Assessment of Thresholds for Clinically Relevant Change in the Pediatric/ Adolescent Shoulder Survey After Shoulder Instability Surgery

Factors Associated With Meaningful Improvement in Outcomes

Kendahl Wallis-Lang,* BS, Tracey P. Bastrom,† MA, Kelly E. Boutelle,† BS, Abigail Wagle,† BS, Andrew T. Pennock,*† MD, and Eric W. Edmonds,*†‡ MD
Investigation performed at Rady Children's Hospital, San Diego, California, USA

Background: The pediatric/adolescent shoulder survey (PASS) score is a subjective measure of shoulder symptomology in younger patients.

Purpose: To establish the minimal clinically important difference (MCID) and minimal detectable change (MDC) for the PASS score in adolescents after surgical treatment for shoulder instability.

Study Design: Case series; Level of evidence, 4.

Methods: Included were patients aged 12.5 to 23 years who underwent surgical treatment for shoulder instability and who had completed PASS forms preoperatively and at 3 months postoperatively. The MCID was established using an anchor-based approach, with the Single Assessment Numeric Evaluation (SANE) and shortened version of the Disabilities of the Arm, Shoulder and Hand (QuickDASH) as anchors. Change in PASS score between anchor groups was determined using receiver operating characteristic curve analysis. MDC with 90% confidence (MDC_{90}) was also calculated. Range of motion and strength data at 3-month follow-up were evaluated to identify the optimal postoperative PASS score. Factors associated with improvement in PASS score beyond the MDC_{90} and MCID were determined in a subset of patients with $\geq$6-month follow-up data.

Results: A total of 95 patients were included. The mean PASS score improved significantly from preoperatively to postoperatively (57 $\pm$ 15 to 75 $\pm$ 16; $P < .001$). The anchor-based MCID ranged from 12.5 to 13.2 points, with an area under the receiver operating characteristic (AUC) curve of 0.87 for the SANE and 0.99 for the QuickDASH. The MDC_{90} was 16.5 points. The optimal PASS score at 3 months after surgery was $\geq$85 (AUC, 0.66). Shorter duration of symptoms, lower preoperative forward elevation, and higher preoperative external rotation were associated with improvement in PASS score above the MDC_{90} and/or MCID for the subset of patients (n = 25) with $\geq$6-month follow-up data. Increased number of suture anchors, less preoperative external rotation deficit, and number of previous dislocations had a moderate effect on improvement in outcomes.

Conclusion: A postoperative increase in PASS score of $\geq$16.5 points had a 90% chance of being a true-positive change, while a score change of approximately 13 points was likely clinically relevant. The optimal PASS score after surgery was $\geq$85. Shorter duration of symptoms, preoperative range of motion, number of surgical anchors, and number of previous dislocations were associated with achieving a clinically relevant improvement in PASS score at minimum 6 months postoperatively.

Keywords: shoulder; pediatric and adolescent shoulder survey; shoulder instability; MCID; patient-reported outcome; pediatrics

Adolescent shoulder instability is associated with varying pathologies, all of which can influence treatment: Bankart lesions, superior labral anterior-posterior lesions, rotator cuff tears, cartilage disruptions, or glenoid bone defects,[17]

The Orthopaedic Journal of Sports Medicine, 11(9), 23259671231196943
DOI: 10.1177/23259671231196943

As patient-reported outcome measures (PROMs) continue to grow in popularity in response to pay-for-performance models and an emphasis on patient-centered care, it is important to have tailor-made outcome tools for this youthful population. Generic PROMs are often not sensitive enough to detect changes in otherwise healthy patients; thus, disease-specific PROMs have become commonplace.[2,4,18,22] For young adolescents with shoulder injuries, the pediatric/adolescent shoulder survey (PASS) score has recently been established as a reliable and valid tool.[9]

The PASS form consists of 13 questions that assess (in child-friendly language) symptoms, limitations, need for compensatory mechanisms, and emotional distress related to shoulder dysfunction.[9] Previous research has established good internal reliability, test-retest reliability, convergent validity, discriminant validity, and responsiveness to change for the PASS outcome tool.[9] PROMs that overlap shoulder function with internal reliability and concurrent validity in children[9] include the shortened version of the Disabilities of the Arm, Shoulder and Hand (QuickDASH), which assesses similar metrics using more adult-focused language (but omits the adult-specific questions of the full DASH), and the Single Assessment Numeric Evaluation (SANE), which is not joint specific.

