OPEN

PRS GLOBAL OPEN

ORIGINAL ARTICLE

Peripheral Nerve

Evaluation of PROMIS Scores 6 Weeks after Conservative Management of Carpometacarpal Thumb Arthritis

Amy Phan, BS*†
Thais Calderon, MD†
Warren C. Hammert, MD‡

Background: Patient-reported outcome measures are being increasingly emphasized to assign value to care, given the current trend toward pay-for-performance healthcare. We sought to determine if the Patient-reported Outcomes Measurement Information System (PROMIS), a general questionnaire, is sensitive enough to detect improvement after corticosteroid injection or splinting/hand therapy for thumb carpometacarpal (CMC) arthritis.

Methods: This is a retrospective study analyzing two groups with thumb CMC arthritis: 88 patients who received splinting/hand therapy and 6-week follow-up and 70 patients with steroid injection and 6-week follow-up. PROMIS Physical Function (PF), Pain Interference (PI), Depression, and Upper Extremity (UE) scores were collected at each visit. We used paired t-tests to compare 6-week follow-up scores to baseline scores within each group.

Results: The mean age for the steroid injection group was 60.1 years old, and it was 61.8 years old for the returning splinting/hand therapy group. There were no significant differences in PROMIS PF, PI, Depression, or UE scores for patients who returned after 6 weeks of treatment with splinting/hand therapy. Moreover, at 6 weeks postinjection, PROMIS PF and UE scores marginally increased, whereas PI and Depression scores decreased with statistical significance.

Conclusions: Hand surgeons should be aware of the limitations of PROMIS when evaluating patients after conservative treatment for thumb CMC arthritis. There were no significant differences in PROMIS scores for patients with thumb CMC arthritis who returned after receiving splinting/hand therapy for 6 weeks. Meanwhile, PI scores can be used primarily to monitor for improvement after steroid injection for thumb CMC arthritis. *(Plast Reconstr Surg Glob Open 2022;10:e4493; doi: 10.1097/GOX.0000000000004493; Published online 7 October 2022.)*

INTRODUCTION

Recently within healthcare, payment initiatives have been realigned to reward clinical outcomes as we shift toward a pay-for-performance healthcare environment.[1] The Patient-reported Outcomes Measurement Information System (PROMIS) was developed by the National Institute of Health (NIH) as a comprehensive outcomes health system with the goal of being applied across all fields of healthcare.[2] PROMIS was developed specifically to address the disadvantages of legacy instruments including narrow scope and significant administrative and responder burden.[3,4] In addition, legacy instruments lack standardization in terms of their structure of questions and their scoring, which limits the ability to perform meta-analyses of data from studies investigating the same pathology.[5] PROMIS uses computerized adaptive testing (CAT) (a method of survey delivery that delivers successive questions based on previous answers) to assess patient symptoms, function, and quality of life. It uses fewer questions, requires less time than legacy instruments, and uses a normalized scoring system allowing for comparison among different populations.[2,3,5] Moreover, PROMIS scores pertaining to the patient's perceived health can be immediately transferred to the electronic medical record, which can reduce recall bias.[2,4]

*From the *Department of Orthopaedics and Physical Performance, University of Rochester, Rochester, N.Y.; †Department of Surgery, Division of Plastic Surgery, University of Washington, Seattle, Wash; and ‡Department of Orthopaedic Surgery, Division of Hand Surgery, Duke University Medical Center, Durham, N.C.*

Work was performed at the University of Rochester.

Received for publication June 23, 2022; accepted July 5, 2022.

DOI: 10.1097/GOX.0000000000004493

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

There is still uncertainty if PROMIS is sufficiently sensitive to detect changes after treatment for common hand conditions such as thumb CMC arthritis. Analyzing this data is crucial as we transition towards value-based healthcare, which considers outcomes achieved per dollar spent.[1] Our purpose was to determine if PROMIS domains are sensitive enough to detect patient improvement after conservative treatments of thumb carpometacarpal (CMC) arthritis including (1) corticosteroid injection or (2) splinting/hand therapy. Our null hypothesis is that there would be no significant improvement in PROMIS domains after treatment of thumb CMC arthritis with corticosteroid injection or with splinting/hand therapy.

Takeaways

Question: Are PROMIS Questionnaires able to detect change following nonoperative treatment of thumb arthritis?

