Patient-Reported Outcomes Measurement Information System Captures Clinically Meaningful Improvement After Transtibial Pull-Out Repair of Medial Meniscal Posterior Root Tears: Two-Year Outcomes

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Purpose: To (1) establish cohort-specific minimal clinically important difference (MCID) and patient acceptable symptom state (PASS) thresholds for Patient-Reported Outcomes Measurement Information System (PROMIS) values and legacy knee-specific patient-reported outcome measures (PROMs) after isolated medial meniscal posterior root tear (MMPRT) repair using the transtibial pull-out repair technique; (2) determine achievement rates; and (3) analyze correlations among scores. **Methods:** Patients undergoing primary isolated MMPRT transtibial pull-out repair with preoperative and minimum 2-year postoperative data were analyzed. PROMs included the PROMIS—Pain Interference (PI) score, PROMIS—Physical Function (PF) score, PROMIS—Depression (D) score, Knee Injury and Osteoarthritis Outcome Score Jr (KOOS Jr), and International Knee Documentation Committee (IKDC) score. Paired 2-tailed Student t tests evaluated PROM changes from preoperatively to postoperatively, with the level of significance at $P < .05$. MCID thresholds were determined using the distribution-based method, whereas PASS thresholds were anchor based. Pearson correlation coefficients were used to compare PROM scores. **Results:** Sixty-eight patients (mean age, 57.2 ± 9.7 years; 75.0% female sex; mean body mass index, 32.2 ± 6.1) were included and followed up for 32.9 ± 10.6 months. From preoperatively to final follow-up, all PROMs significantly improved ($P < .05$). The MCID thresholds and achievement rates were 6.5 and 63%, respectively, for the PROMIS-PF score; −5.7 and 69%, respectively, for the PROMIS-PI score; −4.8 and 50%, respectively, for the PROMIS-D score; 10.5 and 87%, respectively, for the IKDC score; and 10.3 and 75%, respectively, for the KOOS Jr. The PASS thresholds and rates were 47.8 and 59%, respectively, for the PROMIS-PF score; 53.6 and 54%, respectively, for the PROMIS-PI score; 40.5 and 49%, respectively, for the PROMIS-D score; 67.7 and 66%, respectively, for the IKDC score; and 72.3 and 66%, respectively, for the KOOS Jr. The strongest correlations were observed between the PROMIS-PI score and the KOOS Jr ($r = -0.687$) and IKDC score ($r = -0.660$). The PROMIS-D score showed the weakest correlations with the KOOS Jr and IKDC score ($r = 0.395$ and $r = -0.399$, respectively). Knee-specific PROMs showed a strong correlation with each other ($r = 0.710$). **Conclusions:** This study establishes cohort-specific MCID and PASS thresholds for the PROMIS subscale scores, IKDC score, and KOOS Jr at a minimum 2-year follow-up after isolated transtibial pull-out MMPRT repair. At 2 years, the MCID and PASS were achieved by 63% and 59% of patients, respectively, for the PROMIS-PF score; 69% and 54%, respectively, for the PROMIS-PI score; and 50% and 49%, respectively, for the PROMIS-D score. For the IKDC score and KOOS Jr, the MCID rates were 87% and 75%, respectively, and the PASS rates were 66% and 66%, respectively. **Level of Evidence:** Level IV, retrospective case series.

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The Patient-Reported Outcomes Measurement Information System (PROMIS) is a system developed by the National Institutes of Health that enhances evaluations in physical, mental, and social health domains and is increasingly used to assess orthopaedic surgery outcomes.[1] By using item response theory in a computer adaptive test (CAT) format, PROMIS streamlines question sequences to reduce survey length and address limitations of legacy measures such as the Knee Injury and Osteoarthritis Outcome Score Jr (KOOS Jr) and the International Knee Documentation Committee (IKDC) score.[2,3] Notably, orthopaedic surgeons most frequently use the PROMIS—Pain Interference (PROMIS-PI) and PROMIS—Physical Function (PROMIS-PF) subscales.[1,4,5] However, considering the increasingly recognized influence of mental health on outcomes of orthopaedic procedures, the PROMIS—Depression (PROMIS-D) subscale has emerged as a valuable metric.[6,7]

All PROMIS measures yield standardized T-scores (mean, 50; standard deviation, 10) that theoretically range from 0 to 100, although most clinical scores span from 20 to 80.[8-10] Higher scores on the PROMIS-PF subscale indicate better function, whereas higher scores on the PROMIS-PI or -D subscale indicate greater symptom severity.[8-11] Raw responses from short forms or CATs are converted into T-scores through PROMIS-specific calibration tables informed by large reference samples. By adaptively selecting items based on previous responses, CATs maximize measurement precision and minimize respondent burden.[8-11]

Contemporary research, exemplified by Vogel et al.,[12] highlights PROMIS as a promising alternative to traditional patient-reported outcome measures (PROMs), particularly in the context of hip arthroscopy. Moreover, a recent systematic review reaffirmed PROMIS' efficacy in assessing patient outcomes across various arthroscopic procedures involving the hip, knee, and shoulder, with the PROMIS-PF subscale showing particularly strong correlations with measures of physical function and quality of life.[13] Although PROMIS scores primarily reflect the function of the targeted joint, they may also be influenced by the overall musculoskeletal health of the patient.[9]