In order to understand the scores of any given PROM in terms of meaningful change, researchers have been looking beyond individual scores or collective differences in mean scores. Identifying the minimal clinically important difference (MCID) has become a necessary component of establishing validity and reliability for a particular PROM.[3,5,10-12,19-21,24] MCID has been defined as the smallest change in score, typically as a response to disease treatment, that is recognized by the patient as an important or noticeable difference.[14] Three generally accepted methods to establish MCID are the anchor-based approach, the distribution-based approach, or Delphi method driven by expert opinion.[1,20] Establishing the MCID is critical to interpreting the pooled results of research studies, but aside from being a valuable research tool, an established MCID can help set goals and benchmarks for individual progress with treatment.

There are currently no studies evaluating a threshold of meaningful change on the PASS outcome tool. The purpose of this study was to establish clinically relevant changes, using both anchor-based and distribution-based methods for MCID thresholds, in the PASS score after surgical treatment for shoulder instability. Clinically relevant outcomes were also utilized to define treatment success in order to identify an ideal PASS score after surgery. A secondary aim of this study was to identify the factors associated with changes in PASS score that met the clinically relevant threshold for improvement.

METHODS

After receiving institutional review board approval, we reviewed the existing records at Rady Children's Hospital for patients who underwent surgical treatment for shoulder instability between 2013 and 2020. The institution is an integrated pediatric health care system providing hospital and specialty care and is the region's only level 1 trauma center dedicated specifically to pediatric patients. Patients who only underwent arthroscopic labral repair and capsulorrhaphy, regardless of instability type, were identified using the Current Procedural Terminology (CPT) codes 29806 (arthroscopic capsulorrhaphy with labral repair) and/or 29807 (arthroscopy, shoulder, surgical, to capture any miscoded shoulder instability in those who actually underwent capsulorrhaphy and labral repair). We included patients with completed PASS forms available in the electronic medical record (EMR) preoperatively and 3 months postoperatively (accepted range was between 2.4 and 5 months). Three months was selected to most effectively establish clinically relevant thresholds to isolate the impact of the surgical procedure. This time frame was felt to be beyond the immediate postoperative recovery period yet within a period when patients are able to perform activities of daily living without limitation and are about to start sport-specific activities.

As all patients are evaluated for 2 years as part of standard of care at our institution, if a follow-up visit at $\geq$6 months had an available PASS form documented in the chart, then these data were also recorded. During the study time frame, the clinical protocol was to provide patients with shoulder issues with a paper-based PASS form at each visit to assess interval changes as a means to gauge clinical improvement or deterioration with treatment; however, because the remainder of our health system utilized an electronic health record, the forms had to be scanned into the system to become part of the EMR. The availability of the fully executed forms was therefore inconsistent, and the absence of 1 or both of the preoperative and 3-month postoperative PASS forms from the EMR was the primary exclusion criterion of this study.

MCID Methodology

The MCID was established using 2 different methodologies: an anchor-based approach and distribution-based approach. The anchor-based approach compares the change in 1 PROM to a second, external measure of

‡Address correspondence to Eric W. Edmonds, MD, Rady Children's Hospital, 3020 Children's Way, San Diego, CA 92123, USA (email: ewedmonds@rchsd.org).

*University of California, San Diego, San Diego, California, USA.

†Department of Orthopedics, Rady Children's Hospital, San Diego, California, USA.

Final revision submitted April 18, 2023; accepted May 4, 2023.

