

Original Research

The Clinical Utility of the Seated Wall Angel as a Test with Scoring

Chad Kofoed^{1a}, Allison Palmsten¹, Jonathon Diercks¹, Michael Obermeier, Marc Tompkins², Terese L Chmielewski¹

¹ Physical Therapy, TRIA Orthopedic Center, ² Orthopedic Surgery, TRIA Orthopedic Center

Keywords: functional outcomes, shoulder, shoulder stretch, shoulder instability, testing battery

<https://doi.org/10.26603/001c.123512>

International Journal of Sports Physical Therapy

Vol. 19, Issue 10, 2024

Background

The seated wall angel (SWA) is an intervention to improve upper quarter mobility but has not been described as a clinical test with scoring.

Hypothesis/ Purpose

To explore the clinical utility of the SWA as a test with scoring. The authors hypothesized that SWA test scores would be lower on the injured than uninjured side, improve over time, and show stronger association with patient-reported shoulder function than shoulder mobility tests.

Study Design

Prospective cohort.

Methods

Patients diagnosed with anterior shoulder instability and referred to physical therapy participated. Testing occurred after physical therapy examination (initial) and six weeks later (follow-up). Rehabilitation was not controlled. Testing included clinical tests (SWA, passive shoulder external rotation range of motion, total arc of motion) and patient-reported outcomes including the American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form, (ASES) and the Western Ontario Shoulder Instability Index (WOSI). The SWA test was scored 0 to 3 points bilaterally based on number of body contacts with the wall (i.e., elbows and fingertips, posterior fingers, posterior forearm). Passive range of motion was measured with a standard goniometer. SWA scores were compared between sides at initial testing and compared between testing timepoints on the injured side. Associations among injured side clinical test values and patient-reported outcome scores were examined.

Results

Mean (SD) SWA score on the injured side was significantly lower than the uninjured side at initial testing [1.6 (1.0) vs 2.2 (1.1), $p = 0.045$] and significantly increased at follow-up testing [2.4 (1.0), $p = 0.041$]. Only SWA test score was significantly correlated with ASES ($r=0.597$) and WOSI ($r=-0.648$) scores at initial testing, and SWA test score was significantly correlated with WOSI score at follow-up testing ($r=-0.611$).

Conclusions

The clinical utility of the SWA test is supported by distinguishing the injured and uninjured sides and having stronger associations with patient-reported shoulder function than shoulder mobility tests.

a Corresponding Author:
Chad Kofoed, PT, DPT
chad.kofoed@tria.com
Phone: 952-806-5705
Fax: 952-806-5510

INTRODUCTION

Upper extremity function requires adequate mobility in the upper quarter, including the extremity joints, the scapulothoracic articulation, and the thoracic spine.¹⁻³ For patients with shoulder conditions, clinical testing typically focuses on mobility of the shoulder, and specifically glenohumeral active and passive range of motion (ROM).^{4,5} Additionally, assessing glenohumeral active and passive external rotation ROM is important during return to sport decision making.⁶ Total arc of motion is the sum of shoulder internal and external ROM measured at 90 degrees of shoulder abduction⁷ and has been studied extensively in overhead athletes.^{5,7-12} A side-to-side difference greater than 5 degrees in total arc of motion has been associated with shoulder and elbow pain and risk for shoulder injury in overhead athletes.^{7,8,13,14} While shoulder ROM and total arc of motion identify impairments in glenohumeral mobility, they do not integrate scapulothoracic and thoracic spine mobility that might give a more comprehensive indication of upper extremity function.

The seated wall angel (SWA), sometimes referred to as the W-stretch, has been described on the internet and on social media sites as an exercise to improve upper quarter mobility.¹⁵⁻¹⁷ The goal of the SWA is to get the entire posterior upper extremity in contact with the wall and some recommend arm elevation (movement) in this position.^{15, 18} Because the SWA requires scapular retraction and thoracic extension, it may give additional information about shoulder complex function compared to glenohumeral mobility testing. In addition, the SWA may be more functional than other glenohumeral mobility tests for overhead athletes and could be used as a screen of upper extremity function in athletes prior to returning to an overhead sport after an injury or as part of a comprehensive upper extremity mobility assessment. The SWA has not been described as a clinical test with a mechanism for scoring.

The purpose of this study was to explore the clinical utility of the SWA as a test with scoring. The authors hypothesized that SWA test scores would be lower on the injured than uninjured side, improve over time, and show stronger association with patient-reported shoulder function compared to other clinical tests of shoulder mobility. Knowledge generated by this study can help clinicians discern the potential for utilizing the SWA test during clinical examination and clinical decision-making.

MATERIALS AND METHODS

STUDY OVERVIEW

This study is a secondary analysis of data acquired for a study focused on developing an upper extremity testing battery. Clinical tests and patient-reported outcomes were collected soon after the physical therapy examination (initial testing) and six weeks later (follow-up testing).

