Preoperative Patient-Centric Predictors of Postoperative Outcomes in Patients Undergoing Arthroscopic Meniscectomy

Sreten Franovic, M.S., B.S., Noah A. Kuhlmann, M.S., B.S., Alex Pietroski, B.S., Collin T. Schlosser, B.S., Brendan Page, B.S., Kelechi R. Okoroha, M.D., Vasilios Moutzouros, M.D., and Eric C. Makhni, M.D., M.B.A.

Purpose: To determine the minimal clinically important difference (MCID) using Patient-Reported Outcome Measurement Information System (PROMIS) computer-adaptive testing assessments in patients undergoing arthroscopic partial meniscectomy. The secondary purpose was to identify which preoperative patient factors are associated with MCID achievement. **Methods:** Three PROMIS computer-adaptive testing assessments (Physical Function [PF], Pain Interference [PI], and Depression [D]) were administered to all patients presenting to 1 of 2 board-certified, sports medicine orthopaedic surgeons. Patients with Current Procedural Terminology codes of 29880 or 29881 were chart reviewed for a host clinical and demographic factors. PROMIS scores were assessed for improvement and patient characteristics were assessed for influence on any improvement. MCID was calculated according to the distribution methodology and receiver operating characteristics were used to assess preoperative scores predictive ability. **Results:** In total, 166 patients met inclusion criteria (58 exclusions). Postoperative PROMIS-PF (45.6), PROMIS-PI (54.6), and PROMIS-D (44.1) significantly improved at least 3 months after surgery when compared with baseline ($P = .002$). MCID values for PROMIS-PF, PROMIS-PI, and PROMIS-D were 3.5, 3.3, and 4.4, respectively. Individuals with PROMIS-PF scores below 34.9 yielded an 82% probability of achieving MCID, while PROMIS-PI scores above 67.5 yielded an 86% probability of achieving MCID and a cutoff of 58.9 for PROMIS-D yielded a 60% probability of achieving MCID, with 90% specificity. **Conclusions:** PROMIS scores, obtained preoperatively, were shown to be valid predictors of postoperative clinical improvement in patients undergoing meniscectomy. Our findings suggest that patients with physical function scores of 34.9 or less have an increased probability of reaching a minimal clinically important difference. Similarly, patients with pain interference scores of 67.5 and above have increased probability of reaching MCID for pain interference. These cutoffs may be used by physicians to aid in the counseling of patients considering arthroscopic meniscectomy. **Level of Evidence:** IV, Case Series.

Arthroscopic meniscectomy has faced scrutiny by some orthopaedic surgeons and researchers due to its variable capacity for improvement of patients' physical function. While some studies using patient-reported outcome measures (PROMs) have shown it to be an effective and minimally invasive solution for patients with symptomatic torn knee cartilage that did not respond to nonoperative treatment,[1] other studies in the literature have raised questions regarding the comparative success when other conservative measures are considered, or even when compared with sham surgery.[2,3] Currently, there is an unclear standard, for orthopaedic surgeons, on how to identify which patients may benefit from meniscus surgery.[4] Therefore, precise indications of this surgery, especially in the setting of concomitant degenerative joint disease, should be defined.

Measuring patient-reported outcomes for orthopaedic procedures has become efficient and reliable through the National Institutes of Health Patient-Reported Measurement Information System (PROMIS) survey. PROMIS has been validated among a host of orthopaedic procedures and specifically has shown the

Henry Ford Health System, Detroit, Michigan, U.S.A.

The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received January 21, 2020; accepted October 16, 2020.

Address correspondence to Eric C. Makhni, M.D., M.B.A., Henry Ford Health System, 2799 W Grand Blvd., Detroit, MI 48202. E-mail: Emakhni1@hfhs.org

0749-8063/2092/$36.00

https://doi.org/10.1016/j.arthro.2020.10.042

capacity to reliably measure and discriminate between various lower-extremity procedures.[1-7] The efficiency of PROMIS comes from using item response theory in its computer adaptive test (CAT) version, which allows for patients to be asked fewer questions without compromising reliability or accuracy of assessing patient-reported outcomes.[5,6] Also important to note, PROMIS provides a host of different health domain measures to allow for multidisciplinary evaluation of patients with respect to their physical function, pain interference (the measurable detriment of pain to the patient's quality of life), and mental health.

The purpose of this study was to determine the minimal clinically important difference (MCID) using PROMIS CAT assessments in patients undergoing arthroscopic partial meniscectomy. The secondary purpose was to identify which preoperative patient factors are associated with the achievement of MCID. We hypothesized that poor preoperative physical function and pain levels would increase the likelihood of achieving MCID following surgery.

