CRITICALLY APPRAISED TOPIC

FOCUSED CLINICAL QUESTION

For a 34-year-old active male with multidirectional glenohumeral instability, are closed chain exercises or open chain exercises more effective for return to recreational sporting activities?

AUTHOR

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CLINICAL SCENARIO

The patient was a 34-year-old active male referred to physical therapy with a diagnosis of atraumatic glenohumeral multidirectional instability (MDI) of his R shoulder. He participated recreationally in martial arts 3 times per week and basketball one time per week on a regular basis. The patient reported multiple nontraumatic subluxations over the past year with a gradual increase in pain and activity limitations. During the evaluation he demonstrated scapular winging and full shoulder ROM bilaterally with intermittent pain throughout the motion, 4/5 strength in all directions with pain elicited during external rotation and abduction on the R shoulder. Positive special tests supporting the diagnosis were apprehension/relocation, sulcus test, and the push-pull test.[1] He had been avoiding his usual sporting activities secondary to the increased pain and discomfort that he felt in his shoulder. His goals were to return to martial arts and basketball with less instability, improved strength, and little to no pain.

Glenohumeral MDI is characterized by symptomatic capsular and ligamentous laxity, altered scapulohumeral rhythm, decreased strength, and decreased proprioception.[2] Initial treatment for MDI is conservative rehabilitation focusing on strengthening the scapular stabilizers and periscapular muscles in order to compensate for the lack of passive stability.[2] However, there is a paucity of well-controlled studies that support the effectiveness of conservative rehabilitation[3] and until recently, only 1 protocol[4] published in 1992 existed to guide rehabilitation efforts. The 1992 Rockwood protocol[4] includes a combination of both open and closed chain exercises. Gathering more recent data regarding the comparative effectiveness of open versus closed chain exercise for patients with glenohumeral MDI can guide the therapist's exercise prescription, improve patient outcomes, and potentially reduce the need for surgery.

SUMMARY OF SEARCH

[Best evidence appraised and key findings]

A literature search was conducted in 4 electronic databases to address the clinical question. Eight articles meeting the inclusion/exclusion criteria were selected including 2 systematic reviews, 1 randomized controlled trial, 1 cohort study, and 4 case series.

- As of November 2019, no studies directly comparing open chain and closed chain exercises for rehabilitation of patients with glenohumeral MDI have been published. One article was selected comparing the effects of two rehabilitation protocols in patients with glenohumeral MDI and one was selected because it analysed and synthesized components of rehabilitation in overhead athletes with shoulder pathology. The studies were appraised and the findings were synthesized to provide an evidence-based recommendation.
- The Watson MDI program resulted in large functional improvements and should be used in the clinic for treatment of patients with atraumatic glenohumeral MDI.
- Low quality evidence suggests that both open and closed chain exercises can be incorporated into a return to sport program for overhead athletes with shoulder pathology.

CLINICAL BOTTOM LINE

The Watson MDI program is currently the best conservative treatment for patients with glenohumeral MDI and should implemented into clinical practice. Research has shown that completing 12-weeks of the Watson MDI program resulted in large functional improvements at 12 and 24 weeks. Treatment of glenohumeral MDI should first incorporate scapular motor control, then rotator cuff and periscapular strengthening, and finally tailored, sport-specific training. While the evidence is low in quality, research supports the use of both open and closed chain exercises for return to sport in overhead athletes with shoulder pathology.

This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor

The above information should fit onto the first page of your CAT

SEARCH STRATEGY

Terms used to guide the search strategy			
Patient/Client Group	**I**ntervention (or Assessment)	**C**omparison	**O**utcome(s)
Multidirectional instability MDI Athlete* Shoulder Glenohumeral	Closed chain exercise Physical therapy Rehabilitation Conservative	Open chain exercise	Return to play Return to sport

Final search strategy (history):

Show your final search strategy (full history) from PubMed. Indicate which "line" you chose as the final search strategy.

#1 multidirectional instability OR MDI OR athletes*
#2 shoulder OR glenohumeral
#3 conservative OR nonoperative OR physical therapy OR physiotherapy
#4 closed chain exercise OR closed chain OR closed kinetic chain
#5 open chain exercise OR open chain OR open kinetic chain
#6 return to play OR return to sport OR rehabilitation

Final: (#1 AND #2 AND #3 AND (#4 OR #5) AND #6)

In the table below, show how many results you got from your search from each database you searched.