PARTICIPANTS

Between April 2017 and March 2020, patients with anterior shoulder instability undergoing physical therapy were recruited for this study (Figure 1). Inclusion criteria for the study were age 16 to 30 years, physician-diagnosed anterior shoulder instability determined by recent traumatic dislocation or subluxation, and participation in at least 50 hours of exercise in the year prior to injury. Patients were excluded from participation if they had resting shoulder pain greater than 5 on the 0 (no pain) to 10 (worst pain imaginable) point Numeric Pain Rating Scale (NPRS),¹⁹ an additional episode of shoulder instability before completing the study; or history of another physician-diagnosed shoulder, elbow, or wrist injury to either upper extremity. All patients provided written informed consent to participate in the study on a form approved by the Institutional Review Board.

STUDY DESIGN

Patients participated in initial testing soon after their physical therapy examination and follow-up testing six weeks later. The interval between test sessions was selected to allow time for improvement in shoulder function and near the anticipated end of the physical therapy episode of care. Testing consisted of collection of demographic information, performance of clinical tests (SWA test, external rotation passive ROM, and total arc of motion), and completion of patient-reported outcomes focused on shoulder function.

DEMOGRAPHIC INFORMATION

Demographic information was collected by self-report including age, sex, height, weight, the number of prior shoulder instability events, the date of the most recent shoulder instability event, the side of injury, and the arm used to throw a ball (dominant extremity). The NPRS was used to determine the intensity of shoulder pain (0= No pain, 10=Worst pain imaginable).¹⁹ Patients rated their current, usual, best, and worst levels of pain, which were averaged to create a composite of shoulder pain intensity. Height and weight were used to compute body mass index (BMI). The time from the most recent shoulder instability event to initial testing and from the physical therapy evaluation to initial testing were computed. The number of physical therapy visits attended was determined from the electronic medical record.

TESTING PROCEDURES

Testing was administered by a physical therapist or athletic trainer, each with more than 10 years of clinical experience treating patients with upper extremity conditions. The same clinician administered initial and follow-up testing for a given subject. Before the study was initiated, the clinicians reviewed and practiced the standardized testing and scoring procedures.

Pre-testing warm-up consisted of five minutes of light upper body ergometry, 30 small forward and backward arm

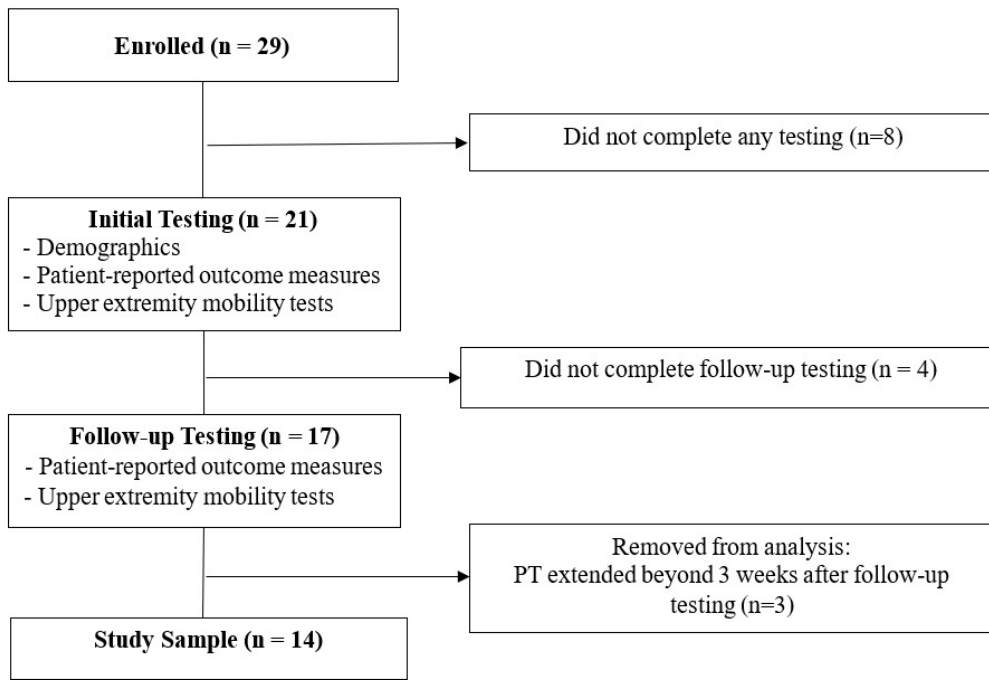


Figure 1. Study Flow Diagram.

circles, and self-stretching as desired by the patient. For all tests, patients were given standardized instructions and a practice trial.