Findings: There were significant changes in PROMIS PI and Depression scores following injection, but not in PF or UE.

Meaning: PROMIS domains were not able to detect improvement following nonoperative treatment of thumb basal joint arthritis.

MATERIALS AND METHODS

This study was approved by our university's institutional review board, which granted a waiver of consent for this retrospective study that examined data collected for routine clinical care beginning in February 2015. Patients completed PROMIS Physical Function (PF; v1.2/v2.0, which have been shown to be comparable across versions), Pain Interference (PI; v1.1), and Depression (v1.0) CATs on computer tablets (Apple iPads) as part of routine care at a hand clinic of a tertiary academic center. The Upper Extremity (UE; v2.0) instrument was added in November 2016. For each PROMIS instrument, the scores are normalized to a population mean score of 50 with an SD of 10 points.[2,3] Higher PROMIS scores represent more of the construct being assessed (ie, higher PF and PI scores represent more function and more difficulty with activities due to pain, respectively).[1,2]

Inclusion criteria consisted of patients 18 years and older who had been diagnosed with thumb arthritis and identified through ICD-10 codes (M18.0, M18.9, M18.11, M18.12, M79.644, M79.645, M79.646) from June 2015 to November 2020, and completed PROMIS instruments. Diagnosis of thumb CMC arthritis was from history and physical examination, with supporting evidence from radiographic imaging.[6] Patients often describe increasing difficulty with activities of daily living. On physical examination, patients may have a positive grind test which shows point tenderness at the thumb basal joint with swelling and crepitus when the joint is compressed.[6,7] Within the senior author's clinic, it is standard to recommend a trial of splinting/hand therapy for 4–6 weeks for any new patient presenting with symptoms of thumb arthritis. Therapy includes daily exercise focusing on thenar cone and first dorsal interosseous strengthening. All splinting/hand therapy patients included within the study were evaluated by the senior author. We identified two cohorts of patients who had been diagnosed with thumb CMC arthritis: patients who received splinting/hand therapy with a follow-up visit of 6±2 weeks and patients who received an intra-articular corticosteroid injection for their thumb arthritis with a follow-up visit of 6±2 weeks. Patients included in the returning hand therapy/splinting group were patients with a new diagnosis of thumb CMC arthritis who had not been treated for this pathology before. CPT code 20600 was used to identify patients who received a corticosteroid injection into the first CMC joint. Steroid injection was administered in one of eight hand surgeons' clinics. As such, medications and other modalities were not standardized.

Upon review of the medical records for patients who received splinting/hand therapy with a follow-up visit of 6 weeks, it was thought by the authors that there may be a selection bias of more symptomatic patients returning to the hand clinic after splinting/hand therapy. Therefore, we also identified a third cohort of patients who received splinting/hand therapy at their initial presentation but did not have another appointment for their thumb arthritis.

Statistical Analysis

Statistical analysis was performed using RStudio [R Foundation for Statistical Computing, Version 1.2.5042 (2009–2020); Vienna, Austria] and Microsoft Excel (Redmond, Wash.). Paired t-tests were used to compare continuous variables within the same cohort at different time points. We used chi-squared tests to compare categorical variables. *P* values less than 0.05 were considered statistically significant.

RESULTS

We identified 70 patients within the corticosteroid injection cohort and 88 patients in the returning splinting/hand therapy cohort. There were no statistically significant differences in age, gender, race, ethnicity, or body mass index (BMI) between the corticosteroid or the returning splinting/hand therapy cohorts. Complete demographic information has been included in Table 1. Mean PROMIS PF, PI, Depression, and UE scores for each cohort over time are shown in Table 2. Furthermore, corticosteroid injection

Table 1. Demographics

	Returning Splinting/ Hand Therapy	Steroid Injection
Mean age (± SD), y	61.8±8.9	60.1±10.2
Male	17 (19.3%)	17 (24.3%)
Female	71 (80.7%)	53 (75.7%)
White	82 (93.2%)	64 (91.4%)
Black	1 (1.1%)	3 (4.3%)
Other/unknown	5 (5.7%)	3 (4.3%)
Not Hispanic or Latino	84 (95.5%)	67 (95.7%)
Hispanic or Latino	3 (3.4%)	2 (2.9%)
Unknown	1 (1.1%)	1 (1.4%)
Mean BMI (± SD)	29.4±6.4	28.6±6.5

