
No Carelink	95 (76)
Carelink	30 (24)
Commercial	78 (62)
Carelink/Medicaid	47 (38)
Age <60 y	76 (61)
Age 60+ y	49 (39)
Men	98 (78)
Women	27 (22)
Non-Hispanic	56 (45)
Hispanic	69 (55)
White	119 (95)
Black	6 (5)
	Mean (SD)
Age, y	59 (7)
Preoperative two-point	9 (4)

SD, standard deviation.

Table 2. Demographics by Improvement

	Improved	Not Improved
Commercial	63	15
Carelink/Medicaid	25	22
No comorbidity	30	14
Comorbidity present	58	23
Age <60 y	54	22
Age 60+ y	34	15
Women	76	22
Men	12	15
Non-Hispanic	39	17
Hispanic	49	20
White	86	33
Black	2	4

Proportions of improved versus not improved between groups. Fisher exact test was used to gauge significance. Bolded variables designate significance $P < 0.05$.**Table 3. Mean Comparison between Carelink/Medicaid and Commercial Insurance for Preoperative Two-Point Score**

Insurance Status	N	Mean	P
Commercial	78	6.85 (2)	<0.001
Carelink/Medicaid	47	13.19 (2.1)	

This table compares the two-point means between groups, Carelink and Medicaid versus those with commercial insurance. Results were significant top less than 0.001.

It was found that compared with commercial insurance, Medicaid or Carelink patients had 8.67 (95% CI, 2.74–27.78) times increased odds of not showing improvement in postoperative 2PD ($P < 0.001$) (Fig. 2).

Additionally, women were more likely to show improvement after surgery. Women had 6.71 (95% CI, 2.23–20.00) times increased odds of showing improvement when compared with men ($P < 0.001$) even when age, insurance status, race, ethnicity, and comorbidities were controlled for. Age, race, ethnicity, and our documented comorbidities were not significant predictors of improvement.

DISCUSSION

Many conditions have been found to be associated with carpal tunnel surgery release outcomes, including a history of drinking, tobacco use, and/or illicit drug use.^{10,11} However, an analysis of 2PD before and after CTR with respect to socioeconomic status (SES) is limited in the current literature. The results of our study demonstrate that government-insured patients have a worse 2PD on initial presentation, suggesting a greater disease burden. Furthermore, this cohort was less likely to have an improvement in postoperative 2PD following CTR.

The current study has several limitations. First, the retrospective nature may skew or bias the data. Second, there is complex interplay between patient demographics and SES, making it difficult to isolate relationships. In addition, our patient population may not be representative of the entire population, as data were collected from a single center, limiting the external validity of the current study. Importantly, various other socioeconomic factors, such as SF-36, workers' compensation, and mental health issues, have been associated with inferior outcomes. These factors were not analyzed or included in this study. Another limitation of our study is the worse preoperative 2PD in the lower socioeconomic status cohort. A potential confounding variable for worse postoperative improvement is thus later presentation with CTS. Furthermore, this study links insurance to SES due to the lack of individual income data available. The availability of income data would allow for better estimation of SES.

Insurance status has been shown to influence patient outcomes in the orthopedic literature. A total of 37% of our patient population were found to have Medicaid/Carelink insurance and were significantly less likely to improve following CTR. Barrack et al¹² found low household income among other socioeconomic factors to be associated with numerous functional limitations and worse patient satisfaction after total knee arthroplasty. Odum and Springer¹³ reported a 53% reduction of in-hospital mortality after total knee replacement in patients with private insurance when compared with Medicare patients. Furthermore, their study showed Medicaid patients to have a 34% increase in risk of major complications. In a one-on-one patient-matched study, Sabesan et al¹⁴ demonstrate that matched Medicaid patients treated for proximal humerus fracture had an increased risk of complications, decreased surgical rates, and increased resource utilization. In a study of 5051 patients in Rome with a hip fracture, a significant association between mortality and a city-specific index (a measure of deprivation) was found after controlling for confounders. This study highlights an important fact that despite universal health care coverage in Rome, patients with low SES had a higher risk of mortality and a lower risk of early intervention.¹⁵