Methods

Institutional review board approval was obtained before the onset of data collection. From July 2017 to July 2019, 3 PROMIS CAT forms were prospectively collected from patients presenting to 2 different board-certified, sports medicine orthopaedic surgeons. PROMIS CAT forms were collected at 2 time points: at the preoperative and 3-month postoperative time points. Patients were identified using Current Procedural Terminology codes 29880 and 29881. Exclusion criteria for this study included the failure to complete PROMIS forms postoperatively, concomitant surgery (identified by any additional Current Procedural Terminology codes), age younger than 40 years, or the inability to communicate in the English language.

PROMIS domains analyzed in this study included PROMIS Physical Function v2.0, PROMIS Pain Interference v1.1, and PROMIS Depression v1.0. These CAT forms were administered on iPad devices (Apple Inc., Cupertino, CA) using an electronic, secure platform for recording PROMIS CAT forms (REDCap, Vanderbilt University, Nashville, TN). These domains have previously demonstrated validity when compared with other legacy PROMs.[7,8] The CAT algorithm present in these 3 PROMIS domains standardized T scores according to a reference population, providing a mean score of 50 and a standard deviation of 10. It is also important to note, while an increase in PROMIS-Physical Function (PF) demonstrates an increase in physical function and increase in PROMIS- Pain Interference (PI) or PROMIS-Depression (D) demonstrates an increase in the interference of pain on quality of life and an increase in measurable depression, respectively. All PROMIS surveys were administered by 1 of 3 research assistants working alongside the physician.

Patient charts were reviewed for demographics and comorbidities and are outlined in Table 1. Osteoarthritis (OA) grade (0-5) was gleaned from written radiologic reports; greatest values were recorded. All data were summarized with counts, means, standard deviations, and ranges. Median household income (MHI) was calculated, using a previously documented method,[9] based on the ZIP code of residence

Table 1. Patient Characteristics

Variable	Mean ± SD/n	Value
Age*	55.2 ± 8.0	(40-74)
BMI*	31.5 ± 6.3	(18.6-50.7)
MHI*	$68,574 ± 21,882	(25,951-134,283)
Time to surgery, d*	29.6 ± 36.9	(112-0)
Time to physical therapy, d*	11.7 ± 6.0	(3-41)
Sex		
Male†	85	51%
Female†	81	49%
Race†		
White	125	75%
Black/African-American	21	13%
Asian	10	6%
Other	10	6%
Smoking status†		
Never smoker	106	64%
Former smoker	40	24%
Current smoker	120	12%
Osteoarthritis grade†		
0	13	8%
1	12	7%
2	43	26%
3	58	35%
4	40	24%
Heart disease†		
Yes	17	10%
No	149	90%
Kidney disease†		
Yes	15	9%
No	151	91%
Liver disease†		
Yes	17	10%
No	149	90%
Hypertension†		
Yes	56	34%
No	110	66%
Diabetes mellitus†		
Yes	27	16%
No	139	84%
ASA status		
1	20	12%
2	113	68%
3	33	20%
Laterality		
Medial	100	60%
Lateral	36	22%
Both	30	18%

ASA, American Society of Anesthesiologists; BMI, body mass index; MHI, median household income; SD, standard deviation.
*Values are expressed as mean ± SD (min-max).
†Values are expressed as number (percentage).

according to the United States Bureau website for MHI estimations. (https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml?src=bkmk).

Statistical Analysis

Descriptive statistics for all data collected, such as counts, means, and standard deviations, are listed in Table 1. Paired-Samples *t* tests were used to identify significant differences among preoperative and postoperative PROMIS domains. MCID values were calculated using the well-defined distribution-based method.[10,11] With this method, MCID values are derived from taking the standard deviation of the preoperative sample and dividing by 2. While other methods, such as anchor-based, provide a means for direct patient-input in their clinical improvement, there still remains uncertainty as to what is the best question for this approach.[12,13] Furthermore, anchor-based calculations are not suitable for populations in which high post-treatment satisfaction occurs[14,15] One-way analysis of variance (ANOVA) was used to identify differences in delta-PROMIS (change in score from preoperative to postoperative timepoints) based on all categorical variables collected. Least significant difference post hoc tests were then used to analyze specific differences between groups with statistically significant variance. Pearson χ^2 tests were used to identify differences in MCID achievement rate among categorical variables. Categorical variables are denoted in Table 1 by footnote †. Age, MHI, time to physical therapy and time to surgery were all treated as binary categorical variables using their mean values as cutoffs, whereas 30 was as a binary cutoff for obesity in body mass index (BMI). OA was assessed in 2 ways: 5 separate categories (0-4) and binarily. The binary assessment of OA was used to delineate none-to-minimal (0-2) and moderate-to-severe (3-4) grades.