Table 2. PROMIS Physical Function, Pain Interference, Depression, and Upper Extremity for Patients with Carpometacarpal Thumb Arthritis

Mean Outcome Measure (Mean ± SD)	Returning Splinting and/or Hand Therapy: Baseline	Returning Splinting and/or Hand Therapy: 6-wk Follow-up	Steroid Injection: Baseline	Steroid Injection: 6-wk Follow-up
PROMIS Physical Function	45.00 ± 8.47	45.13 ± 7.91	43.42 ± 8.62	44.10 ± 9.27
PROMIS Pain Interference	57.56 ± 5.51	57.07 ± 5.51	59.19 ± 6.72	57.46 ± 7.71
PROMIS Depression	47.36 ± 9.31	47.67 ± 9.85	48.64 ± 10.55	46.98 ± 10.29
PROMIS Upper Extremity	37.74 ± 8.73	37.18 ± 7.65	37.23 ± 8.59	38.05 ± 8.87

Table 3. Formulations of Corticosteroid Injections Received by the Patients Included within the Corticosteroid Injection Cohort

n	Percent Received by Corticosteroid Injection Cohort, %	Corticosteroid Injection Formulation
23	32.9	3 mg betamethasone acetate and sodium with 0.5 mL lidocaine HCL 1 %
17	24.3	6 mg of betamethasone acetate and 10 mg 1% lidocaine
9	12.9	1 mL of betamethasone acetate with 1 mL of 1% lidocaine without epinephrine
8	11.4	20 mg methylprednisolone acetate 40mg/mL and 0.5 mL lidocaine 1%
5	7.1	6 mg betamethasone acetate and sodium phosphate 6 (3–3) mg/mL and 1 mL lidocaine HCL1 %
4	5.7	2 mL of 50:50 betamethasone acetate (3 mg/mL): 1% lidocaine
1	1.4	1.0 mL methylprednisolone acetate 40 mg/mL and 1.0 mL lidocaine
1	1.4	20 mg of methylprednisolone acetate and 10 mg of lidocaine

There were two patients for which the exact formula of their steroid injection was not found in the medical record.

formulations for the patients included in the steroid injection cohort are listed in Table 3. It should be noted that for two of 70 (2.9%) patients in the steroid injection cohort, the exact formula for their injections could not be found in the medical record. For the returning hand therapy/splinting group, completion rates for PROMIS PF, PI, Depression, and UE ranged from 100%, 96.6% to 98.9%, 96.6% to 98.9%, and 64.8% to 68.2%, respectively. For the steroid injection group, the completion rates for PROMIS PF, PI, Depression, and UE ranged from 100%, 95.7% to 97.1%, 92.9% to 98.6%, and 47.1% to 51.4%.

Corticosteroid Injection Group

The mean age of the steroid injection group was 60.1 years old, and the majority were women (53/70, 75.7%) and White (64/70; 91.4%). Within the injection group, there were two of 70 (2.9%) patients with Eaton stage 1, 10 of 70 (14.3%) patients with Eaton stage 2, one of 70 (1.4%) patients with Eaton stage 2–3, 12 of 70 (17.1%) patients with Eaton stage 3, one of 70 (1.4%) patients with Eaton stage 3–4, and three of 70 (4.3%) patients with Eaton stage 4. For 41 of 70 (58.6%) patients, the Eaton stage of arthritis was not found within the medical record. Moreover, although patients in the returning hand therapy/splinting group had not received any previous treatments for their thumb arthritis, 60 of 70 (85.7%) patients within the injection group had been previously treated conservatively with modalities such as bracing, splinting, hand therapy, or medications such as nonsteroidial anti-inflammatory medications. For 10 of 70 (14.3%) patients included in this group, a previous treatment for their thumb CMC arthritis was not listed. Furthermore, per the medical records, at the time of injection, 63 of 70 (90%) of the patients in the steroid injection group were recommended to continue their hand therapy, bracing, or splinting regimen on the date of their steroid injection.

In comparison to their baseline scores, there was no significant improvement in PROMIS PF or in PROMIS UE scores 6 weeks postinjection ($P = 0.36$; $P = 0.37$). However, there were significant improvements noted 6 weeks postinjection within the mean PI and Depression scores ($P = 0.04$; $P = 0.005$). Changes in PROMIS PF, PI, Depression, and UE scores from baseline to 6 weeks postinjection are shown visually in Figure 1.