Ethnic disparities, although multifaceted, have a significant impact on disease outcomes with higher morbidity in the Black and Latino patients.¹⁶ In the current study, Black patients were 5.3 times more likely to show no improvement after CTR. In the trauma literature, Dy et al¹⁷ found Black patients with hip fractures to be at greater

Medicaid & Carelink Vs Commercial Insurance in Postoperative Improvement

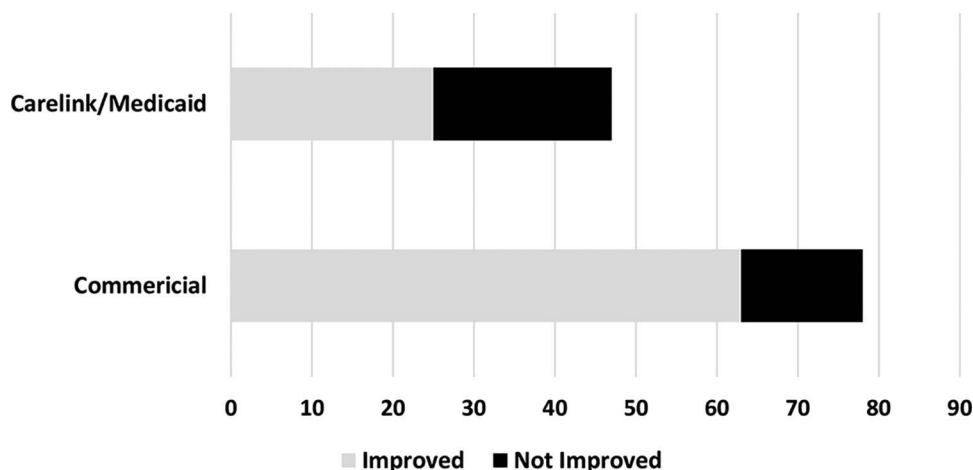


Fig. 2. Comparing proportions of improved vs not improved in the Carelink/Medicaid group vs those who had commercial insurance ($P = 0.0021$).

risk for delayed surgery, readmission, reoperation, and 1-year mortality compared with White patients. Singh et al¹⁸ reported poorer physical function and greater pain in Black and Latino patients compared with White patients following distal radius fracture. Similar findings have been found in the knee and hip arthroplasty literature. Laverna et al¹⁹ demonstrated Black patients to have undergone joint replacement earlier in life and have significantly worse patient-reported outcomes compared with White patients at a follow-up of at least 1 year. It is imperative for the surgeon to keep this in mind in preoperative counseling and postoperative care.

Medical comorbidities and age older than 60 did not have a significant effect on postoperative 2PD in the current study. Similar to our results, both Phalen²⁰ and Choi and Ahn²¹ did not find diabetes to adversely affect the surgical outcome. In addition, Choi and Ahn²¹ demonstrated improvement (with good-to-excellent results) in 74% of their patients. Two other studies suggest that patients older than 60 have more severe symptoms with less success in postoperative outcomes.^{22,23} Hobby et al²³ report greater preoperative CTS symptoms in women; however, there was no significant difference in outcome compared with men. Conversely, in our study, women were 4.1 times more likely to show improvement than men.

Our study suggests that there is an association between lower SES and improvement after carpal tunnel surgery. These socioeconomic considerations are critical in appropriately risk stratifying surgical candidates and counseling patients in whom tactile acuity may be less predictable. As value-based health care becomes increasingly prevalent, it is necessary to identify these risk factors that lead to poor outcomes to optimize spending and improve outcomes. Further investigations analyzing modifiable factors in this vulnerable population may yield superior outcomes and more satisfied patients.