One or more of the authors has declared the following potential conflict of interest or source of funding: A.T.P. has received education payments from ImpactOrtho and SportsTek Medical and consulting fees from OrthoPediatrics. E.W.E. has received nonconsulting fees from Arthrex. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Ethical approval for this study was obtained from University of California, San Diego (No. 170519X).

change, whereas the distribution-based approach is focused on statistical characteristics. For the anchor-based approach, 2 other PROMs were selected based on their published ability to determine clinically relevant changes.[10–12] (1) The validated SANE was utilized, and changes in PASS scores were compared between patients with 3-month postoperative SANE cutoff scores of $\leq$60 versus $>$75. A SANE score of $>$75 has been identified as an acceptable outcome.[10] (2) The second anchor was a 3-month postoperative improvement in QuickDASH score that met the established minimal detectable change (MDC) on the QuickDASH of 11 points versus worsening of 11 points.[10,19]

The distribution-based approach for establishing the MCID included calculation of the standard error of measurement (SEM) using the standard deviation (SD), as well as calculation of the MDC with 90% confidence (MDC_{90}). SEM was calculated as $SD\sqrt{1-r}$, where r represents the test-retest reliability correlation of 0.75, which was established during the initial reliability and validity study of the PASS tool.[9] MDC_{90} was calculated as SEM $\times \sqrt{2} \times 1.67$.

Subgroup Examining Factors Associated With Meaningful Change

In order to identify an optimal PASS score 3 months after surgery, a cohort of patients considered to have a clinically successful outcome was defined. This was done utilizing 5 different physical examination tests: forward elevation range of motion (ROM), internal rotation ROM, and 3 measures of strength testing (supraspinatus, infraspinatus, and subscapularis). Ideal outcome for the ROM measures was defined as equal to or better than the contralateral arm and strength testing score of 5. Patients were included in this analysis if they had $\geq$4 of the 5 clinical measures assessed and available in the EMR. The successful outcome cohort included those patients who had 100% ideal outcomes on the available measures.

The subset of patients within our original cohort (those with both preoperative and 3-month postoperative PASS scores), who also had an additional PASS score available at a follow-up visit $\geq$6 months from surgical intervention, were further analyzed to identify factors potentially associated with both MDC_{90} and MCID improvement in PASS score at the latest visit. This subsequent visit was selected so as to not utilize the same data used for MCID/MDC_{90} development and to capture data after patients had a period of return to full activity. This return-to-activity cohort was then separated into 2 groups – worsened/unchanged and improved – based on MDC_{90} and MCID determined from the original cohort. Factors analyzed included age, sex, insurance type, ROM before surgical treatment (in-clinic active forward elevation with no abduction, plus examination under anesthesia with shoulder abducted to 90° and elbow flexed to 90°, rotated through the shoulder to identify external and internal rotation), duration of symptoms before surgical treatment, number of previous dislocations, number of suture anchors, and type of Hill-type of Hill-Sachs lesion. Data were collected using EMR review and magnetic resonance imaging (MRI) measurements.

Radiographic Measurement Methodology

Hills-Sachs interval and type of lesion (on-track or off-track) were measured using the glenoid track concept described by Yamamoto et al.[27] Using axial and sagittal MRI scans, the diameter of best-fit over the inferior glenoid face (D), the width of maximum anterior bone loss (d), and the interval between the Hill-Sachs lesion and the rotator cuff insertion (HS interval) were measured.[15,27] The glenoid track (GT) was calculated as $0.83(D-d)$ as described in the literature.[27] The distance between the medial edge of the Hill-Sachs lesion and the anterior edge of the glenoid track (DTD distance) was calculated as $GT - HS\ interval$, where a DTD distance of $>$0 indicated an on-track lesion and a DTD distance of $\leq$0 indicated an off-track lesion.[15]

Statistical Methodology

Descriptive statistics are reported as percentages or means $\pm$ SDs. Pre- to postoperative PASS scores were compared utilizing repeated-measures analysis of variance (ANOVA). Receiver operating characteristic (ROC) curve analysis of change in PASS score between responders and nonresponders based on the 2 anchor groups (SANE and QuickDASH) was performed to identify the MCID at optimal sensitivity and specificity.[23] ROC was also used to identify the optimal PASS score at 3 months based on the cohort of patients identified as clinically successful. The area under the ROC curve (AUC) was obtained to assess overall accuracy, with values between 0.7 and 0.8 considered acceptable; 0.81 to 0.9, excellent; and $>$0.9, outstanding.[13,16] For the subanalysis of patients with $\geq$6-month PASS scores, univariable analyses were performed comparing the worsened/unchanged group to the improved group. Each of the factors potentially associated with an improvement in both MDC_{90} and MCID were evaluated using ANOVA or chi-square test. Effect sizes are reported for these analyses due to the small sample size and were categorized based on Cohen[6] (chi-square test w: 0.1 = small, 0.3 = medium, 0.5 = large; ANOVA η^2: 0.01 = small, 0.06 = medium, 0.14 = large). Analyses were performed utilizing SPSS (Version 27, IBM SPSS Statistics for Windows; IBM Corp). Alpha was set at $P < .05$ to declare significance.