Using our derived MCID values for each PROMIS domain, receiver operating characteristic (ROC) curves were generated to assess the predictive ability of each respective preoperative PROMIS domain. Area under the curve (AUC) analysis was used to determine the efficacy of these predictors, with values of 0.6 to 0.69 defined as moderate predictive ability, 0.7 to 0.79 defined as strong predictive ability, and >0.8 defined as having excellent predictive ability.[16] Corresponding *P* values for testing the hypothesis that AUC was 0.5 (no discriminatory ability) were computed. Coordinate points of the ROC curve were assessed to find preoperative cutoff scores that maximize MCID achievement, using 90% specificity. Similarly, coordinate plots were used to determine scores that would maximize failure to achieve MCID. Percentages of patients achieving MCID, or failing to achieve MCID, with and without these cutoffs were reported.

Finally, a multivariate model was assessed for its ability in predicting MCID achievement. For the multivariate model, a binary logistic regression was used to create an associated probability variable for achievement of MCID. Other than respective preoperative PROMIS *t* scores, only variables that showed association delta-PROMIS scores or achievement of MCID, through aforementioned ANOVA and χ^2 tests, were included in multivariate analysis. Once probability variables were generated, these were subject to ROC and AUC analysis.

All analyses used a significance level of 5%. SPSS software was used for all statistical analyses (Released 2017. IBM SPSS Statistics for Windows, Version 25.0; IBM Corp., Armonk, NY).

Results

After the removal of 58 patients due to exclusion criteria (10 with concomitant surgery, 18 with incomplete PROMIS surveys, 30 younger than the age of 40 years), a total of 166 patients met the inclusion criteria for the study. The patient cohort included 85 male (51%) and 81 female (49%) patients, aged 55.2 ±8.2 years (mean ± standard deviation, range 40-74 years). Further summary statistics for patient demographics and patient clinical history are detailed in Table 1. Mean preoperative scores for PROMIS-PF, PROMIS-PI, and PROMIS-D were 39.1 ± 7.2, 62.8 ± 6.6, and 47.7 ± 10.5, respectively. All 3 domains showed statistically significant improvement at minimum 3 months' follow-up ($P < .001$). Distribution-based MCID values for PROMIS-PF, PROMIS-PI, and PROMIS-D were determined to be 3.5, 3.3, and 4.4, respectively (Table 2).

ANOVA was only statistically significant for 2 variables assessed: smoking status and OA. Smoking status showed significant differences in delta-PROMIS scores for both PF and PI, with "never smokers" displaying significantly greater improvements than "former smokers" or "current smokers" ($P < .048$, $P < .035$). Similarly, Independent samples *t* tests revealed that none-to-minimal grades of OA displayed significantly less improvement in PROMIS-PF and PROMIS-PI than moderate-to-severe grades ($P = .020$, $P = .037$). Interestingly, when comparing those with (≥30 BMI) and without obesity (<30 BMI), significantly different

Table 2. PROMIS Domain Change Over Time

PROMIS Domain	PROMIS Score, Mean (SD)		Change in Score	MCID
	Preoperative	Postoperative		
Physical Function	39.1 (7.2)	45.1* (7.4)	+6.0	3.6
Pain Interference	62.8 (6.6)	55.0* (8.6)	−7.8	3.3
Depression	47.7 (10.5)	44.3* (10.0)	−3.4	5.3

*$P < .01$.

preoperative ($P = .016$, $P = .011$) and postoperative ($P = .005$, $P < .001$) PROMIS-PF and PI scores were identified, yet this was not found for difference in delta-PROMIS ($P = .721$, $P = .203$). Similarly, Pearson χ^2 tests showed significant difference in MCID achievement among smoking statuses ($P = .043$) and binary OA groups ($P = .031$). No other clinical or demographic factor showed significant influence on delta-PROMIS or MCID achievement.

ROC analysis, using the univariate model, revealed that preoperative PROMIS-PF and PI possess strong abilities to predict postoperative achievement of MCID, whereas PROMIS-D possesses an excellent ability to predict postoperative achievement of MCID. The ROC curves displayed AUCs of 0.74, 0.76, and 0.82 for PROMIS-PF, PI, and D, respectively ($P < .01$, Table 3). Before establishing prognostic cutoffs, a post hoc analysis was conducted to identify the percentage of patients, in our cohort, that achieved MCID at minimum 3 months' follow-up. This showed 60% of patients achieving MCID for PROMIS-PF, 66% achieving MCID for PROMIS-PI, and 40% achieving MCID for PROMIS-D (Table 4). Using coordinate plots from our ROC curves, 90% specificity cutoffs were identified for both achieving and failing to achieve MCID (Table 4). Of patients with a preoperative PROMIS-PF score of <35.1, 83% achieved MCID. Similarly, of patients with a preoperative PROMIS-PI score of >67.6, 92% achieved MCID. Finally, of patients with a preoperative PROMIS-D score of >55.5, 74% achieved MCID. Further details including percentage of patients failing to achieve MCID are presented in Table 4. Scatter plots of patients achieving MCID can be visualized in Figs 1-3.