Databases and Sites Searched	Number of results	Limits applied, revised number of results (if applicable)
PubMed	**439**	**206 -** Humans, Adults 19+
CINAHL	**477**	**101 –** Limited to Full Text
SPORTDiscus	**275**	**N/A**
PEDro	**3**	**N/A**

INCLUSION and EXCLUSION CRITERIA

Inclusion Criteria
• All levels of intervention studies (I-IV) including systematic reviews • Reports on multidirectional instability (MDI) or shoulder pain or shoulder pathology • Includes rehabilitation protocol details or details of exercise interventions
Exclusion Criteria
• Not human; Not English; Not reporting on interventions for shoulder instability or shoulder pathology; Not looking at exercise or conservative treatment in at least one treatment group; Abstract, conference proceedings, editorials

RESULTS OF SEARCH

Summary of articles retrieved that met inclusion and exclusion criteria

For each article being considered for inclusion in the CAT, score for methodological quality on an appropriate scale, categorize the level of evidence, indicate whether the relevance of the study PICO to your PICO is high/mod/low, and note the study design (e.g., RCT, systematic review, case study).

Author (Year)	Risk of bias (quality score)*	Level of Evidence**	Relevance	Study design
Warby (2018)[2]	PEDro 8/10	2b (downgraded due to wide confidence intervals)	Moderate-High	Randomized Controlled Trial
Watson (2018)	Modified Downs and Black 18/29	4	Moderate-High	Case Series
Warby (2014)[3]	AMSTAR 5/11	3a Poor quality of included studies	Low	Systematic Review (4 retrospective cohort, 2 case-control, 1 case series)
Bateman (2019)	Modified Downs and Black 14/29	4	Moderate-High	Case Series
Misamore (2005)	Modified Downs and Black 12/29	4	Low	Case Series
Merolla (2015)	Modified Downs and Black 15/29	4 No comparison/control	Moderate	Cohort Study
Ide (2003)	Modified Downs and Black 9/29	4	Low	Case Series
Wright (2018)	AMSTAR 6/11	3a Poor quality of included studies	Moderate	Systematic Review (3 prospective cohort, 2 randomized cohort, 1 case series, 33 expert opinion)

*Indicate tool name and score

**Use Portney & Watkins Table 16.1 (2009); if downgraded, indicate reason why

BEST EVIDENCE

The following 2 studies were identified as the 'best' evidence and selected for critical appraisal. Rationale for selecting these studies were:

No studies exist comparing open vs. closed chain exercise for patients with MDI of the shoulder. Therefore, I selected one article that exclusively looked at the effects of 2 rehabilitation protocols

in patients with MDI and one article that analysed components of return to sport exercises (including open and closed chain) in overhead athletes with shoulder pathology.

- **Warby, 2018[2] – This RCT was the highest level of evidence that was identified through a search of the literature. Additionally, the study has an overall low risk of bias as evidenced by PEDro risk of bias score of 8/10. The study details the effects of administering 2 non-surgical rehabilitation protocols for patients with MDI and provides details about exercises performed in each protocol.**
- **Wright, 2018[10] – This systematic review was the second highest level of evidence that my search yielded. It includes over 39 articles and provides a best evidence synthesis. While this paper doesn't exclusively look at patients with MDI, it does analyse components of return to sport programs for overhead athletes with shoulder pathology, including open chain and closed chain exercises. My patient was a recreational martial artist and basketball player hoping to return to participation in that sport 2-3 times per week. Thus, I felt that this paper would be appropriate, despite it not including patients with MDI.**

SUMMARY OF BEST EVIDENCE

(1) Description and appraisal of "Comparison of 2 Exercise Rehabilitation Programs for Multidirectional Instability of the Glenohumeral Joint" by (Warby et al. 2018).

Aim/Objective of the Study/Systematic Review:

The purpose of this RCT was to compare the effects of the Watson MDI (Multidirectional Instability) and Rockwood instability program on functional outcomes, shoulder girdle mechanics, and strength in patients with non-traumatic MDI of the glenohumeral joint.

Study Design

[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]

Note: For systematic review, use headings 'search strategy', 'selection criteria', 'methods' etc. For qualitative studies, identify data collection/analyses methods.

- Randomized Controlled Trial with published protocol[11]
- Randomization: Participants were allocated by a blinded researcher via block randomization with an allocation ratio of 1:1 to one of 2, 12-week programs; the Watson MDI program or the Rockwood Instability program. The treating physiotherapist alone was aware of treatment allocation.
- Participants attended once-weekly physiotherapy sessions to be instructed in exercise to be performed at home corresponding to their respective program allocation.
- Blinding: The participants, researchers that scored and input data, and the researchers that collected objective data (scapular coordinates, upward rotations, and shoulder girdle strength) were blinded to participant treatment allocation. The treating physiotherapists could not be blinded.
- Data was analysed via intention to treat to detect within and between group effect sizes at 6, 12, and 24 weeks. This method preserves the benefits of randomization and allows the reader to draw unbiased conclusions about the results.[12]
- Linear mixed models were used to analyse continuous data, ordinal data were analysed with a Mann-Whitney U test, and categorical data was analysed with chi-square tests to examine differences between the 2 groups.
- A responder analysis was performed to determine clinically important results.
- Statistical Significance was set at α=0.05 with 95% confidence intervals
- Treatment fidelity: Clinical notes were evaluated for treatment fidelity at 3, 6, and 12 weeks by unblinded researchers to check protocol compliance. Physiotherapists had to complete a 2-day training program prior to treating patients and were also required to attend quarterly workshops for participant case review.