SEATED WALL ANGEL TEST

The test was performed with the patient seated on the floor with knees bent, feet flat on the floor, and the lumbar spine and head in contact with the wall (Figure 2). From this position, the patient was instructed to elevate elbows to shoulder height, and externally rotate the shoulders as much as possible. The patient held the position for scoring, which differs from the SWA as an intervention during which the arms are elevated overhead while maintaining contact with the wall. Scoring was based upon the number of contact points with the wall (elbow and fingertips, posterior fingers, posterior forearm). 0: < 2 points of contact, 1: elbow and fingertip contact, 2: elbow and posterior finger contact, 3: elbow, posterior forearm, and posterior hand contact. The injured and uninjured sides were scored separately.

Reliability of the SWA test was assessed during the study with a sample of convenience. Inter-rater reliability of the scoring method was assessed for the right and left sides of two patient study participants and 10 uninjured controls. One rater performed scoring in real-time, and one rater performed scoring from video. Intraclass correlation coefficients [95% confidence interval] were 0.894 [0.681, 0.968] for the right side and 0.867 [0.618, 0.959] for the left side. Additionally, intra-rater reliability of scoring was assessed for the right and left sides of 11 study participants and 11 uninjured controls. Scoring was completed from video on two occasions, 10 days apart. Intraclass correlation coefficients [95% confidence interval] were 0.891 [0.758, 0.953] for the right side and 0.891 [0.751, 0.954] for the left side.

SHOULDER EXTERNAL ROTATION RANGE OF MOTION AND TOTAL ARC OF MOTION

Total arc of motion is the sum of passive shoulder internal and external rotation ROM (Figure 3).⁷ Testing was performed with the subject in supine and the arm abducted to 90 degrees in the scapular plane with manual stabilization of the scapula at the coracoid process.⁷ A small towel roll was placed under the humerus to ensure motion occurred in the correct plane. External rotation ROM was measured with a standard goniometer when the end point was perceived by the tester or if a patient had apprehension. Internal rotation was measured in the same position with a standard goniometer when the end point was perceived by the tester. Total arc of motion was determined by summing external rotation and internal rotation ROM.

PATIENT-REPORTED OUTCOMES

The American Shoulder and Elbow Surgeons Shoulder Assessment Form (ASES) is a standardized questionnaire for measuring shoulder pain, instability, and activities of daily living.^{20,21} Scores range from 0 to 100 points, and higher scores represent better shoulder function. The ASES is responsive to change, and the minimal clinically important difference (MCID) is 6.4 points.²⁰

The Western Ontario Shoulder Instability Index (WOSI) is a disease-specific quality of life questionnaire for patients with shoulder instability.²² Scores range from 0 to 2100 points, with lower scores representing better function. The WOSI is responsive to change, and the MCID is 220 points.²²




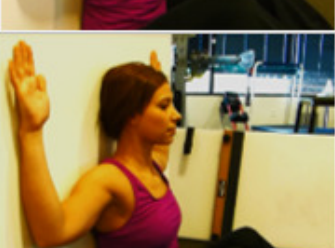
Score	Position	Description
0		Less than 2 points of contact
1		Elbows and fingertip contact
2		Elbows and posterior finger contact
3		Elbows, posterior forearm, and hand contact

Figure 2. Seated Wall Angel Test with Scoring.

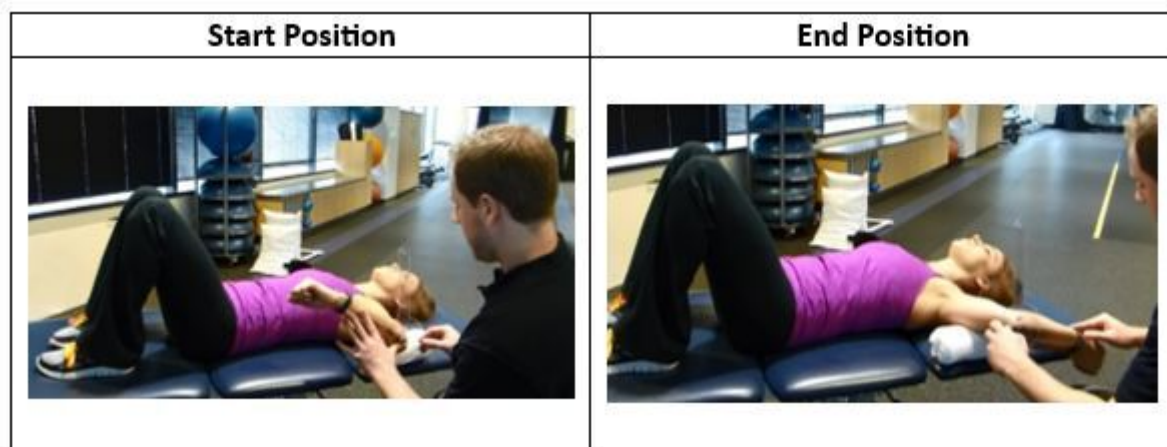


Figure 3. Total Arc of Motion.