RESULTS

The CPT code search identified 344 cases to be screened for eligibility; of these, 106 cases did not have any completed PASS data in the medical record and another 143 did not have PASS data available for both the preoperative and the 3-month postoperative windows. Thus, 95 patients were included in this study. These patients completed

TABLE 1
Mean Change in PASS Score Between the Anchor Groups[a]

Anchor Group	Change in PASS Score	*P*
SANE		<.001
≤60	–0.9 ± 16.7	
>75	25.5 ± 19	
QuickDASH		<.001
Worsened >11 points	9.6 ± 11.3	
Improved >11 points	31.9 ± 13.1	

[a]Data are reported as mean ± SD. PASS, pediatric/adolescent shoulder survey; QuickDASH, shortened version of the Disabilities of the Arm, Shoulder and Hand; SANE, Single Assessment Numeric Evaluation.

the PASS form as part of routine care at a mean of 2 ± 2 months before surgery and approximately 3 months after surgery (mean, 3.2 ± 0.6 months; range, 2.5-5 months). The mean age of the cohort at time of surgery was 16 ± 1.7 years (range, 12.5-23 years). There were 40 female and 55 male patients. The side injured was the right shoulder in 63 (66%) of cases.

The mean PASS score significantly increased from preoperatively (57 ± 15; range, 26-99) to postoperatively (75 ± 16; range, 27-100) ($P < .001$). The mean change in PASS scores for the 2 anchor groups is seen in Table 1. There was a significant difference in change in PASS score for patients with a 3-month SANE score of ≤60 versus >75 ($P = .001$). Similarly, there was a significant decrease in PASS score for patients with a 3-month QuickDASH score that was 11 points worse versus 11 points improved ($P < .001$).

The results of the MCID and MDC_{90} analyses are seen in Table 2. The MCID ranged from 12.5 to 13.2 points for the anchor-based approach, with an AUC of 0.87 (95% CI, 0.75-0.99; $P < .001$) and 0.99 (95% CI, 0.98-1.0; $P < .001$) for the SANE and QuickDASH, respectively. The distribution-based approach resulted in an MDC_{90} of 16.5 points, with an SEM of 7.

There were 76 (80%) patients with ≥4 of the 5 physical examination measures utilized in evaluating a successful outcome. Of these patients, 20 (26%) had ideal outcomes on all available physical examination measures and were included in the ROC analysis as the successful outcome group. The results indicated that a PASS score of ≥85 was associated with a successful outcome (AUC, 0.66; 95% CI, 0.5-0.82; $P = .049$).

There were 25 patients within the main cohort who had ≥6-month follow-up PASS scores and were therefore included in the secondary assessment to determine clinical and radiographic parameters associated with clinically significant improvements. Factors found to be significantly associated with an improved PASS score above the MDC_{90} and MCID are seen in Tables 3 and 4. Duration of symptoms before surgical treatment was significantly shorter in patients with an MCID improvement ($P < .05$). Preoperative ROM variables were found to be significantly different for both MDC_{90} and MCID improvement ($P < .05$). Higher external rotation values before surgical treatment were significantly associated with MDC_{90} and MCID improvement, while decreased forward elevation was significantly associated with MDC_{90} improvement ($P < .05$). Due to the small sample, effect sizes are reported with medium to large effects highlighted. The group that met clinically relevant improvement thresholds had shorter duration of symptoms, lower preoperative forward elevation, and higher preoperative external rotation, and these differences met criteria for large effect sizes. The group that met clinically relevant improvement thresholds also had increased number of suture anchors, less preoperative external rotation deficit compared with the contralateral shoulder, and a higher rate of ≥1 previous dislocations (a zero value being recorded for those who had associated pathology consistent with an instability event but who did not report having dislocated their shoulder). These differences met the criteria for medium effect size and may play a role in clinically relevant improvements in outcome.