Finally, the 2 variables that displayed significant impact on either delta-PROMIS scores or MCID achievement (smoking status and binary OA grade) were included with respective PROMIS domain scores to create a multivariate model of predicting MCID achievement. The addition of these 2 variables to the respective preoperative PROMIS *t* score increased the predictive ability of all 3 domains (Table 3). Being a "never smoker" yielded a 13.7 times greater likelihood of achieving PROMIS-PF MCID than those that are "current smokers." Similarly having none-to-minimal OA resulted in a 3.3 times greater likelihood of achieving PROMIS-PF MCID than having moderate-to-severe OA. Complete results of the binary logistic regression are displayed in Table 5.

Discussion

The results of this study demonstrate that patients undergoing meniscectomy experience significant improvements in PROMIS CAT scores for PROMIS-PF, PROMIS-PI, and PROMIS-D, at 3 months' postoperative. MCID following arthroscopic meniscectomy was determined to be 3.5, 3.3, and 4.3, in PROMIS-PF, PROMIS-PI, and PROMIS-D. In particular, patients with baseline scores of 34.9, 67.5, and 58.9, on PROMIS-PF, PROMIS-PI, and PROMIS-D were especially likely to achieve MCID following surgery. No other independent patient-centric factors showed significant involvement in achievement of MCID for our patient cohort.

The current literature regarding clinically significant outcomes following knee surgery using PROMIS domains is sparse. Hung et al.[17] evaluated MCID in PROMIS-PF, using a distribution-based method, for 2226 patients undergoing knee or hip joint reconstruction. Their determined value of 4.35 was deemed by the authors as greater than average, likely due to the varying time points they used for their calculations. Similarly, Okoroha et al.[18] recently defined MCID in 73 patients undergoing arthroscopic meniscectomy using PROMIS scores. Their study found that an improvement in PROMIS-PF score of 2.09 following arthroscopic meniscectomy is clinically significant for a patient, although this was done with anchor-based methodology. Forty-four percent of patients in their study achieved MCID at 6 months postoperatively. Their study presented with a preoperative standard deviation of 9, which would suggest a distribution-based MCID of 4.5 for PROMIS-PF. Our study defined MCID following meniscectomy in a larger cohort of patients (135) while evaluating additional PROMIS domains. MCID values for PROMIS-PF, PROMIS-PI, and PROMIS-D for patients undergoing arthroscopic meniscectomy where found to be 3.5, 3.3, and 4.3, respectively. Sixty-two percent of the current cohort achieved MCID for PROMIS-PF, at 3 months' post-surgery. Similarly, 92 patients (68%) achieved MCID

Table 3. Predictive Ability of Preoperative PROMIS Domains

	Univariate Analysis			Multivariate Analysis		
PROMIS Domain	AUC	*P* value	Predictive Ability	AUC	*P* value	Predictive Ability
Physical Function	0.74	<.01	Strong	0.82	<.01	Excellent
Pain Interference	0.76	<.01	Strong	0.80	<.01	Excellent
Depression	0.82	<.01	Excellent	0.87	<.01	Excellent

MCID, minimal clinically important difference; PROMIS, Patient-Reported Outcomes Measurement Information System.
AUC, area under curve; PROMIS, Patient-Reported Outcomes Measurement Information System.

Table 4. PROMIS Domain Prognostic Cutoffs for Achievement of MCID

PROMIS Domain	MCID Achievement	90% MCID Cutoff	MCID Achievement After Cutoff	No MCID Achievement	90% MCID Cutoff	No MCID Achievement After Cutoff
Physical Function	60%	≤35.1	83%	40%	≥44.7	71%
Pain Interference	66%	≥67.6	92%	34%	≤58.1	72%
Depression	40%	≥55.5	74%	60%	≤44.9	91%

MCID, minimal clinically important difference; PROMIS, Patient-Reported Outcomes Measurement Information System.

for PROMIS-PI and 55 patients (41%) achieved MCID for PROMIS-D. Comparatively, our distribution-derived PROMIS-PF MCID value falls between both the anchor-based (2.09) and distribution-based (4.5) values from the aforementioned study, although our results provide a clinically significant difference in PROMIS-PF in a larger subset of patients while additionally defining MCID for PROMIS-PI and PROMIS-D.

Previous studies have demonstrated improvement of PROMIS domains following lower-extremity orthopaedic surgeries.[11,19] Bernholt et al.[20] demonstrated statistically significant improvements of PROMIS-PF, PROMIS-PI, and PROMIS-D in 75 patients undergoing arthroscopic meniscectomy at 6-weeks postoperatively. The present study extends the clinical window of Bernholt et al.'s work and presents even greater improvement as early as 3 months after surgery. Interestingly, these findings suggest that arthroscopic meniscectomy may be a useful intervention in patients presenting with symptomatic meniscal tears. While other studies have raised controversy regarding meniscectomy in comparison with nonoperative measures or sham surgery,[2,3] the current study presents data illustrating statistically significant patient-reported increases in physical function, as well as decreases in pain and depression as little as 3-months after surgery. Although our study was not a clinical trial that compared meniscectomy treatment with sham surgery or absence of surgery, so these improvements must only be taken at face value.