STATISTICAL ANALYSIS

No a priori power calculations were performed for this study because it is a secondary analysis. All analyses were performed with commercial software (IBM SPSS Statistics version 28). Descriptive statistics were generated for demographic information variables, clinical test variables, and patient-reported outcome scores. Statistical significance was set at alpha less than 0.05.

Paired t-tests were used to compare SWA test scores between sides at initial testing and to compare injured side SWA test scores at initial and follow-up testing. Effect sizes (Cohens *d*) were calculated for the difference in clinical test values and patient-reported outcome scores from initial testing to follow-up testing using the standard deviation of the difference. An effect size of 0.2 is considered a small effect size, 0.5 is considered moderate, and > 0.8 is considered large.²³

Associations among the clinical test values on the injured side (SWA test, external rotation ROM, and total arc of motion) and patient-reported outcome scores were examined at initial testing and follow-up testing with Pearson correlation coefficients. Correlation coefficients less than 0.4 were considered weak correlations, between 0.4 and 0.69 considered moderate correlations, and 0.7 and higher considered strong correlations.²⁴ If more than one clinical test showed significant correlation with a patient-reported outcome score, stepwise linear regression analysis was performed with the clinical tests as independent variables and patient-reported outcome score as the dependent variable to understand the relative contribution of the clinical tests to patient-reported shoulder function. The criteria for removal from the model was $p > 0.05$.

RESULTS

Demographic information for the patients is found in [Table 1](#). Males comprised 71% of the sample. Initial testing occurred on average about four weeks after the most recent instability event, and approximately a week after the physical therapy evaluation. The number of instability events ranged from one to 20. Patients attended between one and 13 physical therapy visits in the six weeks from initial to follow-up testing. Only two patients had additional physical therapy visits after follow-up testing: one visit and two visits, respectively.

SWA test scores, values for shoulder external rotation ROM, total arc of motion, and patient-reported outcome scores are found in [Table 2](#). Shoulder external rotation ROM was unavailable for two patients at both testing dates and three additional patients at follow-up testing because only total arc of motion was recorded. Thus, analyses involving shoulder external rotation ROM include data from 12 patients at initial testing and nine patients at follow-up testing. At initial testing, the mean injured side SWA test score was significantly lower than the score on the uninjured side ($p = 0.045$). Also, the injured side SWA test score significantly increased from initial testing to follow-up testing ($p = 0.041$). The distribution of SWA test scores is found in

[Figure 4](#). Only 21% of patients achieved the highest score (i.e., “3”) on the injured side at initial testing, whereas 64% achieved the highest score on the injured side at follow-up testing. Effect sizes for the change from initial to follow-up testing did not cross 0 for injured side SWA test score, injured side total arc of motion value, and patient-reported outcome scores. The magnitude of the effect sizes in descending order was ASES score, WOSI score, injured side SWA test score, and injured side total arc of motion value ([Table 2](#)).

SWA test was the only clinical test to show significant correlation with ASES and WOSI scores at initial testing ($r=0.597$ and $r=-0.648$, respectively; [Table 3](#)). The magnitude of the correlations is moderate, and the direction of association is positive for ASES and negative for WOSI, indicating that a higher injured side SWA test score is associated with better patient-reported shoulder function. SWA test score and total arc of motion on the injured side were both associated with WOSI score at follow-up testing ($r=-0.611$ and $r=-0.574$, respectively; [Table 4](#)). The magnitude of the correlations is moderate, and the direction of associations is negative, indicating that higher values for the injured side SWA test and total arc of motion on are associated with better patient-reported shoulder function. The linear regression model with these clinical tests retained only the injured side SWA test score, and the correlation to WOSI score as indicated in [Table 4](#). In addition, significant positive correlations of a moderate to high magnitude were found among clinical tests at initial testing and follow-up testing.

DISCUSSION

This study explored the clinical utility of the SWA as a test with a proposed scoring mechanism. This is novel because the SWA has previously been described as an intervention, not as a clinical test. The hypotheses for the study were supported. First, the injured side SWA test score was lower than the uninjured side at initial testing and improved at follow-up testing. Moreover, the injured side SWA test score demonstrated significant associations with ASES score and WOSI score at initial testing and WOSI score at follow-up testing. Injured side values for the other clinical tests (i.e. total arc of motion and external rotation ROM) were not significantly correlated with ASES and WOSI scores at initial testing and total arc of motion was removed from the regression model in favor of the SWA test score for association with WOSI score at follow-up testing. The clinical utility of the SWA test is supported by distinguishing the injured side from the uninjured side and by having stronger associations with patient-reported shoulder function than shoulder mobility tests.