The exploration of PROMIS within orthopaedic research also extends to its role in defining clinically significant outcomes, using cohort-specific minimal clinically important difference (MCID) and patient acceptable symptom state (PASS) thresholds as key indicators.[14,15] These metrics, when tailored to specific study populations, provide a valuable framework for understanding postoperative outcomes by helping to identify the smallest change in patient condition that is perceptible and deemed important and to evaluate whether postoperative symptoms have reached an acceptable level, respectively.[15,16]

Given the evolving recognition of meniscal root tears' significance in knee health and function, as well as their impact on quality of life, the comparison of PROMIS scores with established PROMs in this context is crucial.[17-20] Although previous studies have explored the use of PROMIS after arthroscopic meniscal surgery and indicated its possible superiority over knee-specific legacy PROMs in detecting clinical change, the applicability of PROMIS for meniscal root tear repair remains unexplored.[21] On thorough review, no study has investigated its utility in this context, and neither MCID nor PASS thresholds have been established.

Therefore, the purpose of this study was to (1) establish cohort-specific MCID and PASS thresholds for PROMIS values and legacy knee-specific PROMs after isolated medial meniscal posterior root tear (MMPRT) repair using the transtibial pull-out repair technique; (2) determine achievement rates; and (3) analyze correlations among scores. On the basis of prior investigations,[12] we hypothesized stronger correlations among knee-specific legacy PROM scores than those among PROMIS CAT scores, expecting an overall high achievement rate for the MCID and PASS.

Methods

Study Design

Approval for this study was granted by the institutional review board (No. 23083005-IRB01), with informed consent waived because of its retrospective nature, involving data from patients who underwent MMPRT repair performed by the senior authors (J.C., A.B.Y., B.J.C., N.N.V.). The patients analyzed in this study cohort have not been included in any prior publications. The inclusion criteria consisted of patients who underwent primary isolated MMPRT repair between January 2017 and January 2021, were aged 18 years or older, and had complete preoperative and postoperative PROMs at a minimum 2-year follow-up. The exclusion criteria included patients undergoing revision MMPRT repair, concomitant ligamentous repair or reconstruction, concomitant meniscal repair or meniscectomy, or concomitant bony procedures and patients with a history of ipsilateral knee surgery, a Kellgren-Lawrence (KL) grade of 3 to 4, incomplete PROMs at baseline or final follow-up, or a lack of preoperative posteroanterior flexed knee radiographs and magnetic resonance imaging (MRI).

Demographic Information

Patient demographic information and traits such as age, sex, body mass index, medical and surgical history, and tobacco use were prospectively documented at the initial clinic visit and retrospectively analyzed. On the basis of prior literature, injury chronicity was

categorized as acute if the time interval between injury and repair was less than 12 weeks and chronic if it was 12 weeks or more.[22,23]

Patient-Reported Outcome Measurements

Preoperative and minimum 2-year postoperative scores were prospectively collected and retrospectively analyzed for the PROMIS-PF subscale, PROMIS-PI subscale, PROMIS-D subscale, IKDC tool, and KOOS Jr. The IKDC instrument and KOOS Jr were denoted "legacy PROMs." Ceiling and floor effects were assessed by determining the number of patients who reached the maximum and minimum scores for each PROM. A percentage of 15% or greater was designated as a significant ceiling or floor effect.[24,25] Higher scores on the IKDC tool, KOOS Jr, and PROMIS-PF subscale signified greater functionality. Higher scores on the PROMIS-PI subscale signified greater pain. Higher scores on the PROMIS-D subscale signified greater depression.

Clinical and Radiographic Evaluation

Patients were evaluated for osteoarthritis using standard procedures, including weight-bearing posteroanterior knee radiographs taken at 45° of flexion (Rosenberg view) following the method described by Rosenberg et al.,[26] with grading using the KL system.[27,28] An experienced residency-trained orthopaedic surgeon (F.A.) analyzed the radiographs, measuring joint space width on the Rosenberg view using the midpoint method as described by Ravaud et al.[29] and assessing knee mechanical axis angle via standing mechanical axis radiographs as either varus (>180°) or valgus (<180°).[30] Medial tibial slope was determined from MRI scans using the method described by Hudek et al.,[31] and extrusion of the medial meniscus was measured in millimeters from the medial tibial plateau margin on the coronal cut at the medial femoral condyle midpoint, as outlined by Costa et al.[32] Meniscal width was measured using the method of Lee et al.,[33] and the percentage of extrusion was calculated using the following formula: [(Degree of extrusion [in millimeters])/(Width of meniscus [in millimeters])] × 100.

Surgical Technique and Rehabilitation

Arthroscopic transtibial pull-out repair of MMPRTs was performed by 1 of 4 sports medicine fellowship–trained surgeons (J.C., A.B.Y., B.J.C., N.N.V.). Patients were positioned supine for surgery, received general anesthesia, and underwent a bilateral knee examination. The operative leg was secured with a high-thigh tourniquet and placed in a leg holder, while the nonoperative leg was positioned in an abduction stirrup. A diagnostic arthroscopy was performed through 2 standard parapatellar portals to confirm the presence and extent of the MMPRT, assess adjacent tissues for repair feasibility, and examine the notch and lateral compartment for any additional pathology.

