Comparison of 2 Exercise Rehabilitation Programs for Multidirectional Instability of the Glenohumeral Joint

A Randomized Controlled Trial

Sarah A. Warby,*†‡§ PhD, B Physio (Hons), Jon J. Ford,† PhD, M Physio, B AppSci (Physio), Andrew J. Hahne,† PhD, B Physio (Hons), Lyn Watson,†‡§ DProf., B AppSci (Physio), GradDip, Simon Balster,‡§ BPhty (Hons), BSc(Hons), Ross Lenssen,†‡§ BHSc, and Tania Pizzari,† PhD, B Physio (Hons)
Investigation performed at La Trobe University, Bundoora, Australia

Background: The recommended initial treatment for multidirectional instability (MDI) of the shoulder is a rehabilitation program, yet there is very low-quality evidence to support this approach.

Purpose/Hypothesis: The purpose was to compare the Watson MDI program and Rockwood Instability program among patients with nontraumatic, nonstructural MDI. The hypothesis was that the Watson MDI program would produce clinically and statistically superior outcomes over the Rockwood Instability program.

Study Design: Randomized controlled trial; Level of evidence, 2.

Methods: Forty-one participants with MDI were randomly allocated to the Watson MDI or Rockwood Instability program. Participants attended 12 weekly physiotherapy sessions for exercise prescription. Outcomes were assessed at baseline and 6, 12, and 24 weeks after randomization. Primary outcomes were the Melbourne Instability Shoulder Score (MISS) and the Western Ontario Shoulder Index (WOSI). Secondary outcomes included the Orebro Musculoskeletal Pain Questionnaire, pain, muscle strength, scapular upward rotation, scapular coordinates, global rating of change, satisfaction scales, limiting angle in abduction range, limiting factor in abduction range, and incidence of dislocation. Primary analysis was by intention to treat based on linear mixed models.

Results: Between-group differences showed significant effects favoring the Watson program for the WOSI (effect size [ES], 11.1; 95% CI, 1.9-20.2; $P = .018$) and for the limiting factor in abduction (ES, 0.1; 95% CI, 0.0-1.6; $P = .023$) at 12 weeks, and for the WOSI (ES, 12.6; 95% CI, 3.4-21.9; $P = .008$), MISS (ES, 15.4; 95% CI, 5.9-24.8; $P = .002$), and pain (ES, -2.0; CI: -2.3 to -0.7, $P = .003$) at 24 weeks.

Conclusion: For people with MDI, 12 sessions of the Watson MDI program were more effective than the Rockwood program at 12- and 24-week follow-up.

Registration: ACTRN12613001240730 (Australian New Zealand Clinical Trials Registry).

Keywords: multidirectional instability; MDI; shoulder; rehabilitation; randomized controlled trial; scapula

Multidirectional instability (MDI) of the shoulder is commonly defined as symptomatic glenohumeral subluxation or dislocation in at least 2 directions.[2,4,16] MDI is typically attributed to a history of microtrauma imposed on a congenitally lax and redundant joint capsule.[1,16,28,36] In addition, patients with MDI have altered muscle patterning,[35,39] reduced muscle strength,[20] and reduced scapular upward rotation.[20,38] MDI can affect quality of life owing to pain and activity limitation.[1,2] The true prevalence of MDI is unknown,[60] although the incidence is reported to peak in the second and third decades of life.[36]

The most commonly recommended initial treatment for MDI is a rehabilitation program, with the rationale that strengthening the shoulder muscles compensates for a lack of passive stability and assists in active control.[53] Surgery may be considered if nonoperative management fails.[2,4,16] However, the long-term outcomes of surgery on a capsule that has a high susceptibility to stretch[54] are still unknown; therefore, rehabilitation is considered the primary treatment option.[16] Systematic reviews[53,54] have

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reported benefits of rehabilitation programs for patients with MDI; however, the quality of this evidence is very low because of heterogeneous patient samples and outcome measures nonspecific or not sensitive to measuring change in people with MDI.[53,54]

Apart from 1 instability program[3] whose published protocol was released after the commencement of the current trial, the Rockwood Instability program[7] was the only published MDI program that provided enough detail for practitioners to replicate it in the clinical setting. Burkhead and Rockwood[7] demonstrated that 87% of their participants with MDI (n = 6) had good to excellent results on the Constant score with this program. The Rockwood program focuses on strengthening the deltoid and the glenohumeral rotators with the arm at low degrees of shoulder elevation. There is no specific retraining of faulty scapular biomechanics. It is commonly used clinically when treating MDI, yet there is little evidence for its efficacy.[53,54]

The Watson MDI program[58,59] focuses on reestablishing patient-specific scapular motor control, typically scapular upward rotation, before any rotator cuff or deltoid strengthening. Scapular motor control is emphasized throughout the program, and exercises progress into functional and sport-specific ranges depending on patient requirements. A pre- and posttest study[56] showed significant improvements on the Melbourne Instability Shoulder Score (MISS) and the Western Ontario Shoulder Index (WOSI) for people with MDI.

No randomized controlled trial (RCT) has been published comparing the effect of 2 rehabilitation programs for MDI.[53] The primary aim of this RCT was to compare the effectiveness of the Rockwood Instability program and the Watson MDI program on the functional and instability-specific outcomes, scapular biomechanics, and muscle strength of participants with nontraumatic nonstructural MDI. The researchers hypothesized that the Watson MDI program would produce clinically and statistically superior outcomes over the Rockwood Instability program.