The patient population and the timing of initial and follow-up testing may contribute to the findings of this study. The population for this study was patients with anterior shoulder instability. As opposed to passive shoulder range of motion testing that took place in the scapular plane, the SWA test position of combined shoulder abduction and external rotation in the frontal plane could make patients ap-

Table 1. Demographic Information.

Variable		Result
Age (years)		21.0 (5.0)
Body mass index (kg/m ²)		25.7 (5.1)
Sex (n)	Males	10
	Females	4
Dominant side (n)	Right	8
	Left	6
Injured side (n)	Dominant	7
	Non-Dominant	7
Composite pain rating (points)	Baseline	2.8 (2.3)
	Follow-up	1.5 (1.6)
Instability events (n)		3.8 (5.3)
Most recent injury to initial testing (weeks)		27.4 (14.7)
Physical therapy evaluation to initial testing (days)		7.7 (4.7)
Physical therapy visits (n)		4.6 (3.2)

Continuous variables are mean (SD).

Table 2. Values for Clinical Tests and Patient-Reported Outcome Measures.

Test		Initial	Follow-up	Effect Size
Seated Wall Angel (points)	Injured	1.6 (1.0) *	2.4 (1.0)**	0.70 [0.10, 1.28]
	Uninjured	2.2 (1.1)	2.6 (0.8)	0.35 [-0.19, 0.89]
External Rotation ROM (degrees)†	Injured	90.8 (15.8)	103.7 (9.6)	0.75 [-0.01, 1.48]
	Uninjured	95.9 (21.5)	103.8 (12.2)	0.36 [-0.33, 1.03]
Total Arc of Motion (degrees)	Injured	129.3 (18.7)	142.0 (24.5)	0.59 [0.01, 1.15]
	Uninjured	144.9 (15.1)	148.1 (18.6)	0.22 [-0.31, 0.75]
ASES (points)		80.0 (8.7)	94.5 (5.9)	1.40 [0.64, 2.14]
WOSI (points)		919.3 (427.3)	502.6 (434.4)	1.24 [0.52, 1.93]

ROM: range of motion

ASES: American Shoulder and Elbow Surgeons Shoulder Assessment Form

WOSI: Western Ontario Shoulder Instability Index

*Value is significantly lower than uninjured side at initial testing (p<0.05)

**Value is significantly higher than initial testing (p<0.05)

†Data available for 12 patients at initial testing and 9 patients at follow-up testing

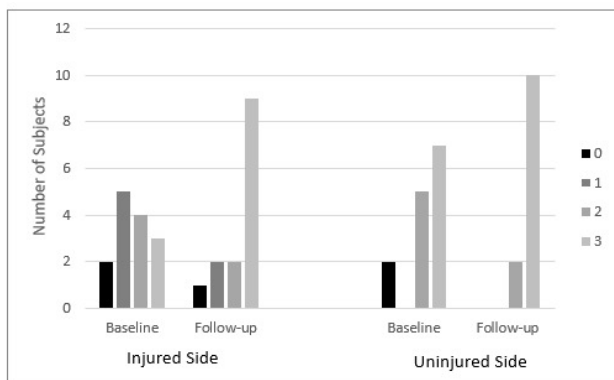


Figure 4. Distribution of Seated Wall Angel Scores at Initial and Follow-up Testing.

prehensive of experiencing instability²⁵⁻²⁷ and may explain the lower test score on the injured side than the uninjured side at initial testing. Further testing in patient populations with other shoulder conditions is necessary to confirm whether the SWA test discriminates the injured side from the uninjured side. Significant improvement in the SWA test score on the injured side at follow-up testing indicates more body contacts with the wall. It cannot be determined how much of the improvement was the result of increased shoulder external rotation ROM, decreased apprehension, changes in scapular movement and thoracic spine ROM, or improved scapular and rotator cuff muscle strength. At follow-up testing, which was near the end of rehabilitation for the patients, 64% achieved the highest score on the SWA test. The six-week interval between testing time points was intended to allow time for a change in shoulder function and not to coincide with return-to-sport testing. Recovery

Table 3. Correlations Coefficients Among Clinical Tests and Patient-Reported Outcome Measures at Initial Testing.

	Seated Wall Angel Test	External Rotation ROM†	Total Arc of Motion
Seated Wall Angel Test			
External Rotation ROM†	n.s.		
Total Arc of Motion	0.615*	0.786*	
ASES	0.597*	n.s.	n.s.
WOSI	-0.648*	n.s.	n.s.

ROM: range of motion
 ASES: American Shoulder and Elbow Surgeons Shoulder Assessment Form
 WOSI: Western Ontario Shoulder Instability Index
 †Data available for 12 out of 14 patients.
 *p<0.05
 n.s.=not significant

Table 4. Correlations Coefficients Among Clinical Tests and Patient-Reported Outcome Measures at Follow-up Testing.