The anatomic location of the root was identified, and the torn fragment was mobilized to this location. The footprint was prepared with a curved ring curette, and a grasper was used to position the torn meniscal root for repair. Either 1 or 2 transtibial tunnels were created, per attending preference, positioned at the anatomic footprint of the posterior medial meniscal root. A root aiming guide was used to ensure precise tunnel placement, and when 2 tunnels were used, an offset guide was used. Sutures were passed through the transtibial tunnel(s) using an arthroscopic cannula and a suture-passing device, with care taken to avoid intra-articular tangling. The sutures were threaded through either a suture anchor or cortical button, ensuring optimal placement and tension on the anterior tibia to achieve a thorough and effective repair.

A standard postoperative rehabilitation regimen was implemented, mandating a 6-week period of non–weight bearing complemented by the support of a hinged knee brace. For the first 4 weeks, movement of the knee was limited to a range of 0° to 90°. At 6 weeks postoperatively, patients were permitted to gradually resume weight-bearing activities as manageable, phase out use of the knee brace, and work toward restoring complete range of motion. Starting at 8 weeks, closed-chain exercises were introduced, and jogging was permitted at the 3-month mark.

Statistical Analysis

Data analysis was performed using R, version 4.3.1 ("Beagle Scouts," released June 16, 2023; The R Foundation for Statistical Computing). For continuous variables, means and standard deviations were reported, whereas categorical variables were described using frequencies and percentages. The analysis included comparing PROMs before surgery and at a minimum of 2 years after surgery using the paired 2-tailed Student t test. To evaluate the relationship between PROMs at least 2 years after surgery, Pearson correlation coefficients (r) were calculated. The strength of correlation was defined as strong (≥0.7), moderate (≥0.3 to <0.7), and weak (<0.3). The level of statistical significance was set a priori at $P < .05$ for all statistical tests. On the basis of the retrospective review of Vogel et al.[12] establishing MCID and PASS thresholds for the PROMIS subscales and correlating to legacy PROMs after hip arthroscopy, which showed statistical significance with 65 patients, we estimated that a sample size of 65 patients would be sufficient to meet these statistical goals.

The MCID was established through a distribution-based method specific to this cohort, set at half the standard deviation of the observed change in PROM scores from preoperatively to a minimum of 2 years

postoperatively.[15,34] The PASS was identified using an anchor-based approach tailored to this cohort.[24,35] Patients were asked a yes-no question at a minimum of 2 years postoperatively regarding their satisfaction: "Taking into account all the activities you have during your daily life, your level of pain, and also your functional impairment, do you consider that your current state is satisfactory?" The answers to this question facilitated the creation of receiver operating characteristic curves for each PROM, with an area under the curve of 0.70 or above deemed clinically significant. The Youden J statistic was applied to determine PASS thresholds for each PROM. The rate of reaching both the MCID and PASS for each PROM, covering the PROMIS subscales and validated knee-specific PROMs such as the IKDC tool and KOOS Jr, was recorded. Calculations were tailored to the study cohort to ensure that the results reflect the specific characteristics and outcomes of this population.

Results

The initial review identified 173 patients treated with transtibial pull-out repair of an MMPRT between January 2017 and January 2021. The selection process, following Consolidated Standards of Reporting Trials guidelines,[36] is outlined in Figure 1. There were 90 patients excluded, including 58 because of incomplete preoperative PROMs; 15, a history of ipsilateral knee surgery; 13, concomitant ligamentous repair or reconstruction; 2, concomitant femoral drilling decompression; 1, revision MMPRT repair; and 1, age younger than 18 years. Eighty-three patients were eligible for inclusion. A total of 15 patients were lost to follow-up; hence, 68 patients were included, with a compliance rate of 81.9%. The mean follow-up duration was 32.9 ± 10.6 months.

Patient Characteristics

The 68 patients included in the study had a mean age at surgery of 57.2 ± 9.7 years and a mean body mass index of 32.2 ± 6.14 (Table 1). Female patients constituted 75.0% of the cohort. Rates of tobacco smoking/use, diabetes mellitus, and Workers' Compensation were low, at 14.7%, 11.8%, and 4.4%, respectively. Chronic injuries were present in 57.3% of cases.

Imaging Characteristics

Preoperatively, the mean KL grade was 1.80 ± 0.56, with a mean joint space of 4.5 ± 0.97 mm (Table 2). The mean absolute meniscal extrusion measured 4.16 ± 1.11 mm, whereas the mean relative meniscal extrusion was 45.11% ± 15.42%. The average medial