Setting

[e.g., locations such as hospital, community; rural; metropolitan; country]

- Each participant was treated at one of 7 private physiotherapy clinics affiliated with LifeCare Health Network in the metropolitan area of Melbourne, Australia.[11]

Participants

[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]

Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article.

N = 41

- To be eligible, participants had to be between 12-35 years old and have "symptomatic glenohumeral dislocation in >1 direction," no trauma to the affected shoulder, negative MRI for articular lesion of the glenohumeral joint, positive sulcus sign, and positive drawer or apprehension test.
- Participants were recruited from public advertising, orthopaedic surgeons, physicians, and physiotherapists over a 2-year period.

Both groups were comparable at baseline on key demographic variables (*mean (SD))*:

- The 18 participants in the Watson MDI group had an average age of 21.8 (6.5), were 83.3% female, with a mean duration of symptoms of 43.28 (87) months. Average WOSI and MISS baseline scores were 37.9 (17.5) and 47.6 (16.8), respectively.
- The 23 participants in the Rockwood group had an average age of 23 (6.5), were 78.3% female, with a mean duration of symptoms of 46.8 (45.8) months. Average WOSI and MISS baseline scores were 41.8 (16) and 48.7 (15.3), respectively.

Regarding sport participation, groups were similar at baseline:

- In the Watson MDI group, 7 (38.9%) were involved in overhead sports, 1 (5.6%) in dance, 6 (33.3%) in weightlifting, 2 (11.1%) in primarily lower-limb sports, 1 (5.6%) classified as other, and 1 (5.6%) not involved in any sport.
- In the Rockwood group, 6 (26.1%) were involved in overhead sports, 4 (17.4%) in dance, 4 (17.4%) in weightlifting, 1 (5.6%) in lower-limb sports, 3 (13%) classified as other, and 5 (21.7%) were not involved in any sport.

One participant from each treatment group dropped out of the study before its completion

At 24-week follow-up, 17/18 participants in the Watson MDI group and 20/23 in the Rockwood group were available for follow-up.

Intervention Investigated

[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided]

Control

There was no control group

Experimental

- Interventions for both groups consisted once-weekly 30-minute physiotherapy sessions for 12 weeks. Treatment involved exercise instruction and progression as well as education about MDI, the importance of program compliance, and the role of exercise. Interventions for both groups were protocol-specific with standardized dosage, resistance, range of motion, and criteria for progression. Each participant was treated by the same physiotherapist throughout the study.
- Criteria for progression was based on being pain free with exercises for both groups. The Watson MDI group also required achievement of shoulder complex motor-control as determined by the treating physiotherapist. The Rockwood progressed when the level of resistance was easy for the patient to perform.

	Watson MDI*	**Rockwood Instability***
Program Overview	Focuses on retraining motor control of the shoulder complex before beginning rotator cuff and deltoid strengthening. The program increases load, progressively throughout glenohumeral range of motion	Strengthening program for the deltoid and glenohumeral internal/external rotators in open and closed chain.
Phase/stage*	6 stages: Stage 1: Scapular motor control, controlling arcs of motion (0-45 degrees elevation) Stage 2: Posterior glenohumeral joint muscle	2 phases: Phase 1: Theraband resistance Phase 2: Pulley resistance

	Stage 3: Sagittal plane motor control Stage 4: Control throughout 45-90 degrees of elevation Stage 5: Deltoid strengthening Stage 6: Function and sport-specific	
Exercise Dose	Prescription based on patient needs Motor control: 3x20 2 times/day Endurance: 3x10-15 2 times/day Strength: 4x8-12 every other day Repetitions held for 3 seconds with most exercises.	2 times per day 5 repetitions with 5 second hold at end range for all exercises

*Detailed protocol including specific exercises for each stage can be found on p.90[2]

Outcome Measures

[Give details of each measure, maximum possible score and range for each measure, administered by whom, where]

Self-report questionnaires were delivered to the participants online through email or as a paper copy through mail

- Administered at baseline, 6, 12, 24, and 52 weeks: #1-5 (below)

Objective data was collected by 2 researchers who were blinded to treatment allocation

- Administered at baseline and 12 weeks: #7-10 (below)

Primary outcome measures:[11]

1. Melbourne Instability Shoulder Scale (MISS): Self-report measure that assesses 4 domains: pain (0-15), instability (0-33), function (0-32), and ability to perform occupational/sporting demands (0-20). The MISS is scored by adding up the total for each category (0-100) with higher scores indicating higher levels of disability. The authors converted the MISS total score into percentage of a healthy shoulder. The MCID = 5 points.
2. Western Ontario Shoulder Index (WOSI): 21-item self-report measure covering 4 domains: physical symptoms, sport/recreation/work, lifestyle function, and emotional function. Each question is scored 0-100 with a higher score indicating higher levels of disability. Total score range is 0-2100, however, the authors converted the score to percentage of a healthy shoulder. The MCID = 10.4%.