	Seated Wall Angel Test	External Rotation ROM	Total Arc of Motion
Seated Wall Angel Test			
External Rotation ROM†	0.807*		
Total Arc of Motion	0.868*	0.797*	
ASES	n.s.	n.s.	n.s.
WOSI	-0.611*	n.s.	-0.574*

ROM: range of motion
 ASES: American Shoulder and Elbow Surgeons Shoulder Assessment Form
 WOSI: Western Ontario Shoulder Instability Index
 †Data available for 9 out of 14 patients.
 *p<0.05
 n.s.=not significant

time after a shoulder anterior instability event varies in the literature but many athletes return to sport within two to three weeks after injury.²⁸⁻³⁰ If testing took place at return-to-sport, it is unknown if the SWA test would show a ceiling effect. Regardless, experts recommend including ROM as a part of upper extremity return-to-sport testing.⁶

The glenohumeral joint, thoracic spine and scapula make contributions to maximal external rotation of the upper quarter.¹ To achieve the highest score on the SWA test, a patient must have the necessary shoulder external rotation ROM, scapular movement, and thoracic extension to contact the entire posterior upper extremity with the wall. At initial testing, five patients achieved 90 degrees or more of external rotation ROM on the injured side, however, none of these patients received the highest possible score on the SWA test, suggesting apprehension or possible limitations at the thoracic spine or with scapular movement. The SWA test may guide the clinician to examine both the thoracic spine and scapular movement to determine limitations in these areas if the patient has 90 degrees or more of shoulder external rotation ROM.

Change in ASES and WOSI scores exceeded thresholds for MCID, demonstrating clinical improvement over the six-week interval from initial to follow-up testing. The SWA test score demonstrated moderate associations with ASES and WOSI scores at initial testing and WOSI score at follow-

up testing. These findings support the validity of the SWA test as being related to patient-reported shoulder function. It is possible that the SWA test was not associated with ASES score at follow-up testing because ASES score approximated the maximum score (ceiling effect). Additionally, the WOSI has been shown to be more responsive than the ASES in patients with shoulder instability.³¹⁻³³ Interestingly, the shoulder mobility tests (total arc of motion and external rotation ROM) did not show association with the patient-reported outcome scores at initial testing, and the association between total arc of motion and WOSI score at follow-up testing was not retained in multivariate analysis. The authors are unaware of any other studies that have examined the association between total arc of motion and patient-reported shoulder function.

The strength of this study is the exploration of the SWA maneuver, commonly used as an intervention, to a novel clinical test with proposed scoring. The SWA test can be performed quickly in the clinic without special equipment and is less burdensome to the clinician than performing individual measurements of shoulder rotational ROM, thoracic posture and mobility, and scapular function. However, this study has limitations that must be acknowledged. First, the sample size is small and was further reduced for the analyses of shoulder external ROM due to missing data. Second, the patient population is limited to those with an-

terior shoulder instability and may not be generalizable to other patient groups with shoulder pain. Third, rehabilitation during the six-week study period was not monitored nor was scapulothoracic function, thoracic spine mobility, or scapular or rotator cuff muscle strength tested. Thus, the changes in the SWA test score cannot be interpreted to have occurred with respect to any clinical intervention or changes at the scapulothoracic joint, thoracic spine, or scapular and rotator cuff muscle strength. Future studies of the SWA test should include assessment of scapular stabilizer and rotator cuff muscle strength. Fourth, follow-up was based on time, not clinical milestones, and return to sport status was not recorded, so extrapolation of the study findings to return-to-sport decision-making is not appropriate. Finally, the position of the head was not standardized during testing. Adding criteria for head position may improve the reproducibility of testing.

CONCLUSION

The results of this study indicate that the SWA test distinguishes the injured side from the uninjured side, demonstrates a relationship with patient-reported outcome scores, and could augment clinical assessment of shoulder function alongside other shoulder mobility tests. These data provide initial evidence to support further examination of the psychometric properties of the SWA as a clinic test for future inclusion in functional testing batteries.

CONFLICTS OF INTEREST

The authors report no conflicts of interest.

Submitted: February 27, 2024 CDT, Accepted: August 15, 2024 CDT

© The Author(s)



This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CCBY-NC-4.0). View this license's legal deed at <https://creativecommons.org/licenses/by-nc/4.0> and legal code at <https://creativecommons.org/licenses/by-nc/4.0/legalcode> for more information.