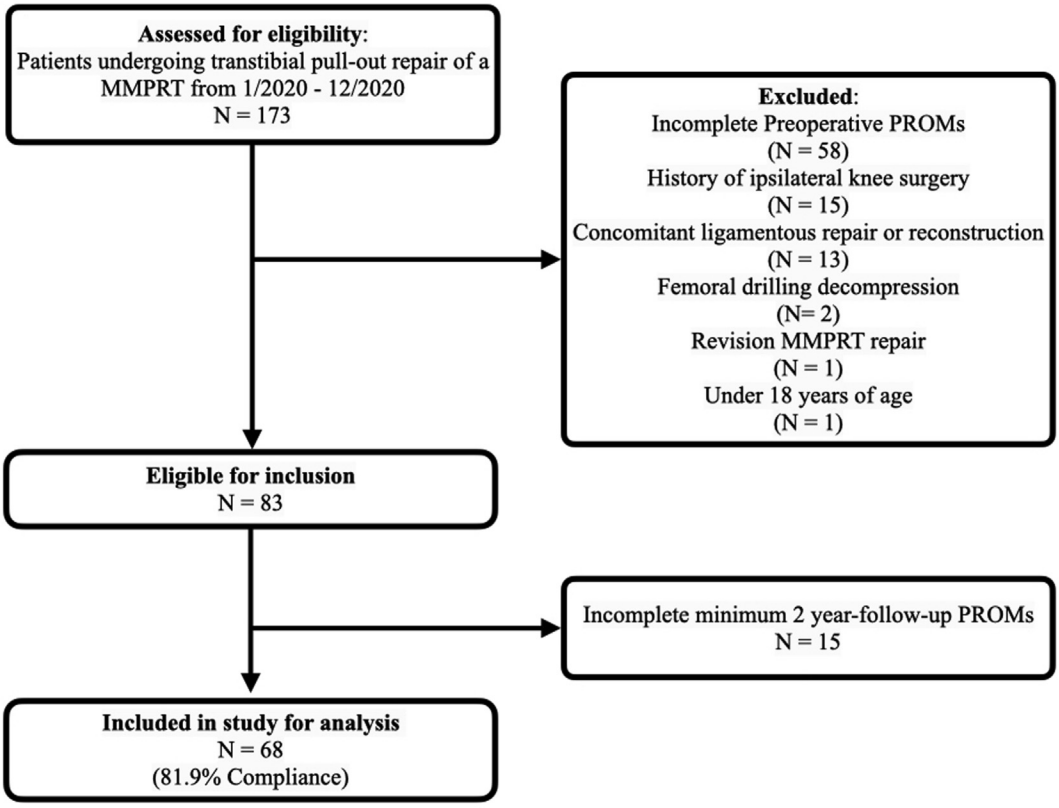

Fig 1. Diagram of patient selection and inclusion per Consolidated Standards of Reporting Trials guidelines.[36] (MMPRT, medial meniscal posterior root tear; PROM, patient-reported outcome measure.)

Table 1. Patient Demographic Information

	Data (N = 68)
Age, yr	57.2 ± 9.78
Sex: female	51 (75.0)
BMI	32.2 ± 6.14
Laterality: left	33 (48.5)
Tobacco smoking (current or former)	10 (14.7)
Diagnosis of diabetes mellitus	8 (11.8)
Chronic injury	39 (57.3)
Workers' Compensation	3 (4.4)

NOTE. Data are shown as mean ± standard deviation or number (percentage).
BMI, body mass index.

tibial slope was 5.16° ± 2.61°, and the knee mechanical axis averaged 181.36° ± 3.64°.

Patient-Reported Outcomes

Significant improvements in all PROMs from preoperatively to 2 years postoperatively ($P < .05$) were observed (Fig 2). The largest mean changes were seen in the IKDC score and KOOS Jr, with changes of 33.19 ± 21.82 and 26.04 ± 22.67, respectively. PROMIS scores showed smaller changes: 7.17 ± 16.58 for PROMIS-PF, −8.47 ± 11.48 for PROMIS-PI, and −2.62 ± 10.05 for PROMIS-D. A ceiling effect, where the maximum score was reached, was observed: PROMIS-PF score at 0%, PROMIS-PI score at 0%, PROMIS-D score at 0%, IKDC score at 1.47%, and KOOS Jr at 17.06%. A floor effect, where the minimum score was reached, was observed: PROMIS-PF score at 0%, PROMIS-PI score at 0%, PROMIS-D score at 0%, IKDC score at 1.47%, and KOOS Jr at 2.94%.

Thresholds for the MCID and PASS were established for each PROM and are presented in Table 3, along with their corresponding sensitivity and specificity values. All receiver operating characteristic curves showed an area under the curve of 0.70 or greater, indicating strong discriminative ability and supporting the clinical relevance of these thresholds in this population. Higher MCID achievement rates suggest that a greater proportion of patients experienced clinically meaningful improvement, whereas higher PASS rates indicate that more patients reached a symptom state they considered acceptable for daily function. For this study's specific cohort, the highest achievement rates for the MCID and PASS were observed for the IKDC score (MCID, 87%; PASS, 66%) and KOOS Jr (MCID, 75%; PASS, 66%). The PROMIS-PF score and PROMIS-PI score had similar achievement rates (MCID, 63% and 69%, respectively; PASS, 59% and 54%, respectively), whereas the PROMIS-D score showed the lowest rates (MCID, 50%; PASS, 49%) (Fig 3).

Table 2. Preoperative Imaging Characteristics

	Data (N = 68)
Preoperative KL grade	
1	13 (19.1)
2	55 (80.9)
3	0 (0)
4	0 (0)
Joint space, mm	4.5 ± 0.9
Meniscal extrusion, mm	4.2 ± 1.1
Relative meniscal extrusion, %	45.1 ± 15.4
Medial tibial slope, °	5.2 ± 2.6
Knee mechanical axis, °	181.4 ± 3.6

NOTE. Data are shown as mean ± standard deviation or number (percentage).
KL, Kellgren-Lawrence.