Secondary outcome measures:[2,11]

3. Orebro Musculoskeletal Pain Questionnaire: 21-item self-report measure used to assess mediating variables (psychosocial risk factors) and has been used to predict recovery in patients with chronic shoulder issues. Each question is scored 0-10 with total scores ranging from 0-210; higher scores indicate more psychosocial affliction.
4. Global Rating of Change: self-report, 7-point Likert scale measuring change from baseline. Scored 1-7 with lower scores indicating greater improvement.
5. Patient Satisfaction Score: (with treatment and results): self-report, 5-point Likert scale measuring *i.* satisfaction with treatment and *ii*. Satisfaction with results. Scored 1-5 with lower scores indicating higher satisfaction.
6. Incidence of complete glenohumeral joint dislocation: the number of times a full dislocation occurs requiring relocation by the participant or doctor reported to the treating physiotherapist at baseline, 6, and 12 weeks.
7. Scapular coordinates: measured by researcher at rest, 90 degrees, and end-range abduction with a tape measurer (centimetres) to assess the effect of exercise on scapular position. Used tip of inferior angle of the scapula, medial root of scapular spine, and the posterior portion of the AC joint as landmarks with the transverse process of the spine serving as the y-axis.
8. Scapular upward rotation: measured by researcher at rest, 30, 45, 60, 90, 120, 135 degrees, and end-range glenohumeral abduction with one inclinometer taped perpendicular to the humeral shaft and the other place on the scapular spine.
9. Muscle strength: assessed by researcher with hand-held dynamometer measured in kilograms in positions: empty and full can positions, ER at 0 and 90, belly press and resisted IR at 0 and 90, shoulder flexion/extension with elbow at 0 and 90, resisted abduction at 45 with elbow flexed to 90, shoulder flexion with arm supinated and extended and shoulder flexed to 90, scapular shrug test
10. Symptomatic onset, limiting factor, and angle of limiting factor in abduction: angle at which abduction limit is reached and when symptoms first occur are measured with an inclinometer by a researcher. Range from 0 to 190 degrees with higher values corresponding to greater range of

abduction reached before symptoms/limitations occur. Patient-reported reason for limitation recorded as either: pain, resistance, or guarding/apprehension.

11. Compliance: the number of sessions attended, missed, and cancelled recorded by treating physiotherapist in clinical notes for sessions 2-12. Scored 0-3; with higher scores indicating greater compliance.
12. Adverse events: recorded at every session by treating physiotherapist and formally assessed at 6, 12, 24, and 52 weeks.
13. Success of blinding: Participants were asked if they were aware if they were aware of which program they were treated with. Options for answers include "no," "unsure," and "yes." Participants who answered "yes" were asked which program they received and why. Administered 12 weeks after randomization by blinded researcher.

Main Findings

[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. You may summarize results in a table but you must explain the results with some narrative.]

There were no serious adverse events and one participant in each group discontinued treatment before the end of the program. The average number of treatments attended (SD) was 11.3 (2.1) for the Watson MDI group and 11.2 (2.3) for the Rockwood group, out of 12 total sessions. Compliance was higher in the Rockwood program (p=0.042). In the Watson group, 12.5% correctly guessed their allocation compared to 22.7% in the Rockwood group, indicating that it's possible that some results could be subject to bias secondary to issues with participant blinding. To preface the presentation of main findings, the results of the 52-week planned follow up were not published as of November 2019.

Tables 1 and 2 illustrate the relevant between group differences. Table 3 shows within group differences for the primary outcome measures. Table 4 shows the clinically relevant data for the primary outcome measures. **Bolded** values indicate statistical significance.