METHODS

Trial Design

This multicenter RCT was prospectively registered (ACT RN12613001240730; Australian New Zealand Clinical Trials Registry) and the protocol published.[52] The flow of participants through the trial is outlined in Figure 1. The La Trobe University Human Ethics Committee (FHEC12/201) approved this trial. Participants read a detailed information sheet and signed a written consent form.[52] Participants were randomly allocated to one of two 12-week exercise programs: the Rockwood Instability program or the Watson MDI program.

Participants and Recruitment

Participants were recruited from physiotherapists, sports physicians, and orthopaedic surgeons, as well as public advertising. Eligible participants were aged 12 to 35 years and had symptomatic glenohumeral joint subluxation or dislocation in >1 direction.[2,4,52] Diagnosis was based on a positive sulcus sign and a positive test (drawer test and/or apprehension test) for anterior and/or posterior instability.[52] Apprehension was the criterion for a positive instability test, not just pain or signs of laxity.[52] These tests are valid and reliable for diagnosing instability when apprehension is used as the criterion for a positive test.[52]

Eligible participants must have reported no history of significant trauma to the affected shoulder. A significant history of trauma was defined as contact with an external object (eg, a fall, impact with another body or surface) with lockout of the glenohumeral joint and conscious awareness by the patient of a sudden onset of pain.[52] Magnetic resonance imaging was performed to rule out any structural lesion of the glenohumeral joint (eg, labral tear, bony Bankart).[52] Participants with a history of trauma and/or structural lesions were more likely to have unidirectional instability.[30] Appendix 1 (available in the online version of this article) details a full list of inclusion and exclusion criteria. All eligible participants signed a consent form, and for those <18 years old, a guardian signed an additional consent form.

Randomization Process

Using a web-based program (http://www.randomisation.com), one of the researchers (A.J.H.) prepared the randomization sequence with random block sizes, stratified per treating practitioner,[45] and allocated participants to interventions (allocation ratio, 1:1).[33] This researcher was the only person with access to the allocation spreadsheet and had no contact with any participants throughout the trail. The spreadsheet was located remotely to the treating clinics. To enroll a participant in a concealed manner, the primary researcher (S.A.W.) emailed the consenting participant's name, date

*Address correspondence to Sarah A. Warby, PhD, B Physio (Hons), LifeCare Prahran Sports Medicine, 316 Malvern Rd, Prahran, Victoria 3181, Australia (email: S.Warby@latrobe.edu.au).

†Department of Rehabilitation, Nutrition and Sport, School of Allied Health, College of Science, Health and Engineering, La Trobe University, Bundoora, Australia.

‡LifeCare Prahran Sports Medicine Centre, Prahran, Australia.

§Melbourne Orthopedic Group, Windsor, Australia.

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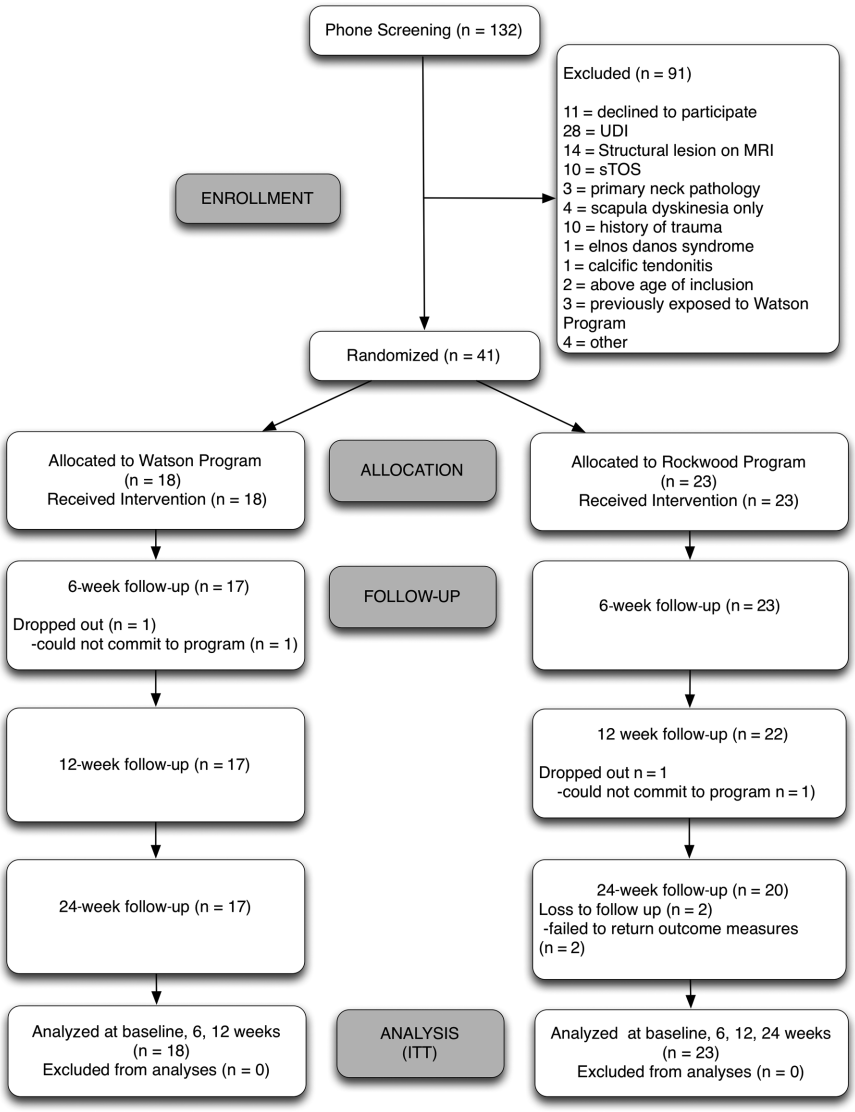