Returning Splinting/Hand Therapy Group

The mean age of the returning splint/hand therapy group was 61.8 years old, and the majority were also women (71/88; 80.7%) and White (82/88; 93.2%). Within the hand therapy/splinting group, there were two of 88 (2.3%) patients with Eaton stage 1, 36 of 88 (40.9%) patients with Eaton stage 2, six of 88 (6.8%) patients with Eaton stage 2–3, 34 of 88 (38.6%) patients with Eaton stage 3, one of 88 (1.1%) patients with Eaton stage 3–4, and six of 88 (6.8%) patients with Eaton stage 4. Eaton stage of arthritis was not found in the medical record for three of 88 (3.4%) patients within the hand therapy/injection group. In addition, we had found that 31 of 88 (35.2%) patients in the hand therapy/splinting group ultimately received a steroid injection later in their treatment courses.

After 6 weeks of recommended splinting/hand therapy, there were no significant improvements noted within any PROMIS scores for these patients who returned to the hand clinic. The mean PF and PI scores marginally improved 6 weeks posttreatment ($P = 0.81$; $P = 0.22$), whereas the mean Depression and UE scores marginally worsened 6 weeks posttreatment ($P = 0.36$; $P = 0.44$). Changes in PROMIS PF, PI, Depression, and UE scores from baseline to 6 weeks after splinting/hand therapy are shown visually in Figure 2.

Nonreturning Splinting/Hand Therapy Group

We had also identified a third cohort of 50 of 1038 (4.8%) patients who received splinting/hand therapy at their initial presentation but did not have another

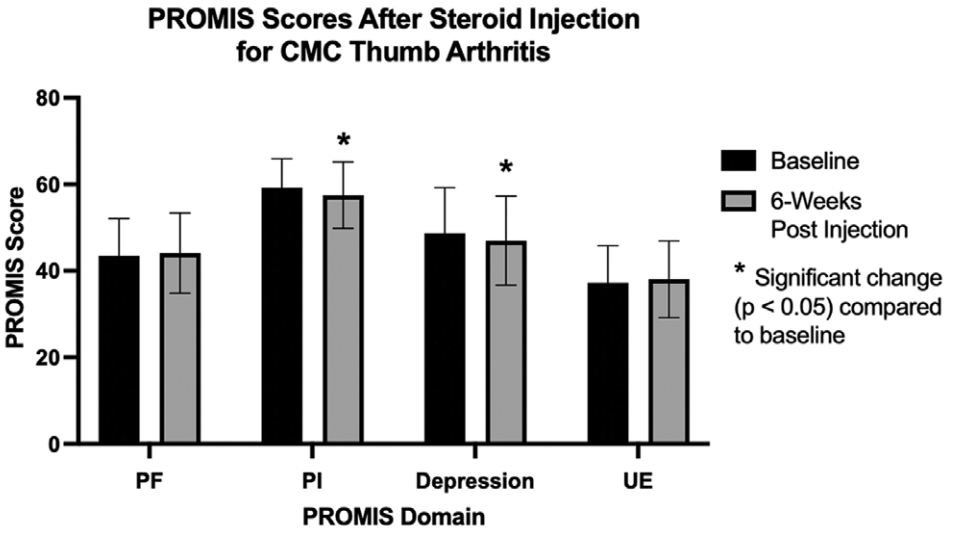

Fig. 1. PROMIS PF, PI, Depression, and UE scores from baseline to 6 weeks postcorticosteroid injection. *Significant change ($P < 0.05$) compared to baseline.