Table 1: Between group difference for primary outcome measures

		Unadjusted Mean Score (SD) 0%-100% of normal shoulder		**Adjusted SMD* (95% CI)**	**Adjusted Between group difference (95% CI)**	**P-value**
		Watson	**Rockwood**			
Primary Outcome Measures	**WOSI total score**					
	Baseline	37.9 (17.5)	41.8 (16)			
	6	54 (20.5)	56.1 (24.2)	0.1 (-0.5-0.7)	2 (-7.1-11.1)	0.667
	12	71.4 (18.5)	65.4 (23.2)	0.5 (-0.1-1.1)	11.1 (1.9-20.2)	**0.018**
	24	72.8 (15.7)	66.7 (22.5)	0.6 (0-1.3)	12.6 (3.4-21.9)	**0.008**
	MISS total score					
	Baseline	47.6 (16.7)	48.7 (15.3)			
	6	60.1 (14.4)	59.9 (24.2)	0.1 (-0.6-0.7)	1.2 (-8.1-10.5)	0.793
	12	74.4 (17.6)	67.8 (20.7)	0.5 (-0.2-1.1)	8.8 (-0.5-18.2)	0.064
	24	78.8 (13.1)	66.6 (21.4)	**0.8 (0.2-1.5)**	15.4 (5.9-24.8)	**0.002**

**Standardized mean difference also known as the effect size*

At 6 weeks there were no differences between groups for any outcome. At 12 weeks the Watson MDI group had greater improvements on the WOSI total. At 24 weeks the Watson MDI group had greater improvements on both the WOSI and MISS total scores, indicating that a significant time was needed to show favourable functional improvements with the Watson MDI compared to the Rockwood program. Additionally, only the MISS total scores at 24 months had a statistically significant large effect size as evidenced by the CI not containing "0."

When examining the subsections of the WOSI, the Watson MDI program had better sport scores at 24 weeks (P=0.009), as well as physical (p=0.031, p=0.022) and emotion (p=0.023, p=0.011) scores at both 12 and 24 weeks, respectively. At 24 weeks, the Watson MDI had better scores for occupational and sporting demands (p=0.007). At 12 and 24 weeks, MISS pain (p=0.017, p=0.002) and function scores (p=0.048, p=0.009) were better for the Watson group, respectively. The results of these subsections illustrate better outcomes for the Watson MDI group for function and sporting demands starting at the 12-week time point.

Table 2: Significant or near significant between group differences for secondary outcome measures

			Unadjusted Mean Score (SD)		Adjusted SMD (95% CI)	Adjusted Between group difference (95% CI)	P-value
			Watson	**Rockwood**			
Secondary Outcome Measures	**Pain (0-10)***						
	Baseline		5.6 (2.1)	4.4 (2.4)			
	6		3.2 (2.1)	2.9 (2.3)	-0.3 (-1-0.3)	-0.8 (-2-0.5)	0.240
	12		2.7 (2)	2.4 (2.3)	-0.5 (-1.1-0.2)	-1 (-2.3-0.3)	0.121
	24		1.9 (1.6)	2.5 (2.1)	-1 (-1.7 to -0.4)	-2 (-2.3 to -1.7)	**0.003**
	Orebro Musculoskeletal Pain Questionnaire (0-210)*						
	Baseline		93.7 (31.9)	89.3 (25.1)			
	6		73.8 (23.8)	73.3 (7)	-0.2 (-0.9-0.4)	-3.9 (-15.9-8)	0.517
	12		59.3 (24.5)	64.9 (29.8)	-0.3 (-1-0.3)	-9.7 (-21.8-2.5)	0.119
	24		59.5 (24.7)	67.1 (30.3)	-0.4 (-1.1-0.2)	-12.1 (-24.5-0.2)	0.053
	Muscle Strength (Short lever shoulder flexion)						
	Baseline		9.2 (3.5)	11.2 (4.9)			
	12		13.5 (3.6)	12.9 (4.6)	0.7 (0-1.3)	2.9 (1.2-4.5)	**0.001**
	Scapular Coordinates (rest) – Acromioclavicular joint (ACJ) y coordinate						
	Baseline		0.9 (1.5)	1.2 (1)			
	12		1 (1.2)	0.9 (0.9)			**0.009**
	Scapular coordinates (90 degrees of abduction) – inferior angle y coordinate						
	Baseline		18.5 (2.1)	18.7 (2.1)			
	12		19.1 (1.6)	18 (1.4)	0.7 (0.1-1.4)	1.1 (0.1-2.1)	**0.033**

	Watson, # (%)	**Rockwood, # (%)**	X^2	**RR (95% CI)**	**NNT (95% CI)**	**P Value**
Pain as the limiting factor in abduction range of motion						
Baseline	7/18 (38.9)	12/23 (52.2)	7.17	0.7 (0.3-1.5)	8 (-6-3)	0.531
12	0/17 (0)	6/22 (27.3)	5.479	0.1 (0-1.6)	4 (59-2)	**0.023**