Figure 1. Flow of participants through the trial. ITT, intention to treat; MRI, magnetic resonance imaging; sTOS, symptomatic thoracic outlet syndrome; UDI, unidirectional instability.

of birth, and treating physiotherapist to the allocator (A.J.H.), who enrolled the participant and notified the treating physiotherapist of the treatment allocation.

Interventions

Participants attended a weekly 30-minute physiotherapy session for 12 weeks in either the Watson MDI program[58,59] or the Rockwood Instability program,[7] where they were prescribed and progressed through a set program of specific exercises to perform at home (Table 1). Physiotherapists spent each 30-minute session in its entirety with the participant, regardless of treatment allocation. Equipment for the relevant program was supplied. All participants were educated regarding the nature of their injuries, the rationale for exercise treatment, and the importance of compliance to the program.

Rockwood Instability Program. The Rockwood program[7] focused on concurrently strengthening all 3 parts of the deltoid and internal and external rotators of the glenohumeral joint in 2 phases. Phase 1 involved 5 exercises for the rotator cuff and deltoid with 6 progressive levels of Theraband resistance. Phase 2 of strengthening began when the participant progressed through all the resistance bands in phase 1. The participant was then asked to perform the same exercises as for phase 1 using a 4-kg weight with a pulley kit. Weights were progressed in increments of 1 kg.

Watson MDI Program. The Watson program[58,59] was primarily based around retraining and maintaining good scapula and humeral head motor control before any rotator cuff and deltoid strengthening. The program was divided into 6 stages, with the first stage focusing on retraining faulty scapular biomechanics. Assessment of the individual participant[52,58] determined the exact scapular position that the

TABLE 1
Treatment Programs[a]

Rockwood Program	Watson Program
Focus: Concurrent rotator cuff and deltoid strengthening and push-ups for scapular stability. Majority of exercises performed at 0° of elevation.	Focus: Retraining specific scapular motor control before any rotator cuff/deltoid strengthening. Exercises progress into functional/sports specific ranges.
Aims and exercise drills	
Phase 1: Strength through progressive levels of Theraband (Theraband Hygenic Corporation) resistance. Load: Tan, yellow, red, green, blue Theraband. Patient standing • ER (0°-45° ER) at 0° abduction • IR (0°-45° IR) at 0° abduction • Extension row to 45° • Flexion • Short-lever abduction to 45° • Wall, knee, or full push-ups (no Theraband resistance)	Stage 1a: Retrain scapular motor control Load: 0-1 kg • Scapular upward rotation/elevation drills in standing Stage 1b: Controlling arcs of motion (0°-45° elevation) Load: yellow-red Theraband Patient standing • Extension rows (from 45° flexion to neutral) • ER (0°-45° ER) at 0° abduction • IR (0°-45° IR) at 0° abduction
Phase 2: Strength through resistance with weights • Exercises as above with a weights-and-pulley system. • Addition of shoulder shrug Load commences at 4 kg Progresses in 1 kg increments 9 kg max for females, 11 max for males	Stage 2: Building posterior GHJ muscle bulk Load: green Theraband/1-2 kg • Standing bent over rows • Side-lying ER • Standing Theraband rows Stage 3: Sagittal plane (flexion motor control) Load: yellow-green Therabands/1-3 kg Patient standing • Flexion with Therabands and weights
Not all exercises need to be progressed at the same time, and participants may be on a different band or weight/resistance for different exercises.	Stage 4: Controlling arcs of motion (45°-90° elevation) Patient standing Load: yellow-green Therabands/2-5 kg • ER at 90° • IR at 90° • Flexion at 90° Stage 5: Specific deltoid strengthening Load: 1-4 kg+ Patient standing • Bent-over rows • Supine and sitting flexion • Short-lever abduction 45°-60° Stage 6: Sports specific and functional stage. Load: depends on participant's requirements. Drills mimic specific sporting or functional activates Part to full practice
Pain and progression of program	
Exercises must be pain free to perform. Band or weight resistance is progressed once the participant reports that the current resistance is "relatively easy" to perform.	Exercises must be pain free to perform. Progression through the components of a particular stage or to the next stage is dependent on achieving scapular and glenohumeral joint motor-control without the presence of pain for a full set of any one exercise
Dosage	
All exercises: 5 repetitions with a 5-s hold at the end range of the exercise. All exercises are performed twice a day.	Depends on the functional needs of the patient. Typically start with a recruitment dosage for motor relearning (3 × 20, 2×/day),[5] followed by an endurance dosage (3 × 10-15, 2×/day), then strength dosage in later stages (4 × 8-12, every second day).[25] For most exercises, repetitions are held for 3 s.

[a]ER, external rotation; GHJ, glenohumeral joint; IR, internal rotation.