DISCUSSION

In the present study, we found that a difference in PASS score that is clinically meaningful to patients was in the range of 12.5 to 13.2 points on a 100-point scale; however, in order to be ≥90% confident that the change was not within measurement error, a difference of ≥16.5 points needed to be observed.

The anchor-based approach to MCID compares the change in 1 PROM with a second, external measure of change. Anchors can be either subjective or objective in nature. In this study, both QuickDASH and SANE scores were used as anchors. The MCID identified by the QuickDASH was a 12.5-point change on the PASS score, whereas the MCID identified by the SANE score was a change of 13.2 points. It is known that the anchor and distribution approaches can produce widely varied MCID thresholds; thus, it is reassuring that both anchors produced a threshold of MCID that was similar.[7] Rather than focusing on statistics, the anchor-based approach relies on the patient's view of one's disease and what a noticeable change in disease state is for him or her.[20] The drawbacks to this process, however, are in potential recall bias on long-term responsiveness and the varying precision of the anchors used. If the patient's report of change is biased toward either baseline or current health status, responses may not truly reflect amount of change posttreatment. If an anchor lacks precision, the patient's true response will be masked.[25] As a result, the reported MCID identified by the anchor-based approach may fall within the measurement error or variation of an outcome measure.[5,8]

To balance the potential deficiencies of the anchor-based approach, we also considered the distribution-based approach. The distribution-based approach to MCID is a statistical methodology that (1) examines the error in measurement of an outcome tool by accounting for the variability in a cohort taking the survey twice within a time frame in which scores would not be expected to change (SEM) and (2) applies a threshold of confidence on top of

TABLE 2
MCID Analysis of PASS Score for the Anchor- and Distribution-Based Approaches[a]

Anchor Based: SANE		Anchor Based: QuickDASH		Distribution Based	
ROC MCID	AUC (95% CI)	ROC MCID	AUC (95% CI)	SEM	MDC_{90}
12.5	0.87 (0.75-0.99)	13.2	0.99 (0.98-1.0)	7	16.5

[a]AUC, area under the ROC curve; MCID, minimal clinically important difference; MDC_{90}, minimal detectable change with 90% confidence; PASS, pediatric/adolescent shoulder survey; QuickDASH, shortened version of the Disabilities of the Arm, Shoulder and Hand; ROC, receiver operating characteristic; SANE, Single Assessment Numeric Evaluation; SEM, standard error of measurement.

TABLE 3
Demographic and Physical Examination Factors Potentially Associated With Improved PASS Score Above the MDC_{90} and MCID[a]

Factor	MDC_{90} Threshold	*P*	ES	MCID Threshold	*P*	ES
Symptom duration[b]		.448	0.04		**.036**	**0.16**
Worsened/unchanged	64 ± 91			81 ± 99		
Improved	24 ± 25			17 ± 17		
Age		>.99	0.002		>.99	0.02
Worsened/unchanged	16 ± 2			16 ± 2		
Improved	16 ± 2			17 ± 3		
Forward elevation ROM[c]		**.002**	**0.55**		.201	*0.11*
Worsened/unchanged	176 ± 8			174 ± 9		
Improved	161 ± 4			168 ± 10		
Forward elevation deficit[c]		.536	0.06		.93	0.003
Worsened/unchanged	–0.9 ± 3			–1.4 ± 4		
Improved	–3 ± 5			–1.8 ± 4		
External rotation ROM		**.012**	**0.27**		**.016**	**0.28**
Worsened/unchanged	50 ± 16			46 ± 12		
Improved	73 ± 23			69 ± 23		
External rotation deficit[c]		.27	*0.08*		.72	0.01
Worsened/unchanged	–3 ± 4			–1.4 ± 4		
Improved	–0.6 ± 4			2.2 ± 5		
Strength deficit preoperatively (no/yes)		.9	0.09		.62	0.24
Worsened/unchanged	75/67			58/33		
Improved	25/33			42/67		
Sex (female/male)		.39	0.2		.7	0.11
Worsened/unchanged	56/75			44/56		
Improved	44/25			56/44		
Insurance (private/government)		.9	0.03		.69	0.12
Worsened/unchanged	69/67			46/58		
Improved	31/33			54/42		
No. of dislocations (0/≥1)		.67	0.18		.1	*0.33*
Worsened/unchanged	75/58			67/33		
Improved	25/42			33/67		