**Negative SMDs indicates more favourable outcome for Watson MDI than Rockwood.*

The Watson MDI group demonstrated better treatment effects for pain reduction (large effect at 24 weeks), short-lever shoulder flexion strength (12 weeks), scapular "y" coordinates at the ACJ and inferior angle (12 weeks), and a lower proportion of participants reporting pain as the limiting factor in abduction range of motion (12 weeks). Other secondary outcomes did not reach between group significance, including ordinal data such as global rating of change, incidence of dislocation, and treatment satisfaction scores. Scores for the Orebro Musculoskeletal Pain Questionnaire were trending towards significance at 24 weeks indicating both programs resulted in lower psychological risk related to shoulder MDI. With a larger sample size, significant results for the Orebro questionnaire may have been observed. No patients in the Watson MDI reported pain as a limiting factor in abduction at 12 weeks. The risk ratio at 12 weeks was 0.1 for pain indicating that for participants in the Watson MDI group had a 90% lower chance of reporting pain as the limiting factor in abduction compared to the Rockwood group.

Table 3: Within-group mean differences (95% CI) for primary outcome measures

WOSI total (0%-100% of a normal shoulder) *		
	Watson MDI	**Rockwood Instability**
6	16.3 (9.7-22.8)	14.3 (8-20.6)
12	33.6 (27.1-40.1)	22.5 (16.1-28.9)
24	35.1 (28.6-41.6)	22.3 (15.6-28.9)
MISS total (0%-100% of a normal shoulder)*		
6	12.4 (5.3-19.6)	11.2 (4.7-17.7)
12	26.6 (29.5-33.8)	17.8 (11.2-24.4)
24	31.1 (24.5-37.5)	15.6 (8.9-22.3)

***Higher percentage = higher functioning shoulder*

Table 3 illustrates the large within-group mean differences from baseline at each time point for the primary outcome measures. The within-group differences for these primary measures and all continuous secondary measures (muscle strength, scapular upward rotation, scapular coordinates) improved significantly for both groups and can be viewed in more detail in Appendix 4. Both groups improved from baseline on all outcomes.

Table 4: Proportion of participants with clinically relevant outcomes on primary outcome measures

	% meeting MCID					
	Watson (n=17)	**Rockwood**	**Risk difference (95% CI)[a]**	**Relative risk (95% CI)[b]**	**P value**	**NNT (95% CI)[c]**
WOSI total						
6	82%	57% (n=23)	26% (-3%-495)	1.5 (2.2-1)	0.1030	4 (-28-2)
12	94%	68% (n=22)	26% (0%-47%)	1.4 (1.9-1)	0.1030	4 (-454-2)
24	94%	80% (n=20)	14% (-1%-36%)	1.2 (1.5-0.9)	0.1030	7 (-10-3)
MISS total						
6	53%	74% (n=23)	-21% (-47%-8%)	0.7 (1.2-0.4)	0.198	-5 (-2 to -12)
12	82%	82% (n=22)	1% (-25% to -24%)	1.0 (1.4-0.7)	1	187 (-4-4)
24	100%	80% (n=20)	20% (2-42%)	1.3 (1.6-1.0)	0.109	5 (-51-2)

[a]*Positive risk differences indicates a higher proportion of Watson MDI participants reaching MCID relative to the Rockwood program.*
[b]*Relative Risk; >1 indicates a higher proportion of Watson MDI participants reaching MCID relative to the Rockwood program*
[c]*Number needed to treat; positive NNT is the number of patients that need to be treated with the Watson MDI over the Rockwood program to achieve the MCID for each outcome.*

Table 4 shows that there were no statistically significant differences in the proportion of participants who met the MCIDs for the WOSI and MISS total scores at any time point. At 24 weeks, 94% and 100% of the participants in the Watson group met the MCID for the WOSI and MISS, respectively, compared to 80% for the Rockwood group. The risk difference and relative risk favoured the Watson MDI for the WOSI at all time points and the MISS at 12 and 24 weeks, indicating clinically superior outcomes in the Watson MDI group for these measures. In order to meet the MCID for the WOSI, 7 patients need to be treated for 24 weeks with the Watson MDI as opposed to the Rockwood. The NNT for the MISS is 5 at 24 weeks, however these results did not reach significance.

Original Authors' Conclusions

[Paraphrase as required. If providing a direct quote, add page number]

"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." (p.95) The differences can be attributed to the Watson MDI program's progression of exercises into patient-specific sport movements, focus on motor control, and building proximal stability for distal mobility. There were no significant between group differences for any outcome at 6 weeks.

Critical Appraisal

Validity

[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.]

PEDro Scale (Internal Validity): **8/10** (discussed below)

Strengths:

- Subjects were randomly allocated, allocation was concealed, the groups were comparable at baseline, there was blinding of assessors, an intent-to-treat analysis was performed, there was adequate follow-up of >85% of initially allocated patients for all outcomes, there were between and within group comparisons, and provided treatment effect sizes and measures of variability including standard deviations and 95% CIs.