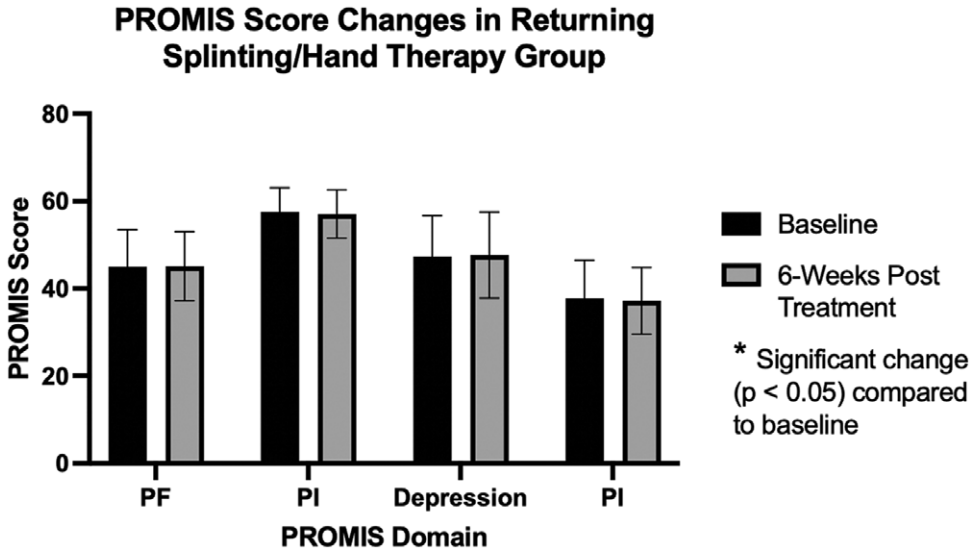

Fig. 2. PROMIS PF, PI, Depression, and UE scores from baseline to 6 weeks after splinting/hand therapy. *Significant change ($P < 0.05$) compared to baseline.

Table 4. Demographics

	Nonreturning Splinting/Hand Therapy
Mean age (± SD), y	60.6 ± 11.5
Male	14 (28%)
Female	36 (72%)
White	48 (96%)
Black	1 (2%)
Other/unknown	1 (2%)
Not Hispanic or Latino	48 (96%)
Hispanic or Latino	1 (2%)
Unknown	1 (2%)
Mean BMI (± SD)	27.05 ± 5.9

Table 5. PROMIS Physical Function, Pain Interference, Depression and Upper Extremity for Patients with Carpometacarpal Thumb Arthritis

Mean Outcome Measure (Mean± SD)	Nonreturning Splinting and/or Hand Therapy: Baseline
PROMIS Physical Function	48.04 ± 8.21
PROMIS Pain Interference	55.03 ± 5.68
PROMIS Depression	46.88 ± 9.34
PROMIS Upper Extremity	41.92 ± 8.25

appointment for their thumb arthritis. Complete demographic and mean PROMIS PF, PI, Depression, and UE Scores are included in Tables 4 and 5 for this group. When comparing to the baseline scores of the returning group, the nonreturning group had a higher mean PF score ($P = 0.11$) and a lower mean PI score ($P = 0.05$). In addition, the nonreturning cohort demonstrated a lower mean Depression score ($P = 0.96$) and a higher mean UE score ($P = 0.06$). Compared to the corticosteroid injection

cohort at baseline, the nonreturning splinting/hand therapy group had higher mean PF and UE scores ($P = 0.01$; $P = 0.05$), and lower PI and Depression scores ($P < 0.001$; $P = 0.61$).

DISCUSSION

Patient-reported outcome measurements (PROMs) such as PROMIS are being increasingly emphasized as we transition toward rewarding value within healthcare and to a pay-for-performance healthcare environment.[1,8] In addition, PROMs are being adopted in orthopedics as a metric to assess quality of care and cost-effectiveness, and may be used to determine financial reimbursement rates for healthcare providers.[3] Barriers to traditional PROM instruments include how reliably an instrument captures the outcomes of interest, how to compare scores between patient populations, and how to reduce patient and administrative burdens associated with legacy PROMs.[3] The NIH developed PROMIS to improve patient reporting in an efficient and precise method that could be applied across all of healthcare. A key advantage of PROMIS is its use of CAT, which is a probability-based algorithm that delivers successive questions based on previous answers. This enables a high level of precision using fewer questions than traditional PROMs.[3,9] However, the current literature underscores the importance of validating PROMIS in specific disease processes and populations.[8] We sought to evaluate the trajectory of PROMIS outcomes following two different conservative treatments for thumb CMC arthritis: corticosteroid injection or splinting/hand therapy.