[a]Data are reported as percentages or mean ± SD. Bolded *P* values indicate statistical significance ($P < .05$). Bolded effect sizes (ESs) indicate large effect; italicized ESs indicate medium effect. MCID, minimal clinically important difference; MDC_{90}, minimal detectable change with 90% confidence; PASS, pediatric/adolescent shoulder survey; ROM, range of motion.
[b]If noted.
[c]With respect to the unaffected shoulder.

that error. The MDC_{90} tells us that a difference in score is not due to the random variation in individual responses to the outcome measure. Thus, for the PASS form, this study suggests that a score change of ≥16.5 points is needed to represent a change that is outside the range of measurement error. The limitation of the distribution-based approach is, however, that the focus is placed on statistical meaning rather than meaning based on the patient's subjective sense – which is the advantage of also knowing the MCID.[7,20] The distribution-based approaches can also vary widely based on the initial test-retest cohort in which reliability was established.[7]

There are unfortunately no widely accepted standards for nonconvergence of identified MCID thresholds.[26] The

TABLE 4
Radiographic and Surgical Factors Potentially Associated With Improved PASS Score Above the MDC_{90} and MCID[a]

	MDC_{90} Threshold	*P*	ES	MCID Threshold	*P*	ES
No. of suture anchors		.187	*0.11*		.23	*0.08*
Worsened/unchanged	4 ± 1			3 ± 1		
Improved	5 ± 2			4 ± 2		
D		.444	0.02		.84	0.0
Worsened/unchanged	30 ± 3			30 ± 3		
Improved	31 ± 3			30 ± 3		
d		.878	0.004		.39	0.02
Worsened/unchanged	2.7 ± 1			3 ± 1		
Improved	2.5 ± 2			3 ± 2		
HS interval		.968	0.0		.73	0.005
Worsened/unchanged	10 ± 7			10 ± 8		
Improved	10 ± 8			11 ± 7		
GT		.298	0.05		.9	0.0
Worsened/unchanged	22 ± 3			23 ± 2		
Improved	24 ± 4			23 ± 4		
DTD distance		.823	0.01		.711	0.003
Worsened/unchanged	12 ± 8			13 ± 8		
Improved	14 ± 12			12 ± 11		
No. of suture anchors (<3/3 +)		.63	0.16		.48	0.14
Worsened/unchanged	83/67			67/50		
Improved	17/33			33/50		

[a]Data are reported as percentage or mean ± SD. Italicized effect sizes (ESs) indicate medium effect. *d*, width of maximum anterior bone loss; *D*, best-fit diameter over the inferior glenoid face; DTD distance, distance between the medial edge of the Hill-Sachs lesion and the anterior edge of the glenoid track (calculated as $GT - HS\ interval$); GT, glenoid track (calculated as $0.83[D - d]$; HS interval, interval between the Hill-Sachs lesion and the rotator cuff insertion; MCID, minimal clinically important difference; MDC_{90}, minimal detectable change with 90% confidence; PASS, pediatric/adolescent shoulder survey.

US Food and Drug Administration determines and reviews meaningful change for a clinical trial on an individual basis and within the context of that particular trial.[26] As such, it is not unreasonable to suggest that selecting the minimum (12.5 points) or the maximum (16.5 points) MCID for the PASS outcome tool as identified by this study should be made within the context of that decision. When critical or universal practice-based changes are being suggested on the basis of the choice of MCID for the PASS form, one may choose to be conservative in one's approach and utilize the maximum MDC_{90} MCID threshold of 16.5 points. Conversely, when evaluating individual patients' response to treatment, it may be more prudent to utilize the anchor-based threshold, which suggests that a patient can notice a meaningful change at approximately 12 to 13 points.

Analysis of the optimal PASS score after surgery based on clinical examination suggests that a score of ≥85 is associated with a successful outcome. This cutoff could be utilized in combination with the MCID and MDC to further define treatment outcomes. The resulting AUC for this analysis was better than chance but still below the range of accuracy that is considered acceptable. This could be due to the retrospective nature of the study (relying on chart documentation of physical examination) and multiple assessors of the physical examination itself.