Pearson correlation coefficients revealed statistically significant relationships among all PROMs ($P < .001$) (Table 4), providing insight into how different measures relate to one another. Stronger correlations suggest overlapping constructs, whereas weaker correlations indicate distinct factors influencing patient outcomes. Specifically, the PROMIS-PI score showed moderate negative correlations with both the IKDC score and KOOS Jr ($r = -0.660$ and $r = -0.687$, respectively), indicating that as pain interference decreased, functional scores improved. Conversely, the PROMIS-PI score had a moderate positive correlation with the PROMIS-D score ($r = 0.399$), suggesting that greater pain interference was associated with higher depressive symptoms. The PROMIS-PF score exhibited a moderate negative correlation with the PROMIS-PI score ($r = -0.537$), reflecting the expected relationship between physical function and pain interference. Its weak negative correlation with the PROMIS-D score ($r = -0.287$) suggests that depressive symptoms may have a lesser but still measurable impact on physical function. The PROMIS-PF score showed moderate positive correlations with the IKDC score and KOOS Jr ($r = 0.566$ and $r = 0.710$, respectively), indicating that although it reflects aspects of knee function, it measures functional status more broadly than knee-specific PROMs, capturing elements beyond joint-specific outcomes. The IKDC score and KOOS Jr showed a strong positive correlation with each other ($r = 0.710$), reinforcing their shared role in assessing knee function and patient-reported outcomes.

Discussion

The most important finding of this study was that MCID thresholds were achieved by 63% of patients for the PROMIS-PF score, 69% for the PROMIS-PI score, and 50% for the PROMIS-D score, whereas PASS thresholds were achieved by 59%, 54%, and 49%, respectively. Similarly, 87% and 75% of patients met MCID thresholds for the IKDC score and KOOS Jr, with 66% achieving PASS thresholds for both, suggesting that knee-specific PROMs captured substantial

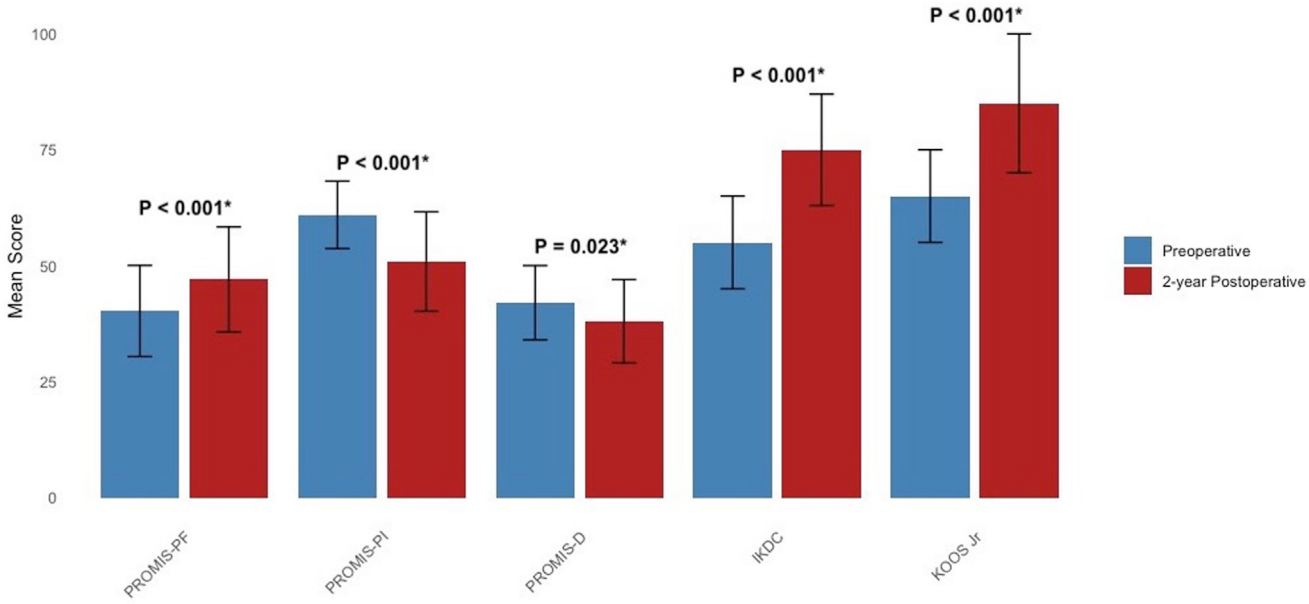

Fig 2. Preoperative and minimum 2-year postoperative scores for patient-reported outcome measures. Asterisks indicate statistical significance at $P < .05$. (IKDC, International Knee Documentation Committee; KOOS Jr, Knee Injury and Osteoarthritis Outcome Score Jr; PROMIS-D, Patient-Reported Outcomes Measurement Information System—Depression; PROMIS-PF, Patient-Reported Outcomes Measurement Information System—Physical Function; PROMIS-PI, Patient-Reported Outcomes Measurement Information System—Pain Interference.)

functional improvement and symptom resolution whereas the PROMIS-PF and PROMIS-PI subscales reflected moderate functional gains with some persistent symptom burden and the PROMIS-D subscale showed the lowest rates, indicating that psychological recovery may be less predictable in this population. These findings highlight the utility of PROMIS in evaluating outcomes for this population and underscore the importance of establishing population-specific thresholds. These thresholds are specific to this cohort and highlight the need for future studies to define similar population-specific thresholds for accurate clinical interpretation.