For patients who received an intra-articular corticosteroid injection for their thumb CMC arthritis, their follow-up visit showed improvement in mean PI and Depression scores at 6 weeks postinjection ($P = 0.04$ and $P = 0.005$), but no significant improvement in PROMIS PF or PROMIS UE scores 6 weeks postinjection ($P = 0.36$; $P = 0.37$). Interestingly, in another study of 831 patients who had undergone common hand surgeries (ie, ganglion excision, A-1 pulley release, carpal tunnel release, trapeziometacarpal arthroplasty), Crijn's et al had found that postsurgical (3–8 weeks) PROMIS PF scores were associated with lower PI and Depression scores. Although we noted a significant decrease in PROMIS PI and Depression scores after corticosteroid treatment, the mean improvement in PF scores 6 weeks postinjection was small. The mean improvement in PF scores (+0.68) did not reach the minimal clinically important difference for PROMIS PF found within the literature for thumb CMC arthritis, which has been reported as 3.9 points using an anchor-based estimate and 3.5 points using a distribution-based estimate.[10] A recent systematic review of intra-articular corticosteroid injection for management of trapeziometacarpal arthritis concluded that corticosteroid injections can lead to a reduction in pain and improved function in the first 1–3 months postinjection.[11–14] For instance, Heyworth et al conducted a randomized controlled trial comparing hylan, corticosteroid injection, and placebo for the treatment of basal joint arthritis.[15] For the steroid injection group, there was a significant decrease in pain as measured by the VAS scale between baseline and weeks 2 and 4, but an increase in weeks 4 and 12.[15] Meanwhile, Joshi et al noted overall that there was a significant decrease in the VAS pain score from 6.7 at baseline to 3.7 at 1 month after corticosteroid injection.[16] At 3, 6, and 12 months, however, there was no significant change found.[16]

When we similarly analyzed the returning splinting/hand therapy cohort, compared to their baseline visit, there were no significant improvements in any PROMIS domain at 6 weeks posttreatment. Moreover, Tsehaie et al investigated predictive outcome factors after hand orthosis and hand therapy for thumb CMC osteoarthritis patients.[17] This study included 809 patients who received 6 weeks of splinting for nearly 24 hours a day with hand therapy followed by another 6 weeks of splinting only during heavy activities with continued hand therapy.[17] They found that there was a significant improvement in satisfaction (from 41 at baseline to 56 at 3 months) and a significant decrease in pain (from 49 at baseline to 40 at 3 months) based on the VAS scores.[17] Meanwhile, Spaans et al[14] conducted a systematic review of 35 studies on the conservative treatment of thumb base osteoarthritis. They concluded that based on the current literature, hand therapy seems to provide some pain reduction for patients with thumb CMC arthritis.[14] In addition, they analyzed data from ten randomized controlled trials on the effect of orthoses and determined that orthoses can reduce pain, but do not alter function, strength, or dexterity for thumb CMC arthritis patients.[14] Based on the current literature, PROMIS may be insufficiently sensitive to detect improvement in thumb CMC patients after 6 weeks of conservative treatment with hand therapy and/or splinting. Alternatively, the changes may be small, and we need a substantially larger cohort to determine if a real change exists.

Other studies have used PROMIS instruments to evaluate patients with thumb CMC arthritis. Phillips et al[8] reported that for patients with thumb basilar joint arthritis, PROMIS UE had good to excellent correlation with the quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) and good correlation with Patient-Rated Wrist Hand Evaluation and Thumb Disability Examination (TDX). In addition, PROMIS UE was found to be significantly less time consuming and required fewer questions compared to the current instruments.[8] In a recent study by Beleckas et al,[2] the authors analyzed PROMIS PF and PI scores from 1471 consecutive new adult patient clinic visits with one of five common nontrauma hand conditions. Within this study, the average new patient presenting to the hand clinic for thumb CMC osteoarthritis had a PF score of 45.9 (SD = 8.1) and a PI score of 60.0 (SD = 6.0). These presenting scores are similar to the mean baseline PF score of our returning splinting/hand therapy cohort and to the baseline mean PI score of our corticosteroid injection group.

Our study has limitations. First, this is a retrospective study performed at one academic institution, and, therefore, may not be generalizable to all populations. In addition, our patients were predominantly women and White, which is

reflective of not only our practice, but demographics of those with thumb CMC arthritis overall, but may be different from other groups. Our study focused on the trajectory of PROMIS scores in the early posttreatment period, while other studies analyzed patient outcomes up to 1 year. In addition, patients were given intra-articular corticosteroid injections within the office of one of eight hand surgeons. Although this has the potential to create variability in our data, it reflects the reality of a department's experience of treatment of patients with thumb CMC arthritis. We have fewer completed PROMIS UE and health status questionnaires since they were added later than other PROMIS instruments.