Weaknesses:

- Treating physiotherapists were not blinded. Researchers attempted to blind participants but had a high proportion (22.7%) correctly guess their treatment allocation in the Rockwood group. The actual sample size was small (n= 41) compared to what was calculated to be adequately powered a priori (n = 328) to detect a MCID of 5 points in the MISS. This could have resulted in a false negative on some outcomes at 6 and 12 weeks. Having more subjects could have minimized the chance of a type II error. The results from the 52-week follow-up have not yet been published.

External Validity: The patients were representative of the population from which they were recruited. The treatment sessions were conducted in PT clinics—which is where care would usually occur for patients with MDI of the shoulder.

Overall Quality: Despite issues with blinding that are inherent in physical therapy intervention studies and a small sample size, this study has good internal and external validity. The results indicating that the Watson MDI is more effective than the Rockwood instability program are believable. Furthermore, the program could be administered to a patient with nontraumatic, non-structural MDI in the clinic.

Interpretation of Results

[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.]

Overall, both the 12-week Watson MDI and Rockwood instability programs resulted in clinically meaningful outcomes for MISS, WOSI, and secondary outcomes as evidenced by a higher proportion of patients meeting the MCID values at each time point. The treatment effects for some measures were larger at 12 weeks, with the largest treatment effects for MISS (SMD=0.8), WOSI (SMD=0.6) and pain (SMD=-1.0) scores being observed at 24 weeks for the Watson MDI group indicating more favourable long-term outcomes compared to those who completed the Rockwood program—The Watson MDI program was superior at the 12 and 24-week follow-ups. The Watson MDI group also had higher scores on function and sport-related subsections of the primary outcome measures which has important implications for athletes with MDI. The results also indicate that for patients undergoing rehab for glenohumeral MDI, it may take a significant amount of time for large improvements in function to become evident.

The between group differences on the MISS and WOSI that became evident starting at 12 weeks could be due to the fact that stage 6 of the Watson MDI program includes patient and sport-specific movements and loading patterns, whereas the Rockwood program does not. The inclusion of patient-specific activities may have improved motor learning and control contributing to improvements in patient-reported function. This is further supported by the fact that these results are likely not explained by increases in muscle strength as only one direction (short-lever flexion) showed a significant difference at 24 weeks.

While compliance was significantly lower in the Watson MDI group, the participants in that group still had better outcomes. The program should be repeated in a larger sample to see if the pattern of compliance is similar. To improve compliance the program may need to be revised, or, other mediating factors specific to this patient population should be exploited to improve adherence.

The study was well-controlled, had a homogenous patient sample, and was conducted under the same condition for which patients would normally seek care. The findings that the Watson MDI program results in lower pain and better functional outcomes than the Rockwood program for patients with nontraumatic, glenohumeral MDI at 12 and 24 weeks are believable.

Applicability of Study Results

[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.]

This study is highly applicable to patients with glenohumeral MDI and moderate-to-highly relevant to my clinical question. The patients were slightly younger than the male patient in my scenario and were predominantly female. However, all the patients had evidence of nontraumatic glenohumeral MDI and most

reported participation in sport or recreational activity. Thus, these results could be applied to my patient based on similar patient characteristics.

A comparison of open and closed chain exercise was not considered, however, both program protocols were included which allowed for analysis of the components. The Rockwood protocol was dominated by open chain exercises but did include closed chain exercises (wall, knee, or full push-ups) in both phases. The open chain exercise preceded the closed chain exercises. The Watson MDI program consists of almost exclusively open chain exercises. Stage 6 of the Watson MDI program is patient and sport-specific. Thus, it is unclear if closed chain exercises were incorporated here. Considering these findings and the positive outcomes with both groups, both open and closed chain exercises are effective for improving function in patients with glenohumeral MDI. Closed chain exercises comprise a smaller proportion of the available rehabilitation protocols for patients with MDI and may or may not be a part of a patient's rehabilitation. However, a definitive conclusion about the comparative effectiveness closed chain versus open exercise for glenohumeral MDI cannot be made with the data from this study alone.

Despite not directly answering my clinical question, the Watson MDI is a feasible program to use with the patient in my clinical scenario. The intervention was delivered in 30-minute sessions, once per week, over 12 weeks which is well within the treatment time frame of a typical episode of care. Furthermore, the program was delivered by physiotherapists which make it a practical protocol to follow for patients with glenohumeral MDI.

(2) Description and appraisal of (Exercise prescription for overhead athletes with shoulder pathology: a systematic review with best evidence synthesis) by (Wright, 2018)

Aim/Objective of the Study/Systematic Review:

The objective of the review was to synthesize the evidence regarding exercise prescription for overhead athletes presenting with shoulder pathology.