PROMs play a crucial role in assessing patients' perspectives on health, function, and quality of life after orthopaedic interventions.[37-40] Clinically, achieving the MCID indicates a meaningful change in a patient's symptoms whereas reaching the PASS suggests that the patient considers his or her symptom state satisfactory. Among the PROMs evaluated, the IKDC score and KOOS Jr have been extensively used to evaluate outcomes after knee surgery, encompassing various procedures such as meniscal, ligamentous, and arthroplasty operations.[41-47] In our study, we observed significant improvements in the IKDC score and KOOS Jr at the 2-year follow-up after MMPRT repair. These findings provide valuable insights into patient outcomes specific to our cohort and underscore the importance of tailoring outcome measures to the characteristics of the study population. Although prior literature has reported improvements in the IKDC score and KOOS Jr after meniscal root repair, MCID

Table 3. Cohort-Specific Clinically Significant Outcome Thresholds at Minimum 2-Year Follow-Up

	MCID	PASS			
	Threshold	Threshold	AUC	Sensitivity	Specificity
PROMIS-PF score	6.6	47.8	0.839	0.765	0.936
PROMIS-PI score	−5.7	53.6	0.892	0.786	0.917
PROMIS-D score	−4.9	40.5	0.720	0.719	0.830
IKDC score	10.5	67.8	0.878	0.768	0.917
KOOS Jr	10.3	72.3	0.812	0.871	0.957

Sensitivity and specificity were determined with the Youden J statistic.

AUC, area under receiver operating characteristic curve; IKDC, International Knee Documentation Committee; KOOS Jr, Knee Injury and Osteoarthritis Outcome Score Jr; MCID, minimal clinically important difference; PASS, patient acceptable symptom state; PROMIS-D, Patient-Reported Outcomes Measurement Information System—Depression; PROMIS-PF, Patient-Reported Outcomes Measurement Information System—Physical Function; PROMIS-PI, Patient-Reported Outcomes Measurement Information System—Pain Interference.

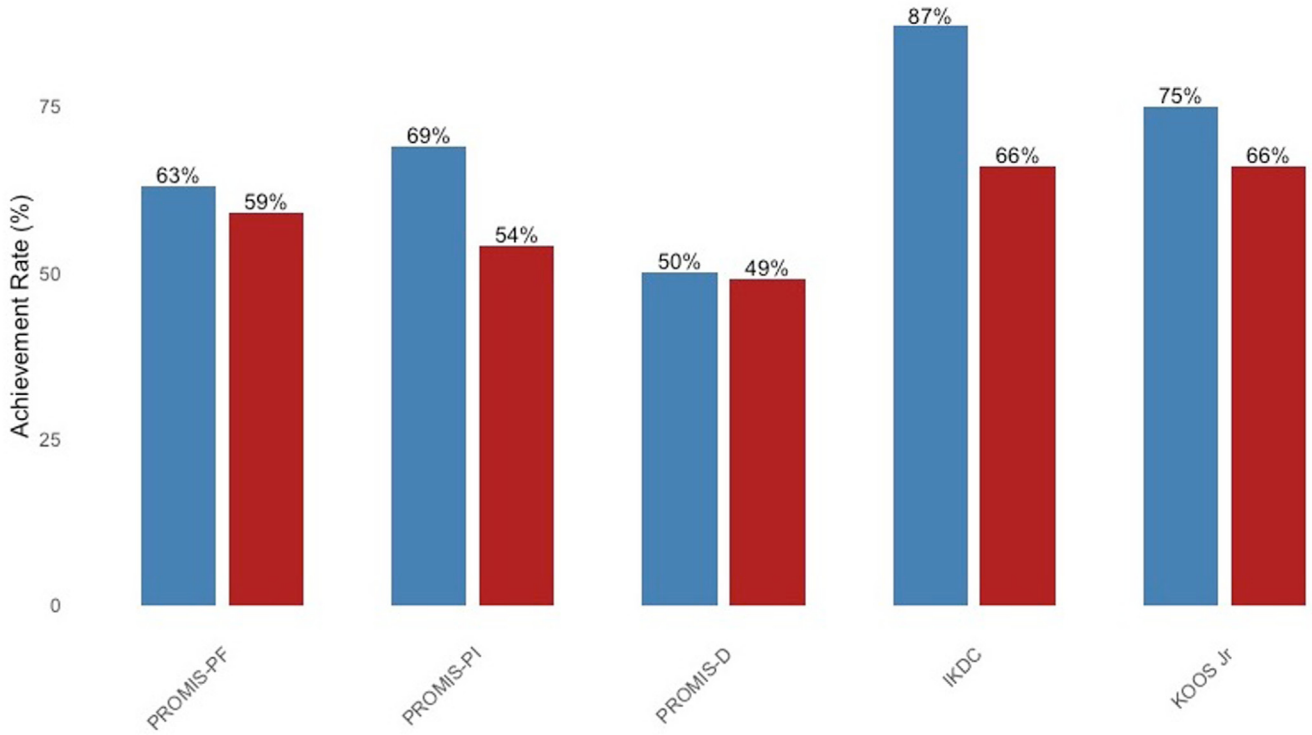

Fig 3. Achievement of minimal clinically important difference (MCID) (blue) and patient acceptable symptom state (PASS) (red) for each patient-reported outcome measure at minimum 2-year postoperative follow-up. (IKDC, International Knee Documentation Committee; KOOS Jr, Knee Injury and Osteoarthritis Outcome Score Jr; PROMIS-D, Patient-Reported Outcomes Measurement Information System—Depression; PROMIS-PF, Patient-Reported Outcomes Measurement Information System—Physical Function; PROMIS-PI, Patient-Reported Outcomes Measurement Information System—Pain Interference.)