Gautham Prabhakar, MD

Department of Orthopaedics

UT Health San Antonio

7703 Floyd Curl Dr, MC-7774

San Antonio, TX 78229

E-mail: prabhakarg@uthscsa.edu

REFERENCES

1. Atroshi I, Gummesson C, Johnsson R, et al. Prevalence of carpal tunnel syndrome in a general population. *JAMA*. 1999;282:153–158.
2. Dale AM, Harris-Adamson C, Rempel D, et al. Prevalence and incidence of carpal tunnel syndrome in US working populations: pooled analysis of six prospective studies. *Scand J Work Environ Health*. 2013;39:495–505.
3. Tseng CH, Liao CC, Kuo CM, et al. Medical and non-medical correlates of carpal tunnel syndrome in a Taiwan cohort of one million. *Eur J Neurol*. 2012;19:91–97.
4. Lee H, Lim HS, Kim HS. Socioeconomic status associated with carpal tunnel syndrome: a retrospective nationwide 11-year population-based cohort study in South Korea. *bioRxiv*. 2018:253633.
5. Wright MA, Beleckas CM, Calfee RP. Mental and physical health disparities in patients with carpal tunnel syndrome living with high levels of social deprivation. *J Hand Surg Am*. 2019;44:335.e1–335.e9.
6. Bernstein DN, Kurucan E, Fear K, et al. Evaluating the impact of patient social deprivation on the level of symptom severity at carpal tunnel syndrome presentation. *Hand (N Y)*. 2022;17:339–345.
7. Zimmerman M, Hall E, Carlsson KS, et al. Socioeconomic factors predicting outcome in surgically treated carpal tunnel syndrome: a national registry-based study. *Sci Rep*. 2021;11:2581.
8. Núñez-Cortés R, Cruz-Montecinos C, Antúnez-Riveros MA, et al. Does the educational level of women influence hand grip and pinch strength in carpal tunnel syndrome? *Med Hypotheses*. 2020;135:109474.
9. Novak CB, Mackinnon SE, Kelly L. Correlation of two-point discrimination and hand function following median nerve injury. *Ann Plast Surg*. 1993;31:495–498.

10. Pourmemari MH, Viikari-Juntura E, Shiri R. Smoking and carpal tunnel syndrome: a meta-analysis. *Muscle Nerve*. 2014;49:345–350.
11. Katz JN, Losina E, Amick BC III, et al. Predictors of outcomes of carpal tunnel release. *Arthritis Rheum*. 2001;44:1184–1193.
12. Barrack RL, Ruh EL, Chen J, et al. Impact of socioeconomic factors on outcome of total knee arthroplasty. *Clin Orthop Relat Res*. 2014;472:86–97.
13. Odum SM, Springer BD. In-hospital complication rates and associated factors after simultaneous bilateral versus unilateral total knee arthroplasty. *J Bone Joint Surg Am*. 2014;96:1058–1065.
14. Sabesan VJ, Petersen-Fitts G, Lombardo D, et al. Medicaid payer status is linked to increased rates of complications after treatment of proximal humerus fractures. *J Shoulder Elbow Surg*. 2017;26:948–953.
15. Barone AP, Fusco D, Colais P, et al. Effects of socioeconomic position on 30-day mortality and wait for surgery after hip fracture. *Int J Qual Health Care*. 2009;21:379–386.
16. National Healthcare Quality & Disparities Reports. Ahrq.gov. Published 2021. Available at <https://www.ahrq.gov/research/findings/nhqdr/index.html>.
17. Dy CJ, Lane JM, Pan TJ, et al. Racial and socioeconomic disparities in hip fracture care. *J Bone Joint Surg Am*. 2016;98:858–865.
18. Singh JA, Lu X, Rosenthal GE, et al. Racial disparities in knee and hip total joint arthroplasty: an 18-year analysis of national Medicare data. *Ann Rheum Dis*. 2014;73:2107–2115.
19. Lavernia CJ, Alcerro JC, Contreras JS, et al. Ethnic and racial factors influencing well-being, perceived pain, and physical function after primary total joint arthroplasty. *Clin Orthop Relat Res*. 2011;469:1838–1845.
20. Phalen GS. The carpal tunnel syndrome: clinical evaluation of 598 hands. *Clin Orthop*. 1972;83:29–40.
21. Choi SJ, Ahn DS. Correlation of clinical history and electrodiagnostic abnormalities with outcome after surgery for carpal tunnel syndrome. *Plast Reconstr Surg*. 1998;102:2374–2380.
22. Townshend DN, Taylor P, Gwynne-Jones DP. The outcome of carpal tunnel decompression in elderly patients. *J Hand Surg*. 2005;30A:500–505.
23. Hobby JL, Venkatesh R, Motkur P. The effect of age and gender upon symptoms and surgical outcomes in carpal tunnel syndrome. *J Hand Surg Br*. 2005;30:599–604.