Previous orthopaedic research efforts have pioneered the effort in demonstrating the influence of preoperative patient factors on postoperative PROMIS scores.[10,11,19,21,22] Chen et al.[10] introduced analysis of both univariate and multivariate predictive models for assessing probability of achieving MCID in patients undergoing total shoulder arthroplasty. While the multivariate model they presented included patient-centric factors such as age, sex, BMI, and American Society of Anesthesiologists score, our study focused on fewer variables. Although many independent patient-centric factors failed to show significant influence of postoperative MCID achievement, both OA and smoking status did show influence on PROMIS score improvement. Furthermore, when these 2 variables were added to our multivariate model, the present study saw predictive ability increases in all 3 PROMIS domains. Univariate models showed strong-to-excellent predictive ability whereas multivariate models displayed excellent abilities to predict which patients would achieve MCID in all 3 domains,

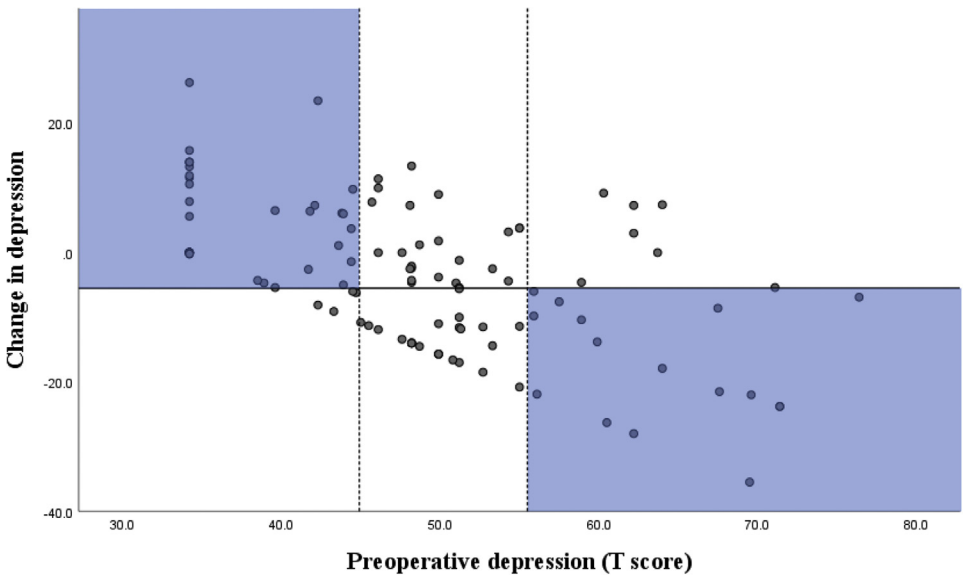

Fig 1. Change in Physical Function is plotted against preoperative physical function t scores. Horizontal solid line indicates MCID value (3.5) and vertical dashed lines represent prognostic cutoffs for achieving MCID (≤34.9) and failing to achieve MCID (≥44.8). Blue-shaded areas represent patients who achieved MCID (upper left) and those who did not achieve MCID (bottom right). To note: one dot may correspond to one or more data points. (MCID, minimal clinically important difference.)