TABLE 2
Outcome Measures[a]

Outcome Measure	Method of Assessment	Time Point for Assessment
	Primary outcomes	
Melbourne Instability Shoulder Score	Online link/booklet	Baseline and 6, 12, 24, and 52 wk after randomization
Western Ontario Shoulder Index	Online link/booklet	
	Secondary outcomes	
Orebro Musculoskeletal Pain Questionnaire	Online link/booklet	Baseline and 6, 12, 24, and 52 wk after randomization
Global Rating of Change	Online link/booklet	Baseline and 6, 12, 24, and 52 wk after randomization
Patient Satisfaction Score (with treatment and results)	Online link/booklet	Baseline and 6, 12, 24, and 52 wk after randomization
Incidence of complete glenohumeral joint dislocation	Online link/booklet	Baseline and 6 and 12 wk after randomization
Scapular coordinates (online supplementary, Appendix 2)	Blinded researcher in clinic	Baseline and 12 wk after randomization
Scapular upward rotation	Blinded researcher in clinic	Baseline and 12 wk after randomization
Muscle strength	Blinded researcher in clinic	Baseline and 12 wk after randomization
Symptomatic onset, limiting factor, and angle of limiting factor in abduction	Blinded researcher in clinic	Baseline and 12 wk after randomization
Compliance	Recorded in clinical notes by physiotherapist	Recorded in the clinical notes from sessions 2-12
Adverse events	Online link/booklet	Recorded in the clinical notes for every session and formally assessed at 6, 12, 24, and 52 wk after randomization
Success of blinding	Online link/booklet	12 wk after randomization

[a]A detailed description of all outcome measures and their validity, reliability, and method of administration, as well the definitions of adverse events for this trial, has already been published.[52] Medications used and any cointerventions were also recorded by the physiotherapist in the clinical notes and by the participant using the online link at baseline and 6, 12, 24, and 52 weeks after randomization.

patient must retrain and maintain throughout the program. The stages progressed via an increase in load and an increase in range of glenohumeral joint elevation. The final stages incorporated functional and/or sport-specific exercises.[58,59]

Blinding

Participants, the researcher scoring and entering outcome measures, and the assessor of scapular coordinates (for method, see Appendix 2, available online), upward rotation, and strength were all blinded to the treatment allocation of participants.[6] The nature of the interventions prevented blinding of trial physiotherapists.

Treating Physiotherapists and Treatment Fidelity

Treating physiotherapists were provided with a treatment manual and were involved in an initial 2-day training program and quarterly workshops to review participant cases. Treating physiotherapists were also required to complete standardized electronic clinical notes at every treatment session. To evaluate treatment fidelity, these were reviewed at 3, 6, and 12 weeks by researchers (T.P., J.J.F., R.L.) unblinded to participant treatment allocation, to ensure compliance with the protocol.[52]

Outcomes

Outcome measures are summarized in Table 2. The primary outcomes were the MISS[57] and the WOSI,[23] which are valid, reliable, and sensitive tools for measuring changes in the shoulder instability population.[40] All secondary outcomes also have good reliability and validity.[52] The majority of outcomes were assessed via a set of self-administered questionnaires that were delivered to the participants via email as a secure online link or as a mailed hard copy. The set of questionnaires were sent to participants 1 week before their first physiotherapy session (baseline time point) and at 6, 12, and 24 weeks after randomization. Compliance with the home program was scored weekly by each participant's treating physiotherapist (Appendix 3). The remaining outcomes were collected at the participant's treatment clinic by a researcher (S.A.W. or T.P.) who was blinded to treatment allocation.

Sample Size

It was calculated a priori that a definitive RCT would require a sample size of 328 participants (164 in each group) to detect a minimal clinically important difference (MCID) of 5 points on the MISS outcome measure, assuming a standard deviation of 16 (alpha of 0.05 and a power of 80%).[11,57] This large estimated sample size could be due to

TABLE 3
Baseline Characteristics of Participants in the Trial[a]

	Watson Group	Rockwood Group
Participants	18	23
Age, y	21.8 ± 6.5	23.0 ± 6.5
Female	15 (83.3)	18 (78.3)
Duration of symptoms, mo	43.28 ± 87	46.8 ± 45.8
Dominant:nondominant shoulders in trial	15 :3	17:6
Unilateral:bilateral symptoms	5 :13	8:15
Instability directions		
Two	7 (38.9)	5 (21.7)
Three	11 (61.1)	18 (78.3)
Presence of generalized ligament laxity	10 (55.6)	16 (69.6)
Main sporting participation		
Overhead/throwing sport	7 (38.9)	6 (26.1)
Dance/yoga/Pilates	1 (5.6)	4 (17.4)
Weight lifting at gym	6 (33.3)	4 (17.4)
Lower limb dominated sport	2 (11.1)	1 (4.3)
Other	1 (5.6)	3 (13)
Nil	1 (5.6)	5 (21.7)
Primary outcome measures, total score		
WOSI	37.9 ± 17.5	41.8 ± 16.0
MISS	47.6 ± 16.8	48.7 ± 15.3

[a]Values are presented as No. (%) or mean ± SD, unless noted otherwise. MISS, Melbourne Instability Shoulder Score; WOSI, Western Ontario Shoulder Index.

the large standard deviation, which was the only available measure of variance for the primary outcomes measures.[57] Based on PhD time lines and the trial funding being exhausted, a decision was made to stop the trial after 2 years. The researchers had no knowledge of the results when making this decision.