and PASS thresholds for these PROMs remain underexplored.[48-51] Maheshwer et al.[14] evaluated 60 patients undergoing meniscal repair, with various meniscal tear patterns, including cases with concomitant anterior cruciate ligament reconstruction. For the IKDC score, the authors reported an MCID threshold of 10.9 with an achievement rate of 65% and a PASS threshold of 69 with an achievement rate of 51.7%. In comparison, our study observed an MCID threshold of 10.5 with an achievement rate of 87% and a PASS threshold of 67.7 with an achievement rate of 66% for the IKDC score. Despite variations in study populations, such as tear types and concomitant procedures, our results align with these findings, further emphasizing the relevance of population-specific thresholds for clinical interpretation.[14]

Although PROMs offer valuable insights into patients' outcomes, the extensive nature of these questionnaires may burden patients, potentially impacting their responsiveness.[13,52] PROMIS uses item response theory, allowing individual questions or combinations thereof to assess specific outcomes of interest.[53-55] This approach, including computer adaptive testing, has shown high reliability, content validity, and

Table 4. Pearson Correlation Coefficients Preoperatively and at 2-Year Minimum Follow-Up

	Preoperative			
	PROMIS-D Score	PROMIS-PI Score	PROMIS-PF Score	KOOS Jr
IKDC score	−0.399	−0.660	0.566	0.710
KOOS Jr	−0.395	−0.687	0.710	—
PROMIS-PF score	−0.287	−0.537	—	—
PROMIS-PI score	0.399	—	—	—
PROMIS-D score	—	—	—	—

NOTE. All Pearson correlation coefficients were significant at <0.001.

IKDC, International Knee Documentation Committee; KOOS Jr, Knee Injury and Osteoarthritis Outcome Score Jr; PROMIS-D, Patient-Reported Outcomes Measurement Information System—Depression; PROMIS-PF, Patient-Reported Outcomes Measurement Information System—Physical Function; PROMIS-PI, Patient-Reported Outcomes Measurement Information System—Pain Interference.

responsiveness to change.[2,56] Notably, PROMIS has emerged as a promising alternative to traditional PROMs, offering validity, efficiency, and a reduced burden in evaluating patient-reported outcomes.[57] A study by Hancock et al.[57] underscores the validity and efficiency of the PROMIS-PF CAT in assessing outcomes after meniscal injury surgery, corroborating our findings regarding PROMIS' validity in assessing outcomes after MMPRT repair.

The PROMIS-PF subscale showed a significant correlation with currently used PROMs of physical function and showed no ceiling effects for patients requiring surgery, further highlighting its utility.[57] Although all correlations were statistically significant ($P < .001$), their clinical relevance may vary. The strongest correlation was between the IKDC score and KOOS Jr ($r = 0.710$), which was expected given that both are knee-specific PROMs designed to assess overlapping aspects of knee function and patient-reported outcomes. The PROMIS-PI score showed moderate negative correlations with the IKDC score ($r = -0.660$) and KOOS Jr ($r = -0.687$), reinforcing the link between pain interference and functional impairment. The PROMIS-PF score had moderate positive correlations with the IKDC score ($r = 0.566$) and KOOS Jr ($r = 0.585$), indicating that it captures aspects of knee function but not as strongly as legacy PROMs. Weaker correlations with the PROMIS-D score ($r = -0.287$ to $r = 0.399$) suggest that depression potentially influences outcomes but reflects a distinct construct. These findings highlight PROMIS as a complementary tool for knee-specific PROMs in MMPRT repair assessment.

This study also identified a significant correlation between the IKDC score and KOOS Jr with PROMIS through Pearson analysis ($P < .001$) and found a significant ceiling effect for the KOOS Jr but none for the PROMIS-PF, PROMIS-PI, or PROMIS-D score. In previous studies, PROMIS CATs have consistently minimized ceiling and floor effects.[24,54,58,59] In the aforementioned study by Vogel et al.,[12] in which they defined MCID and PASS thresholds for PROMIS and PROMs after primary hip arthroscopy for femoroacetabular impingement syndrome, the authors outlined the lack of floor and ceiling effects found in PROMIS (0%) when compared with legacy PROMs (ceiling effects of 12.3% for Hip Outcome Score—Activities of Daily Living, 19.2% for Hip Outcome Score—Sports Subscale, 5.0% for International Hip Outcome Tool 12, and 14.0% for visual analog scale for pain and floor effects of 0.0% for Hip Outcome Score—Activities of Daily Living, 1.9% for Hip Outcome Score—Sports Subscale, 1.7% for International Hip Outcome Tool 12, and 1.8% for visual analog scale for pain). The absence of ceiling and floor effects in PROMIS enhances its ability to detect meaningful clinical changes, avoiding measurement saturation that can limit legacy PROMs. Ceiling effects, where patients reach the highest possible score, and floor effects, where patients cluster at the lowest score, can obscure improvements or deteriorations in patient status.[25] PROMIS mitigates these issues through computer adaptive testing, which tailors questions to individual patient responses, ensuring more precise measurements.[55] Vogel et al. showed that PROMIS had no detectable ceiling or floor effects (0%) whereas traditional PROMs showed ceiling effects up to 19.2%. This highlights PROMIS as a superior tool for evaluating postoperative recovery after MMPRT repair.