REFERENCES

1. Miyashita K, Kobayashi H, Koshida S, Urabe Y. Glenohumeral, scapular, and thoracic angles at maximum shoulder external rotation in throwing. *Am J Sports Med.* 2010;38(2):363-368. doi:[10.1177/0363546509347542](https://doi.org/10.1177/0363546509347542)
2. Lugo R, Kung P, Ma CB. Shoulder biomechanics. *Eur J Radiol.* 2008;68(1):16-24. doi:[10.1016/j.ejrad.2008.02.051](https://doi.org/10.1016/j.ejrad.2008.02.051)
3. Barrett E, O’Keeffe M, O’Sullivan K, Lewis J, McCreesh K. Is thoracic spine posture associated with shoulder pain, range of motion and function? A systematic review. *Man Ther.* 2016;26:38-46. doi:[10.1016/j.math.2016.07.008](https://doi.org/10.1016/j.math.2016.07.008)
4. Stamm MA, Brahmabhatt PS, Brown SM, Miskimin LC, Mulcahey MK. Evaluating risk factors for biceps tendon injuries in softball players: A systematic review. *Clin J Sport Med.* 2023;33(6):623-630. doi:[10.1097/JSM.0000000000001153](https://doi.org/10.1097/JSM.0000000000001153)
5. Ellenbecker TS, Roetert EP, Bailie DS, Davies GJ, Brown SW. Glenohumeral joint total rotation range of motion in elite tennis players and baseball pitchers. *Med Sci Sports Exerc.* 2002;34(12):2052-2056. doi:[10.1097/00005768-200212000-00028](https://doi.org/10.1097/00005768-200212000-00028)
6. Barber P, Pontillo M, Bellm E, Davies G. Objective and subjective measures to guide upper extremity return to sport testing: A modified Delphi survey. *Phys Ther Sport.* 2023;62:17-24. doi:[10.1016/j.pts.2023.05.009](https://doi.org/10.1016/j.pts.2023.05.009)
7. Wilk KE, Macrina LC, Fleisig GS, et al. Correlation of glenohumeral internal rotation deficit and total rotational motion to shoulder injuries in professional baseball pitchers. *Am J Sports Med.* 2011;39(2):329-335. doi:[10.1177/0363546510384223](https://doi.org/10.1177/0363546510384223)
8. Manske R, Wilk KE, Davies G, Ellenbecker T, Reinold M. Glenohumeral motion deficits: friend or foe? *Int J Sports Phys Ther.* 2013;8(5):537-553.
9. Torres RR, Gomes JL. Measurement of glenohumeral internal rotation in asymptomatic tennis players and swimmers. *Am J Sports Med.* 2009;37(5):1017-1023. doi:[10.1177/0363546508329544](https://doi.org/10.1177/0363546508329544)
10. Garrison JC, Cole MA, Conway JE, Macko MJ, Thigpen C, Shanley E. Shoulder range of motion deficits in baseball players with an ulnar collateral ligament tear. *Am J Sports Med.* 2012;40(11):2597-2603. doi:[10.1177/0363546512459175](https://doi.org/10.1177/0363546512459175)
11. Keller RA, De Giacomo AF, Neumann JA, Limpisvasti O, Tibone JE. Glenohumeral internal rotation deficit and risk of upper extremity injury in overhead athletes: A meta-analysis and systematic review. *Sports Health.* 2018;10(2):125-132. doi:[10.1177/1941738118756577](https://doi.org/10.1177/1941738118756577)
12. Gouveia K, Kay J, Memon M, Simunovic N, Ayeni OR. Glenohumeral internal rotation deficit in the adolescent overhead athlete: A systematic review and meta-analysis. *Clin J Sport Med.* 2022;32(5):546-554. doi:[10.1097/JSM.0000000000000945](https://doi.org/10.1097/JSM.0000000000000945)
13. Ruotolo C, Price E, Panchal A. Loss of total arc of motion in collegiate baseball players. *J Shoulder Elbow Surg.* 2006;15(1):67-71. doi:[10.1016/j.jse.2005.05.006](https://doi.org/10.1016/j.jse.2005.05.006)
14. Rosen M, Meijer K, Tucker S, et al. Shoulder range of motion deficits in youth throwers presenting with elbow pain. *Sports Health.* 2022;14(4):478-482. doi:[10.1177/19417381211036387](https://doi.org/10.1177/19417381211036387)
15. Galic B. How to do wall angels for strong, pain-free shoulders. Livestrong.com. Accessed January 20, 2024. <https://www.livestrong.com/article/13769150-wall-angels/>
16. Patient RM. January 21. <https://www.youtube.com/watch?v=vhFxObTi9AM>
17. [P]rehab. November 24, 2023. <https://www.youtube.com/watch?v=mlstZw2dTHU>
18. Intelligence B. November 15. https://www.youtube.com/watch?v=_dweNZff24s
19. Jensen MP, Turner JA, Romano JM, Fisher LD. Comparative reliability and validity of chronic pain intensity measures. *Pain.* 1999;83(2):157-162. doi:[10.1016/s0304-3959\(99\)00101-3](https://doi.org/10.1016/s0304-3959(99)00101-3)
20. Michener LA, McClure PW, Sennett BJ. American Shoulder and Elbow Surgeons standardized shoulder assessment form, patient self-report section: reliability, validity, and responsiveness. *J Shoulder Elbow Surg.* 2002;11(6):587-594. doi:[10.1067/mse.2002.127096](https://doi.org/10.1067/mse.2002.127096)
21. Goldhahn J, Angst F, Drerup S, Pap G, Simmen BR, Mannion AF. Lessons learned during the cross-cultural adaptation of the American Shoulder and Elbow Surgeons shoulder form into German. *J Shoulder Elbow Surg.* 2008;17(2):248-254. doi:[10.1016/j.jse.2007.06.027](https://doi.org/10.1016/j.jse.2007.06.027)