Statistical Methods

The primary method for data analysis was via intention to treat.[27,34] Analyses focused on detecting between- and within-group treatment effects (with effect sizes and 95% CIs) at each follow-up time point (6, 12, and 24 weeks). Continuous data were analyzed with linear mixed models, given its advantages in modeling repeated measures over time and adjusting for baseline scores.[26] Missing continuous data were accounted for by restricted maximum likelihood estimation within the linear mixed models.[31] Ordinal data were analyzed with the Mann-Whitney *U* test[42] and categorical data with chi-square tests.[10] Analysis was performed with SPSS (v 22; IBM). All tests were 2-tailed with alpha set at 0.05.

A responder analysis was conducted on the primary outcome measures (MISS and WOSI) to aid in determining the clinical importance of the effects.[13,15] At each time point (6, 12, and 24 weeks), cases were dichotomized as either "responders" or "nonresponders" based on whether participants improved from baseline by more than the MCID on the MISS (5 points) or the WOSI (10.4%).[13,47] Risk ratio, risk difference, and number needed to treat were calculated with 95% CI and statistical significance evaluated with the chi-square test.[8,33,46]

RESULTS

This trial recruited 41 participants between November 2013 and December 2015. Groups were well matched at baseline (Table 3). The mean (SD) number of treatments attended over the 12-week program was 11.3 (2.1) for the Watson group and 11.2 (2.3) for the Rockwood group. One participant in the Watson group (5.6%) and 1 in the Rockwood group (4.3%) discontinued treatment before the end of the program. Over the 12-week program, 14 minor adverse events were reported (5 Watson, 9 Rockwood), which were all attributed to postexercise soreness and resolved with 48 hours of rest and modification of exercise. No serious adverse events were reported. For success of blinding in the Watson group, 2 of 16 (12.5%) correctly guessed their treatment allocation; 1 (6.3%) incorrectly guessed; and 13 (81.3%) were unsure. For the Rockwood group, 5 of 22 (22.7%) correctly guessed their treatment allocation, and 18 (81.8%) were unsure. During the 12-week program, participants in the Watson group were less compliant than participants in the Rockwood group (−2.5; 95% CI, −5.0 to −0.1; $P = .042$) (Appendix 3).

Primary Intention-to-Treat Analyses

There were no significant between-group differences for any outcomes at 6 weeks. For the primary outcome measures, participants in the Watson MDI program demonstrated significantly greater improvements on the WOSI at 12 and 24 weeks and on the MISS at 24 weeks as compared with participants in the Rockwood program (Table 4). For continuous secondary outcome data (Appendix 4),

the Watson group demonstrated a significantly larger reduction in pain at 24 weeks and a significantly larger increase in flexion strength at 12 weeks. Significantly larger effects were seen for the Watson group for scapular coordinates of acromioclavicular joint *y*-axis at resting abduction and inferior angle of the scapula *y*-axis at 90° of glenohumeral joint abduction at 12 weeks. All other secondary continuous outcomes were not significant. For categorical secondary outcomes, significantly fewer participants in the Watson group reported pain as their limiting factor in abduction range of motion at 12 weeks (Table 5). Significance was not reached for differences between groups for incidence of dislocation, global rating of change scores, and satisfaction scores (Appendix 5).

Within-group analyses showed a significant improvement from baseline to each follow-up for both groups for the MISS, the WOSI, and all continuous secondary outcomes (Table 4, Appendix 4). There were no significant between-group differences in the proportion of participants who achieved more than the MCID on the MISS and the WOSI (Appendix 6).

DISCUSSION

In this trial, 12 sessions of the Watson MDI program were more effective than 12 sessions of the Rockwood Instability program for functional instability-specific outcomes of the WOSI (at 12 and 24 weeks) and the MISS (24 weeks), pain (12 and 24 weeks), and limiting factor in abduction range of motion (12 weeks) for participants with nontraumatic, nonstructural MDI. Although there were no significant differences between groups for any outcome at 6 weeks, the magnitude of effect increased from a moderate size at 12 weeks to a large effect at 24 weeks for the MISS, the WOSI, and pain scores, indicating not only statistical significance but a clinically important difference between groups.[15,37] This difference is meaningful when considering the large and significant within-group treatment effects for both groups on the primary outcomes.[18] Because of the large treatment effects, this study can be considered a definitive RCT, as the effects for the MISS at 12 and 24 weeks were substantially larger than the MCID that was used to estimate the original sample size.[57]

One potential explanation for the between-group differences is the Watson program's progression of exercises into functional and sport-specific ranges. Functional gains are task and position specific,[12,49] and the larger between-group effects favoring the Watson program in the overhead and sporting subsections of the MISS and the WOSI reflect the potential importance of addressing these positions.

Another explanation for the greater improvements in the Watson group could be the effects of building proximal scapular stability for optimal distal control. The scapula thoracic joint provides the base of support from which the glenohumeral joint can adequately function.[44] In MDI, poor scapular control, particularly upward rotation, reduces joint congruency and therefore increases the potential for glenohumeral joint instability.[2] The Watson program has a primary focus on ensuring that proximal scapular stability is achieved and maintained before adding glenohumeral joint movements throughout all stages of the program. In contrast, the Rockwood program strengthens the scapula, deltoid, and rotator cuff concurrently. The Watson program's development of specific proximal control may have enhanced bony congruency[44] and optimized glenohumeral joint function, resulting in improved functional outcomes. The results of this trial are similar to previous intervention studies in neck pain,[22] low back pain,[9] and subacromial impingement,[19,48] which showed significantly favorable effects when the deficit in stability muscles was specifically retrained, as opposed to being progressed through a more global strengthning program.