Beyond preoperative PROM collection, standardized imaging is essential for assessing meniscal root tears preoperatively. Our study used MRI to evaluate meniscal root tears, measure meniscal extrusion, and assess medial tibial slope, along with radiographic assessment of KL grading, joint space width, and mechanical axis. This methodology aligns with prior studies and ensures consistent evaluation of preoperative joint status and structural integrity.[60-62]

Although recent studies have helped expand our understanding of PROMIS' utility in orthopaedic contexts by reporting MCID and PASS thresholds for PROMIS after different orthopaedic procedures, such as hip arthroscopy and meniscal surgery, these thresholds have been tailored to different populations and procedures.[12,21,24] In hip arthroscopy, Bodendorfer et al.[24] established clinically significant thresholds at a 1-year follow-up, reinforcing the importance of procedure-specific MCID and PASS values. Similarly, Vogel et al.[12] evaluated these thresholds at a 2-year follow-up for femoroacetabular impingement syndrome, showing that the PROMIS-PF subscale provides a reliable measure of functional improvement in this population. These findings underscore the clinical relevance of defining PROMIS thresholds for specific patient populations, as our study establishes similar benchmarks for MMPRT repair, facilitating the interpretation of postoperative outcomes. Okoroha et al.[21] pioneered the evaluation of PROMIS after meniscal surgery, calculating the MCID and PASS for the PROMIS-PF score at 6 months postoperatively after partial meniscectomy. They reported a lower MCID threshold (2.09) than we did (6.55) and found a similar PASS threshold (46.1 vs 47.8) for the PROMIS-PF subscale at 6 months.[21] These differences highlight the importance of calculating population-specific thresholds rather than generalizing findings across studies or procedures.

Limitations

The study's findings should be interpreted in the context of its limitations. First, despite having an acceptable number of patients lost to follow-up (18.1%), this may still create selection bias that could influence the calculated MCID and PASS thresholds.

Second, the 2-year follow-up period may not capture long-term outcomes adequately, warranting longer-term investigations. Moreover, the predominance of middle-aged female patients in our study cohort may limit generalizability to other patient populations and influence achievement rates of clinically significant outcomes. Additionally, excluding over 30% of the cohort because of missing preoperative PROMs may introduce selection bias and limit generalizability, although this was necessary to ensure valid MCID calculation. Finally, the significant sex imbalance in our cohort (75% female and 25% male) limits the feasibility of meaningful statistical comparisons by sex because the small sample size of male patients results in underpowered subgroup analyses.

Conclusions

This study establishes cohort-specific MCID and PASS thresholds for the PROMIS subscale scores, IKDC score, and KOOS Jr at a minimum 2-year follow-up after isolated transtibial pull-out MMPRT repair. At 2 years, the MCID and PASS were achieved by 63% and 59% of patients, respectively, for the PROMIS-PF score; 69% and 54%, respectively, for the PROMIS-PI score; and 50% and 49%, respectively, for the PROMIS-D score. For the IKDC score and KOOS Jr, the MCID rates were 87% and 75%, respectively, and the PASS rates were 66% and 66%, respectively.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: A.B.Y. reports a consulting or advisory relationship with AlloSource, Arthrex, JRF Ortho, Organogenesis, and Stryker and owns equity or stocks in Icarus Medical, Patient IQ, and Sparta Biomedical. B.J.C. receives funding grants from B Braun Medical, Arthrex, JRF Ortho, and National Institutes of Health; reports board membership with *American Journal of Sports Medicine*, Arthroscopy Association of North America, and *Journal of American Academy of Orthopaedic Surgeons*; reports a consulting or advisory relationship with Arthrex, Elsevier, and *Operative Techniques in Sports Medicine*; and owns equity or stocks in Bandgrip and OSSIO. N.N.V. reports board membership with American Orthopaedic Society for Sports Medicine, American Shoulder and Elbow Surgeons, Arthroscopy Association of North America, and Slack; receives funding grants from Arthrex, Breg, Ossur Americas, and Stryker; and reports a consulting or advisory relationship with Stryker and Smith and Nephew. J.C. reports board membership with American Orthopaedic Society for Sports Medicine, Arthroscopy Association of North America, and International Society of Arthroscopy Knee Surgery and Orthopaedic Sports Medicine; reports a consulting or advisory relationship with Arthrex, ConMed, Ossur Americas, and Smith & Nephew; and receives speaking and lecture fees from Smith & Nephew. All other authors (J.R.G., F.A., M.A.A., J.R.M.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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