22. Kirkley A, Griffin S, McLintock H, Ng L. The development and evaluation of a disease-specific quality of life measurement tool for shoulder instability. The Western Ontario Shoulder Instability Index (WOSI). *Am J Sports Med.* 1998;26(6):764-772. [doi:10.1177/03635465980260060501](https://doi.org/10.1177/03635465980260060501)
23. Sullivan GM, Feinn R. Using effect size-or why the P value is not enough. *J Grad Med Educ.* 2012;4(3):279-282. [doi:10.4300/JGME-D-12-00156.1](https://doi.org/10.4300/JGME-D-12-00156.1)
24. Schober P, Boer C, Schwarte LA. Correlation coefficients: Appropriate use and interpretation. *Anesth Analg.* 2018;126(5):1763-1768. [doi:10.1213/ANE.0000000000002864](https://doi.org/10.1213/ANE.0000000000002864)
25. Olds MK, Ellis R, Parmar P, Kersten P. Who will redislocate his/her shoulder? Predicting recurrent instability following a first traumatic anterior shoulder dislocation. *BMJ Open Sport Exerc Med.* 2019;5(1):e000447. [doi:10.1136/bmjsem-2018-000447](https://doi.org/10.1136/bmjsem-2018-000447)
26. Eshoj H, Rasmussen S, Frich LH, Jensen SL, Sogaard K, Juul-Kristensen B. Patients with non-operated traumatic primary or recurrent anterior shoulder dislocation have equally poor self-reported and measured shoulder function: a cross-sectional study. *BMC Musculoskelet Disord.* 2019;20(1):59. [doi:10.1186/s12891-019-2444-0](https://doi.org/10.1186/s12891-019-2444-0)
27. Olds M, Ellis R, Parmar P, Kersten P. The immediate and subsequent impact of a first-time traumatic anterior shoulder dislocation in people aged 16-40: Results from a national cohort study. *Shoulder Elbow.* 2021;13(2):223-232. [doi:10.1177/1758573220921484](https://doi.org/10.1177/1758573220921484)
28. Buss DD, Lynch GP, Meyer CP, Huber SM, Freehill MQ. Nonoperative management for in-season athletes with anterior shoulder instability. *Am J Sports Med.* 2004;32(6):1430-1433. [doi:10.1177/0363546503262069](https://doi.org/10.1177/0363546503262069)
29. Watson S, Allen B, Grant JA. A clinical review of return-to-play considerations after anterior shoulder dislocation. *Sports Health.* 2016;8(4):336-341. [doi:10.1177/1941738116651956](https://doi.org/10.1177/1941738116651956)
30. Hasebroock AW, Brinkman J, Foster L, Bowens JP. Management of primary anterior shoulder dislocations: a narrative review. *Sports Med Open.* 2019;5(1):31. [doi:10.1186/s40798-019-0203-2](https://doi.org/10.1186/s40798-019-0203-2)
31. Hajewski CJ, Glass NA, Westermann RW, Bollier M, Wolf BR, Hettrich C. Performance of the PROMIS after operative interventions for shoulder instability. *Orthop J Sports Med.* 2019;7(5):2325967119846920. [doi:10.1177/2325967119846920](https://doi.org/10.1177/2325967119846920)
32. Kemp KA, Sheps DM, Beaupre LA, Styles-Tripp F, Luciak-Corea C, Balyk R. An evaluation of the responsiveness and discriminant validity of shoulder questionnaires among patients receiving surgical correction of shoulder instability. *Sci World J.* 2012;2012:410125. [doi:10.1100/2012/410125](https://doi.org/10.1100/2012/410125)
33. Kirkley A, Griffin S, Dainty K. Scoring systems for the functional assessment of the shoulder. *Arthroscopy.* 2003;19(10):1109-1120. [doi:10.1016/j.arthro.2003.10.030](https://doi.org/10.1016/j.arthro.2003.10.030)