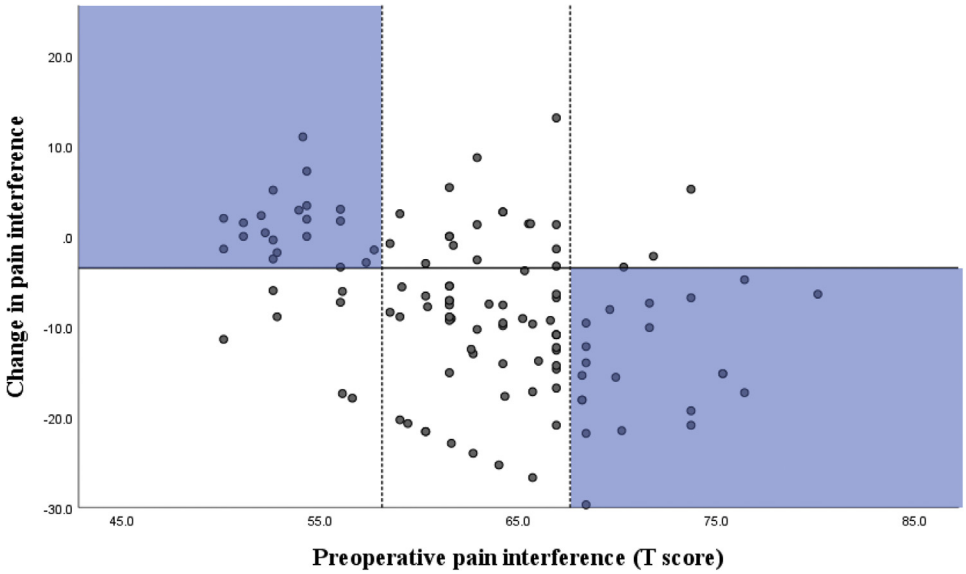

Fig 2. Change in Pain Interference is plotted against preoperative pain interference t scores. Horizontal solid line indicates MCID value (3.3) and vertical dashed lines represent prognostic cutoffs for achieving MCID (≥67.5) and failing to achieve MCID (≤56.0). Blue-shaded areas represent patients who achieved MCID (bottom right) and those who did not achieve MCID (upper left). To note: one dot may correspond to one or more data points. (MCID, minimal clinically important difference.)

suggesting significant involvement of OA and smoking status in the patient's ability to achieve positive outcomes after orthopaedic intervention. While many surgeons may already consider OA in their counseling of patients, this study has shown that smoking history may also contribute to predicting patient's postoperative outcomes. The present study has also provided a means for physicians to counsel patients on the increased likelihood relative of failing to achieve MCID relative to OA and smoking history (Table 5).

With the 90% specificity MCID cutoffs presented in Table 4, surgeons can now supplement their counseling of patients to reflect values based on their preoperative scores. For example, one can picture a scenario in which a patient presents to the clinic with severely limited knee function and persistent pain, with magnetic resonance imaging identifying a meniscal tear, and PROMIS-PF, -PI, and -D scores of 32.4, 60.1, and 44.1, respectively. The surgeon may initially reference the extent of the meniscal tear and any grade of OA in his or her discussion of operative treatment and the patient may elect to go forward with surgery. The patient may then inquire on his or her outcomes after surgery, in reference to his or her knee functioning and pain. With the information in Table 4, one can see that the patient's PROMIS-PF score of 32.4 falls under the

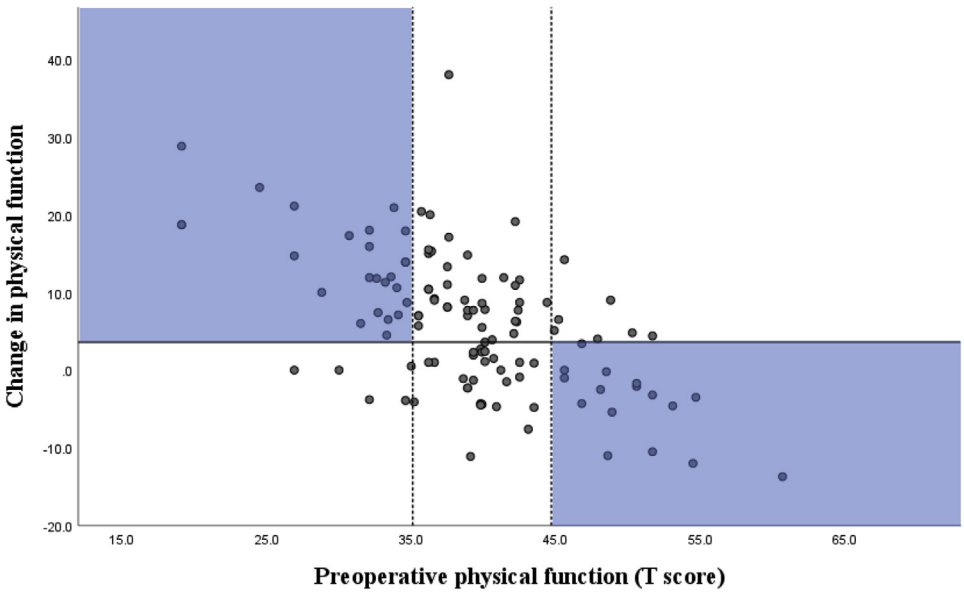

Fig 3. Change in Depression is plotted against preoperative depression t scores. Horizontal solid line indicates MCID value (4.5) and vertical dashed lines represent prognostic cutoffs for achieving MCID (≥58.9) and failing to achieve MCID (≤44.6). Blue-shaded areas represent patients who achieved MCID (bottom right) and those who did not achieve MCID (upper left). To note: one dot may correspond to one or more data points. (MCID, minimal clinically important difference.)