Another approach that can be used when deciding to use the conservative MDC_{90} MCID of 16.5 points or the anchor-based MCID of 12.5 to 13.2 points is the presence of significantly associated clinical factors. In this study, various factors collected from the EMR and measured from patient MRIs were evaluated for potential associations with changes in PASS score above the MCID at ≥6 months of follow-up. Shorter duration of symptoms, higher external rotation, and lower forward elevation before surgical treatment were all significantly associated with improvement in PASS scores above the MCID. The analysis of other potentially associated factors did not produce significant results. This may be due to the small sample size of patients with a PASS score at ≥6 months of follow-up. Because these factors were only evaluated in 25 patients, effect sizes were reported for factors that were not significant but showed medium to large effects as established by chi-square test and ANOVA. Shorter duration of symptoms, lower preoperative forward elevation, and higher preoperative external rotation had large effect sizes. Increased number of suture anchors, less preoperative external rotation deficit compared with the contralateral shoulder, and increased number of previous dislocations had medium effect sizes and may play a role in resulting clinically relevant improvements in outcome. Although some of these factors seem inherently different (shorter duration of symptoms versus increased number of preoperative dislocation events), we believe this analysis can help guide future, larger cohort studies. Shorter duration of symptoms is often associated with improved outcomes after orthopaedic intervention, and it is possible

that patients who have had previous dislocations suffer more significant impairment, thus allowing for greater perceived benefits from surgical intervention. Similarly, someone with lower preoperative forward elevation could be more likely to experience greater perceived benefits from any improvement in motion.

Strengths and Limitations

While the association of factors with clinically meaningful outcomes presented in this study are only preliminary due to small sample size, they can be useful in determining appropriate threshold. Because there is no consensus on identified MCID thresholds, meaningful change for a clinical trial should be decided on an individual basis and within the context of that particular trial.[26] If a future trial includes patients with shorter duration of preoperative symptoms, increased number of surgical anchors, or large number of previous dislocations, using the minimum MCID of 12.5 to 13.2 points may be more appropriate than the conservative approach utilizing the maximum MDC_{90} MCID threshold of 16.5 points on the PASS tool. Moreover, regular use of the PASS tool to assess objective changes from one clinic visit to another can help in the assessment (improvement or worsening) of management success. Knowing the MCID values can provide real-time insight into whether the changes in score values are substantial changes or not clinically meaningful, thus helping to guide whether management needs to be adjusted. Similarly, these preliminary data may be useful in designing a future study to look at improvement in the PASS score above a certain threshold.

The limitations of this study include the heterogeneity of the types of shoulder injuries being treated in the cohort (anterior, posterior, and multidirectional shoulder instability), the anchor cutoff values from the literature not being established in adolescent shoulder instability patients, the small sample size in the $\geq$6-month cohort, and the retrospective study methodology. The diversity of the types of shoulder pathologies being treated may have resulted in a wider variation of outcomes, thus resulting in larger thresholds for the MCID and MDC. Three months postoperative was selected as the time period of interest, as most patients would no longer be experiencing surgical pain and many would be close to completion of their in-person physical therapy visits, while not yet engaging in activities that would leave them susceptible to a reinjury or to improvements unrelated to surgical recovery (ie, changes due to natural maturation). However, due to natural variations in recovery time based on the individual, perhaps this fairly early postoperative time period resulted in a wider spread of outcomes than would a later time period. A larger sample size and longer duration of follow-up will be needed to identify predictors of clinically relevant change. The retrospective nature of the study limited the availability of completed PASS scores. Last, a prospective design with anchor questions intended to establish the Patient Acceptable Symptom State and substantial clinical benefit of the PASS score would be important to get a better understanding of meaningful outcomes in youth shoulder pathologies.

CONCLUSION

According to study findings, physicians and researchers who report a change of 12.5 to 13.2 points on the PASS outcome measure are likely to be reporting the least amount of change that might be important to a patient; however, a score change of $\geq$16.5 points would be required for 90% confidence that the change is above measurement error. The optimal postoperative PASS score was found to be $\geq$85. Duration of symptoms, preoperative ROM, number of suture anchors, and number of previous dislocations were associated with achieving a clinically relevant improvement in PASS score $\geq$6 months after surgery.

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