PROMs are increasingly being emphasized to assign value to care, given the current trend toward pay-for-performance health care.[8] PROMIS PI can be used to monitor improvement in thumb CMC arthritis patients after corticosteroid injection. However, PROMIS scores are likely not sensitive enough to detect improvement in thumb CMC arthritis patients after conservative treatment with hand therapy and/or splinting. We accepted our null hypothesis as there was not a significant improvement in PF or UE function following initial nonsurgical treatment for thumb CMC arthritis. Health policy and payor stakeholders should consider this data showcasing the limitation of PROMIS instruments to capture short term improvement after nonoperative treatment of CMC thumb arthritis.[1]

Warren C. Hammert, MD
Department of Orthopaedic Surgery
Division of Hand Surgery
Duke University Medical Center
Durham, NC
E-mail: warren.hammert@duke.edu

REFERENCES

1. Bernstein DN, Englert CH, Hammert WC. Evaluation of PROMIS' ability to detect immediate postoperative symptom improvement following carpal tunnel release. *J Hand Surg Am.* 2021;46:445–453.
2. Beleckas CM, Gerull W, Wright M, et al. Variability of PROMIS scores across hand conditions. *J Hand Surg Am.* 2019;44:186–191.e1.
3. Brodke DJ, Saltzman CL, Brodke DS. PROMIS for orthopaedic outcomes measurement. *J Am Acad Orthop Surg.* 2016;24:744–749.
4. Döring AC, Nota SP, Hageman MG, et al. Measurement of upper extremity disability using the patient-reported outcomes measurement information system. *J Hand Surg Am.* 2014;39:1160–1165.
5. Bykerk VP. Patient-reported outcomes measurement information system versus legacy instruments: are they ready for prime time? *Rheum Dis Clin North Am.* 2019;45:211–229.
6. Pickrell BB, Eberlin KR. Thumb basal joint arthritis. *Clin Plast Surg.* 2019;46:407–413.
7. Higgenbotham C, Boyd A, Busch M, et al. Optimal management of thumb basal joint arthritis: challenges and solutions. *Orthop Res Rev.* 2017;9:93–99.
8. Phillips JLH, Warrender WJ, Lutsky KF, et al. Evaluation of the PROMIS upper extremity computer adaptive test against validated patient-reported outcomes in patients with basilar thumb arthritis. *J Hand Surg Am.* 2019;44:564–569.
9. Crijns TJ, Bernstein DN, Ring D, et al. Depression and pain interference correlate with physical function in patients recovering from hand surgery. *Hand (N Y).* 2019;14:830–835.
10. Lee DJ, Calfee RP. The minimal clinically important difference for PROMIS physical function in patients with thumb carpometacarpal arthritis. *Hand (N Y).* 2021;16:638–643.
11. Fowler A, Swindells MG, Burke FD. Intra-articular corticosteroid injections to manage trapeziometacarpal osteoarthritis-a systematic review. *Hand (N Y).* 2015;10:583–592.
12. Riley N, Vella-Baldacchino M, Thurley N, et al. Injection therapy for base of thumb osteoarthritis: a systematic review and meta-analysis. *BMJ Open.* 2019;9:e027507.
13. Shridhar V, Williams S. Basal thumb arthritis: treatment strategies for managing pain. *Aust J Gen Pract.* 2020;49:702–706.
14. Spaans AJ, van Minnen LP, Kon M, et al. Conservative treatment of thumb base osteoarthritis: a systematic review. *J Hand Surg Am.* 2015;40:16–21 e1-6.
15. Heyworth BE, Lee JH, Kim PD, et al. Hylan versus corticosteroid versus placebo for treatment of basal joint arthritis: a prospective, randomized, double-blinded clinical trial. *J Hand Surg Am.* 2008;33:40–48.
16. Joshi R. Intraarticular corticosteroid injection for first carpometacarpal osteoarthritis. *J Rheumatol.* 2005;32:1305–1306.
17. Tsehaie J, Spekreijse KR, Wouters RM, et al; Hand-Wrist Study Group. Predicting outcome after hand orthosis and hand therapy for thumb carpometacarpal osteoarthritis: a prospective study. *Arch Phys Med Rehabil.* 2019;100:844–850.