Table 5. Odds Ratios for Achievement of MCID

Dependent Variable	Covariates	Exp (B)	Sig.	Confidence Interval	
				Lower	Upper
Achievement of PROMIS-PF MCID					
	Preoperative PROMIS-PF	0.813	0.000	0.742	0.891
	OA (0-2)	3.259	0.015	1.253	8.478
	OA (3-4)	—	—	—	—
	Never smoker	13.671	0.001	2.886	64.768
	Former smoker	5.246	0.044	1.042	26.410
	Current smoker	—	—	—	—
Achievement of PROMIS-PI MCID					
	Preoperative PROMIS-PF	1.21	0.000	1.112	1.305
	OA (0-2)	1.53	0.035	0.621	3.781
	OA (3-4)	—	—	—	—
	Never smoker	5.38	0.019	1.333	21.853
	Former smoker	2.96	0.0126	0.616	14.166
	Current smoker	—	—	—	—
Achievement of PROMIS-D MCID					
	Preoperative PROMIS-PF	1.213	0.000	1.125	1.307
	OA (0-2)	1.587	0.171	0.576	4.372
	OA (3-4)	—	—	—	—
	Never smoker	7.315	0.028	1.237	43.270
	Former smoker	0.776	0.394	0.115	5.212
	Current smoker	—	—	—	—

NOTE. Dashes (—) denote reference variable.

D, Depression; Exp(B), exponentiation of beta coefficient; MCID, minimal clinically important difference; OA, osteoarthritis; PF, Physical Function; PI, Pain Interference; PROMIS, Patient-Reported Outcomes Measurement Information System; Sig., significance.

90% prognostic cutoff for achieving MCID (35.1). Thus, the surgeon can suggest that the patient has a heightened likelihood of experiencing significant clinical improvement in the functioning of his knee, and that 8 of 10 patients with similar levels of function experience significant clinical improvement at 3 months. However, the patient's PROMIS-PI score of 60.1 falls in between the 90% prognostic cutoffs for achieving and failing to achieve MCID (67.6 and 58.1), therefore limiting the surgeon's predictive ability to ensure the patient will notice a substantial decrease in the interference of pain on his quality of life. Finally, the patient's PROMIS-D score of 50.0 falls under the prognostic cutoff for failing to achieve MCID (44.9), and thus is more likely than not to see no change in his mental health state, due to surgery. In fact, the patient's level of depression is much lower than the national mean and thus his meniscal tear may not have a significant effect on his mental health. Collectively, the surgeon would be able to explain that the patient's preoperative scores suggest a very high likelihood of achieving clinical improvement in knee functioning, a moderate likelihood of achieving clinical improvement in knee pain, and a low likelihood of noticing an improvement in an already-average level of depression impact. The surgeon can then emphasize that the meniscectomy will most likely provide the greatest benefit to the patient's knee functioning while having the possibility of significantly improving the knee pain, as early as 3 months after surgery. These findings will allow the surgeon to counsel the patient more adequately on their current health as well as prognosis for postoperative outcomes.

Limitations

There are several limitations to this study, including potential patient selection bias, early postoperative time frame, and the retrospective nature of the study. Patients who were followed up at 3 months may not be completely representative of the entire meniscectomy cohort. It is possible that those patients who were postoperatively progressing much quicker may have elected to not follow up at 3 months, thus skewing the data. All patients presented to clinics in a metropolitan area and were asked to complete PROMIS surveys if they demonstrated an ability to communicate in English; therefore, results may not be generalizable across the United States or to patient populations that either lack the cognitive ability or understanding of the English language to partake in such surveys. Due to the retrospective nature of this study, the present study was unable to source patient indications for surgery and thus patients undergoing surgery were at the discretion of the 2 aforementioned surgeons. Lastly, our decision to only investigate one method of MCID calculation limits the validity of our outcomes. Distribution-based methods have received criticism in the past due to the unclear nature as to why ½ standard deviation was selected.[23]

Conclusions

PROMIS scores, obtained preoperatively, were shown to be valid predictors of postoperative clinical improvement in patients undergoing meniscectomy. Our findings suggest that patients with physical function scores of 34.9 or less have an increased probability of reaching a minimal clinically important difference. Similarly, patients with pain interference scores of 67.5 and above have increased probability of reaching MCID for pain interference. These cutoffs may be used by physicians to aid in the counseling of patients considering arthroscopic meniscectomy.