Another possible explanation could be the Watson program's focus on motor control training of the scapular muscles. Motor control training is the ability to consciously target a specific component of movement,[5,51] which requires increased levels of attention and precision than does contraction of more global muscles.[5] Motor control training has been shown to enhance reorganization of movement representation within the motor cortex,[21,29,43] which is associated with earlier activation of postural muscles,[51] task performance improvements,[50] and a significant reduction in pain.[41,51] The Watson program uses motor control training to restore a scapular deficit before initiating global shoulder strengthening. The potential effects of motor control training on the movement representation of the motor cortex and, therefore, peripheral motor control may explain the continued improvements of the Watson group on the MISS, WOSI, and pain scale from the 12- to 24-week outcomes, despite the exercise programing ceasing at 12 weeks. In contrast, the Rockwood group regressed on the WOSI and pain scale at 24 weeks. This rationale is speculative, and long-term central changes in response to an exercise program would need to be investigated in future research.

The greater effects in the Watson group were achieved despite lower compliance to exercise in that group. The lower compliance might be explained by the complexity and, hence, perceived effort to perform the exercises in the Watson program versus the Rockwood program. Blinding was successful in both groups owing to the high proportion of participants who were unsure of their treatment allocation.[24]

Trial Limitations

There were no between-group differences for scapular upward rotation angles and strength at higher ranges. As the largest effects for the primary functional outcomes were detected at 24 weeks, the 12-week time point may have been too early to detect significant between-group differences for these outcomes. The significant result of flexion strength only (as well as 2 scapular coordinates points) could also reflect a Type I error based on multiple tests.[14] In addition, the inclinometer (used to measure scapular angles) provides a reliable measure for static upward rotation only[55]; it has limitations for evaluating dynamic scapular motor control. Other mechanisms responsible for changes in scapular motor control need to

TABLE 4
Effects of the Watson Multidirectional Instability Program vs the Rockwood Instability Program on Continuous Primary and Secondary Outcomes[a]