References

1. Thorlund JB, Englund M, Christensen R, et al. Patient reported outcomes in patients undergoing arthroscopic partial meniscectomy for traumatic or degenerative meniscal tears: Comparative prospective cohort study [published online February 2, 2017]. BMJ. https://doi.org/10.1136/bmj.j356.
2. Azam M, Shenoy R. The role of arthroscopic partial meniscectomy in the management of degenerative meniscus tears: A review of the recent literature. *Open Orthop J* 2017;10:797-804.
3. Sihvonen R, Paavola M, Malmivaara A, et al. Arthroscopic partial meniscectomy versus sham surgery for a degenerative meniscal tear. *N Engl J Med* 2013;369:2515-2524.
4. van de Graaf V, Bloembergen CH, Willigenburg NW, et al. Can even experienced orthopaedic surgeons predict who will benefit from surgery when patients present with degenerative meniscal tears? A survey of 194 orthopaedic surgeons who made 3880 predictions. *Br J Sports Med* 2020;54:354-359.
5. Papuga MO, Beck CA, Kates SL, Schwarz EM, Maloney MD. Validation of GAITRite and PROMIS as high-throughput physical function outcome measures following ACL reconstruction. *J Orthop Res* 2014;32:793-801.
6. Tyser AR, Beckmann J, Franklin JD, et al. Evaluation of the PROMIS physical function computer adaptive test in the upper extremity. *J Hand Surg Am* 2014;39:2047-2051.
7. Patterson BM, Orvets ND, Aleem AW, et al. Correlation of Patient-Reported Outcomes Measurement Information System (PROMIS) scores with legacy patient-reported outcome scores in patients undergoing rotator cuff repair. *J Shoulder Elbow Surg* 2018;27:S17-S23.
8. Tishelman JC, Vasquez-Montes D, Jevotovsky DS, et al. Patient-Reported Outcomes Measurement Information System instruments: outperforming traditional quality of life measures in patients with back and neck pain [published online February 1, 2019]. J Neurosurg Spine. https://doi.org/10.3171/2018.10.SPINE18571.
9. Day CS, Makhni EC, Mejia E, Lage DE, Rozental TD. Carpal and cubital tunnel syndrome: Who gets surgery? *Clin Orthop Relat Res* 2010;468:1796-1803.
10. Chen RE, Papuga MO, Nicandri GT, Miller RJ, Voloshin I. Preoperative Patient-Reported Outcomes Measurement Information System (PROMIS) scores predict postoperative outcome in total shoulder arthroplasty patients. *J Shoulder Elbow Surg* 2019;28:547-554.
11. Ho B, Houck JR, Flemister AS, et al. Preoperative PROMIS scores predict postoperative success in foot and ankle patients. *Foot Ankle Int* 2016;37:911-918.
12. Carragee EJ, Cheng I. Minimum acceptable outcomes after lumbar spinal fusion. *Spine J* 2010;10:313-320.
13. Glassman SD, Copay AG, Berven SH, Polly DW, Subach BR, Carreon LY. Defining substantial clinical benefit following lumbar spine arthrodesis. *J Bone Joint Surg Am* 2008;90:1839-1847.
14. Leopold SS. Editor's Spotlight/Take 5: Comparative responsiveness and minimal clinically important differences for idiopathic ulnar impaction syndrome (DOI 10.1007/s11999-013-2843-8). *Clin Orthop Relat Res* 2013;471:1403-1405.
15. Shauver MJ, Chung KC. The minimal clinically important difference of the Michigan Hand Outcomes Questionnaire. *J Hand Surg Am* 2009;34:509-514.
16. Hajian-Tilaki K. Receiver operating characteristic (ROC) curve analysis for medical diagnostic test evaluation. *Casp J Intern Med* 2013;4:627-635.
17. Hung M, Bounsanga J, Voss MW, Saltzman CL. Establishing minimum clinically important difference values for the Patient-Reported Outcomes Measurement Information System Physical Function, hip disability and osteoarthritis outcome score for joint reconstruction, and knee injury and osteoarthritis outcome score for joint reconstruction in orthopaedics. *World J Orthop* 2018;9:41-49.
18. Okoroha KR, Lu Y, Nwachukwu BU, et al. How should we define clinically significant improvement on patient-reported outcomes measurement information system test for patients undergoing knee meniscal surgery? *Arthrosc J Arthrosc Relat Surg* 2020;36:241-250.
19. Chen RE, Papuga MO, Voloshin I, et al. Preoperative PROMIS scores predict postoperative outcomes after primary ACL reconstruction [published online May 8, 2018]. Orthop J Sport Med. https://doi.org/10.1177/2325967118771286.
20. Bernholt D, Wright RW, Matava MJ, Brophy RH, Bogunovic L, Smith MV. Patient Reported outcomes measurement information system scores are responsive to early changes in patient outcomes following arthroscopic partial meniscectomy. *Arthroscopy* 2018;34:1113-1117.
21. Tramer JS, Franovic S, Kuhlmann N, et al. Preoperative PROMIS scores predict postoperative improvements following rotator cuff repair. https://scholarlycommons.henryford.com/merf2019clinres/51%0A%0A. Accessed December 26, 2019.
22. Bernstein DN, Fear K, Mesfin A, et al. Patient-reported outcomes use during orthopaedic surgery clinic visits improves the patient experience. *Musculoskeletal Care* 2019;17:120-125.
23. Revicki D, Hays RD, Cella D, Sloan J. Recommended methods for determining responsiveness and minimally important differences for patient-reported outcomes. *J Clin Epidemiol* 2008;61:102-109.