Weeks[b]	Within-Group Mean Difference (95% CI)		Unadjusted Mean Score (SD)		Adjusted SMD (95 % CI)[c]	Adjusted Between-Group Difference (95 % CI)[c]	*P* Value
	Watson	Rockwood	Watson	Rockwood			
Primary outcomes							
WOSI total score (score from 0% to 100%, 100% = a normal shoulder; a higher percentage indicates a higher-functioning shoulder)							
Baseline			37.9 (17.5)	41.8 (16.0)			
6	16.3 (9.7 to 22.8)	14.3 (8.0 to 20.6)	54.0 (20.5)	56.1 (24.2)	0.1 (−0.5 to 0.7)	2.0 (−7.1 to 11.1)	.667
12	33.6 (27.1 to 40.2)	22.5 (16.1 to 28.9)	71.4 (18.5)	65.4 (23.2)	0.5 (−0.1 to 1.1)	11.1 (1.9 to 20.2)	**.018**
24	35.1 (28.6 to 41.6)	22.3 (15.6 to 28.9)	72.8 (15.7)	66.7 (22.5)	0.6 (0.0 to 1.3)	12.6 (3.4 to 21.9)	**.008**
WOSI physical (score from 0 to 100 points; a lower score indicates a higher level of shoulder physical disability)							
Baseline			64.4 (17.1)	61.3 (15.9)			
6			47.5 (19.6)	46.2 (24.8)	−0.1 (−0.7 to 0.6)	−1.6 (−10.8 to 7.5)	.722
12			30.4 (16.8)	36.2 (23.1)	−0.5 (−1.1 to 0.1)	−10.1 (−19.3 to −0.9)	**.031**
24			30.7 (15.3)	35.8 (22.1)	−0.6 (−1.2 to 0.1)	−10.9 (−20.2 to −1.6)	**.022**
WOSI sport (score from 0 to 40 points; a lower score indicates a higher level of shoulder sporting disability)							
Baseline			27.0 (7.6)	23.3 (8.2)			
6			21.4 (10.3)	18.2 (12.0)	−0.1 (−0.7 to 0.6)	−0.6 (−6.1 to 4.8)	.824
12			12.5 (10.1)	13.7 (10.4)	−0.5 (−1.1 to 0.1)	−5.3 (−10.7 to 0.2)	.060
24			10.1 (8.0)	13.0 (10.3)	−0.8 (−1.4 to −0.1)	−7.4 (−13.0 to −1.9)	**.009**
WOSI lifestyle (score from 0 to 40 points; a lower score indicates a higher level of shoulder lifestyle disability)							
Baseline			17.2 (9.5)	16.9 (8.8)			
6			12.6 (8.5)	12.3 (10.4)	−0.0 (−0.6 to 0.6)	−0.2 (−3.9 to 3.5)	.900
12			7.7 (7.8)	9.8 (9.8)	−0.3 (−1.0 to 0.3)	−3.0 (−6.7 to 0.7)	.108
24			6.7 (6.1)	7.9 (9.2)	−0.3 (−0.9 to 0.3)	−2.6 (−6.3 to 1.2)	.180
WOSI emotion (score from 0 to 30 points; a lower score indicates a higher level of shoulder emotional disability)							
Baseline			21.9 (6.2)	20.7 (6.8)			
6			14.9 (8.0)	15.5 (8.5)	−0.2 (−0.8 to 0.4)	−1.6 (−5.7 to 2.5)	.434
12			9.5 (7.1)	13.0 (8.7)	−0.6 (−1.2 to 0.00)	−4.8 (−8.9 to −0.7)	**.023**
24			9.6 (7.4)	13.3 (8.9)	−0.6 (−1.3 to −0.0)	−5.4 (−9.6 to −1.3)	**.011**
MISS total score (score from 0% to 100%, 100% = a normal shoulder; a higher percentage indicates a higher-functioning shoulder)							
Baseline			47.6 (16.7)	48.7 (15.3)			
6	12.4 (5.3 to19.6)	11.2 (4.7 to 17.7)	60.1 (14.4)	59.9 (24.4)	0.1 (−0.6 to 0.7)	1.2 (−8.1 to 10.5)	.793
12	26.6 (19.5 to 33.8)	17.8 (11.2 to 24.4)	74.4 (17.6)	67.8 (20.7)	0.5 (−0.2 to 1.1)	8.8 (−0.5 to 18.2)	.064
24	31.1 (24.5 to 37.7)	15.6 (8.9 to 22.3)	78.8 (13.1)	66.6 (21.4)	0.8 (0.2 to 1.5)	15.4 (5.9 to 24.8)	**.002**
MISS section A: pain (score from 0 to 15 points; a higher score indicates a lower level of pain)							
Baseline			8.2 (3.1)	9.1 (2.8)			
6			10.8 (2.9)	11.2 (3.2)	0.2 (−0.4 to 0.8)	0.7 (−1.2 to 2.5)	.483
12			13.1 (2.2)	11.9 (2.9)	0.9 (0.2 to 1.5)	2.3 (0.4 to 4.1)	**.017**
24			13.1 (2.4)	11.3 (3.5)	1.0 (0.3 to 1.6)	3.0 (1.1 to 4.9)	**.002**
MISS section B: instability (score from 0 to 33 points; a higher score indicates fewer instability symptoms)							
Baseline			18.9 (7.4)	17.3 (8.6)			
6			23.1 (6.3)	21.0 (9.6)	0.0 (−0.6 to 0.6)	0.00 (−4.6 to 4.6)	.999
12			26.6 (6.4)	24.6 (7.6)	0.1 (−0.6 to 0.7)	0.5 (−4.2 to 5.2)	.827
24			28.9 (6.2)	23.9 (9.4)	0.5 (−0.2 to 1.1)	3.9 (−0.9 to 8.6)	.109
MISS section C: function (score from 0 to 32 points; a higher score indicates a higher level of general function)							
Baseline			12.2 (7.7)	13.0 (5.9)			
6			16.2 (7.0)	16.52 (9.64)	0.1 (−0.6 to 0.7)	0.5 (−3.3 to 4.3)	.801
12			21.8 (7.8)	19.18 (8.7)	0.5 (−0.2 to 1.1)	3.8 (−0.0 to 7.6)	**.048**
24			23.3 (6.4)	19.7 (8.4)	0.7 (0.0 to 1.3)	5.2 (1.3 to 9.0)	**.009**
MISS section D: occupational and sporting demands (score from 0 to 20 points; a higher score indicates a higher level of sporting/occupational function)							
Baseline			8.3 (3.6)	9.4 (3.4)			
6			10.1 (3.9)	11.2 (4.7)	0.0 (−0.6 to 0.7)	0.1 (−2.1 to 2.3)	.905
12			12.9 (3.5)	12.2 (3.9)	0.6 (−0.1 to 1.2)	2.1 (−0.1 to 4.3)	.061
24			13.5 (2.6)	11.8 (4.8)	0.8 (0.1 to 1.4)	3.1 (0.9 to 5.4)	**.007**
Secondary outcomes							
Orebro Musculoskeletal Pain Questionnaire (21 items scored out of 210; higher scores indicate greater psychological risk)							
Baseline			93.7 (31.9)	89.3 (25.1)			
6	−19.9 (−27.9 to −11.9)	−16.0 (−24.2 to −7.7)	73.8 (23.8)	73.3 (7.0)	−0.2 (−0.9 to 0.4)	−3.9 (−15.9 to 8.0)	.517
12	−33.9 (−42.1 to −25.8)	−24.3 (−32.6 to −15.9)	59.3 (24.5)	64.9 (29.8)	−0.3 (−1.0 to 0.3)	−9.7 (−21.8 to 2.5)	.119
24	−33.7 (−42.1 to −25.3)	−21.4 (−30.4 to −12.5)	59.5 (24.7)	67.1 (30.3)	−0.4 (−1.1 to 0.2)	−12.1 (−24.5 to 0.2)	.053
Symptomatic onset angle in abduction range of motion (range of motion from 0° to 190°; a higher value indicates a greater range in abduction reached at symptom onset)							
Baseline			113.3 (38.2)	111.7 (31.8)			
12	50.0 (35.6 to 64.5)	45.5 (30.5 to 60.5)	160.6 (12.8)	157.2 (27.6)	0.2 (−0.4 to 0.8)	4.45 (−16.4 to 25.3)	.672
Limiting angle in abduction range of motion (range of motion from 0° to 190°; a higher value indicates a greater range in abduction reached at limiting range)							
Baseline			158.8 (11.4)	158.4 (17.2)			
12	6.8 (2.2 to 11.3)	5.5 (−2.2 to 13.3)	165 (8.5)	164.0 (15.9)	0.1 (−0.5 to 0.7)	1.2 (−8.4 to 10.8)	.799

(continued)

TABLE 4
(continued)

Weeks[b]	Within-Group Mean Difference (95% CI)		Unadjusted Mean Score (SD)		Adjusted SMD (95 % CI)[c]	Adjusted Between-Group Difference (95 % CI)[c]	*P* Value
	Watson	Rockwood	Watson	Rockwood			
	Pain scores (score from 0 to 10; a lower score indicates a lower level of pain)						
Baseline			5.6 (2.1)	4.4 (2.4)			
6	−2.3 (−3.3 to −1.4)	−1.54 (−2.3 to −0.7)	3.2 (2.1)	2.9 (2.3)	−0.3 (−1.0 to 0.3)	−0.8 (−2.0 to 0.5)	.240
12	−2.9 (−3.8 to−2.0)	−1.87 (−2.7 to −1.1)	2.7 (2.0)	2.4 (2.3)	−0.5 (−1.1 to 0.2)	−1.0 (−2.3 to 0.3)	.121
24	−3.7 (−4.7 to −2.7)	−1.7 (−5.6 to −0.9)	1.9 (1.6)	2.5 (2.1)	−1.0 (−1.7 to −0.4)	−2.0 (−2.3 to −0.7)	**.003**

[a]Positive SMDs (standardized mean differences) and between-group differences for the MISS (total score only), the WOSI (total score only), symptomatic onset angle, and limiting angle in abduction range of motion and negative SMDs and between-group differences for pain and the Orebro Musculoskeletal Pain Questionnaire represent greater improvement in the Watson program as compared with the Rockwood program.

[b]For each data row: Watson, n = 18; Rockwood, n = 23.

[c]Adjusted analyses were linear mixed models adjusted for baseline scores, with *P* values obtained from these adjusted linear mixed models. *P* values in bold highlight outcomes reaching between-group statistical significance ($P < .05$).

TABLE 5
Effects of Watson MDI Program Versus Rockwood Instability Program on Categorical Secondary Outcomes[a]

Weeks	Watson, No. (%)	Rockwood, No. (%)	χ^2	RR (95% CI)	NNT (95% CI)	*P* Value
	Incidence of dislocation					
6	1 of 17 (5.9)	3 of 23 (13)	0.557	0.5 (0.1 to 4.0)	14.0 (−6.0 to 4.0)	.624
12	1 of 17 (5.9)	0 of 22 (0)	1.328	3.9 (0.2 to 89.0)	−16.0 (−4.0 to −9.0)	.436
24	2 of 17 (11.8)	1 of 19 (5.3)	0.496	2.2 (0.2 to 22.5)	−15.0 (−3.0 to 7.0)	.593
	Limiting factor in abduction range of motion: proportion of participants with pain-limiting range as opposed to resistance					
Baseline	7 of 18 (38.9)	12 of 23 (52.2)	7.17	0.7 (0.3 to 1.5)	8.0 (−6 to 3)	.531
12	0 of 17 (0)	6 of 22 (27.3)	5.479	0.1 (0.0 to 1.6)	4.0 (59 to 2)	**.023**

[a]Chi-square presented in percentage with risk ratio (RRs) and 95% CI. *P* values in bold highlight outcomes reaching between-group statistical significance with the χ^2 test ($P < .05$). Positive risk differences and risk ratios >1 represent a higher proportion of Watson MDI program participants achieving the outcome relative to the Rockwood program. Positive NNT represents the number of participants that need to be treated with the Watson MDI program as opposed to the Rockwood program to achieve the specified outcome. MDI, multidirectional instability; NNT, number needed to treat.

be evaluated in future research. Based on our strict inclusion criteria, the results of this trial may be generalized only to patients with nonstructural, nontraumatic MDI.

Trial Strengths and Comparisons With Previous Research

This RCT is the first to investigate the effect of 2 rehabilitation programs on MDI. Our strict diagnostic criteria adhered to recent MDI diagnostic recommendations[32] and ensured a more homogeneous sample.[17] The results of this trial are synonymous with the conclusions of previous studies that reported overall benefits of rehabilitation programs for MDI.[3,53,54] However, as compared with previous published literature, this definitive RCT provides higher-quality evidence on which practitioners can base their treatment choices.

Clinical Implications and External Validity

Physiotherapists should implement the Watson MDI program when treating nontraumatic, nonstructural MDI. The larger effects found at 24 weeks serve to inform practitioners of an approximate time at which they can expect their patients with MDI to show best functional improvements, which may assist in setting treatment outcome expectations with them.

CONCLUSION

In this trial involving participants with nontraumatic MDI of the glenohumeral joint, the Watson program produced significantly better outcomes than the Rockwood program at 12 weeks for the WOSI and limiting factor in abduction and at 24 weeks for the WOSI, MISS, and pain scores.

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