Study Design

[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]

Note: For systematic review, use headings 'search strategy', 'selection criteria', 'methods' etc. For qualitative studies, identify data collection/analyses methods.

Systematic review with best evidence synthesis on exercise prescription for overhead athletes with shoulder pathology.

Search Strategy: A literature search was performed in MEDLINE, PubMed, SPORTDiscus, and CINAHL databases. All articles published before July, 8 2016 were included. Manual searches of references lists were performed for related systematic reviews, not-included abstracts, and the author's private collections. The authors used the following PubMed search strategy: ((((((((((athlete) OR baseball) OR softball) OR tennis) OR swimming))) AND shoulder)) AND (((((physiotherapy) OR physical therapy) OR ("Rehabilitation"[Mesh] OR "rehabilitation"[subheading] OR "physical and rehabilitation medicine"[Mesh])) OR ("Therapeutics"[Mesh] OR "therapy"[subheading])) OR ("plyometric exercise"[Mesh] OR "Exercise Therapy"[Mesh] OR "Resistance Training'[Mesh] OR "Exercise"[Mesh])). Google scholar was also searched using a specific sport name and "exercise" as search terms (i.e. "basketball AND exercise").

Selection Criteria: Two authors performed the title/abstract and full text screening using the selection criteria listed below. A third author was used to resolve conflicts in the title/abstract screening and discussion was used to resolve disagreements between 2 authors in the full text screening. If consensus could not be reached a third researcher was used.

- **Inclusion criteria**: For level I-IV studies to be included they had to include these things: overhead athletic population, shoulder injury or shoulder pain, detailed description of exercise interventions, analysis of the effectiveness of interventions on at least one impairment, available in full text, published in English. Level V studies (i.e. expert opinion) were included if they: reported on conservative treatment of shoulder pathology in the overhead athlete, detailed exercise description, and an approach different from that of the included level I-IV studies.
- **Exclusion criteria**: Non-human and cadaver studies, history of stroke or hemiplegia, exercise no described in enough detail to be replicated clinically, full text unavailable, no association examined between exercise intervention and outcome, postoperative management.

Data Extraction: Four reviewers performed data extraction of information regarding study design, study population, exercise interventions, outcome data (including mean change and p values) related to the intervention.

Data Synthesis: The authors used the Centre for Evidence-based Medicine (CEBM) levels of evidence. The findings were split to allow analysis for research based and clinic based (expert opinion) recommendations. The entirety of the available evidence was given a grade (A-F) based on the quality of research (see table). The level of evidence was downgraded with risk of bias was found to be moderate or high.

Centre for Evidence Based Medicine "Grades of Recommendation"[13] *	
A	Consistent findings from >2, level I studies
B	Consistent findings from >2 level II or III studies OR ≤2 level I studies
C	Consistent findings from >2 level IV studies OR ≤2 level II or III studies
D	Findings from >2 level V studies
F	Conflicting findings or findings from ≤2 level V studies

**adapted from the Oxford Centre for Evidence Based Medicine consistent with the grading used in the article.*

Quality Assessment (risk of bias): Risk of bias was assessed by two researchers using the modified Downs and Black checklist for Level I-IV studies. Quality assessment of expert opinion papers was assessed by years of experience treating overhead athletes or being board certified in orthopaedics or sports. Disagreements were resolved by discussion and consensus.

Setting

[e.g., locations such as hospital, community; rural; metropolitan; country]

Authors (n) were from the Department of Physical Therapy at High Point University (2), Department of Exercise Science at High Point University (1), and the Department of Physical Therapy at Duquesne University (1).

Participants

[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]

Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article.

- This systematic review included a total of 39 articles: 3 prospective cohort studies, 2 randomized cohort studies, 1 case series, and 33 expert opinion pieces.
- N = 191 athletes (118 M, 73 F) across the 6 research-based studies from baseball, volleyball, tennis, canoe polo, swimming, badminton, and handball.
    - Age ranged from 15-32 (see appendix B)
    - The primary diagnoses (N) in the six research-based studies were shoulder impingement (3) and shoulder pain, or inhibition secondary to pain (3).
- Modified Downs and Black scores ranged from 12-19/28 indicating moderate to high risk of bias for all included research-based studies.

Intervention Investigated

[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided]

Control

- 2 of the 6 research-based studies included a control group. The authors did not specify if the control groups received any treatment. The remaining 4 studies did not have control groups.

Experimental

Three researchers organized extracted exercises into the following common clinical phases of shoulder rehabilitation program progression:

- Upper extremity exercise less than or equal to 90 degrees of elevation
- Upper extremity exercise greater than or equal to 90 degrees of elevation
- Closed chain upper extremity exercise
- Unspecified upper extremity exercise
- Isokinetic exercise

- Plyometric exercise
- Kinetic chain/core/lower extremity exercise
- Sport-specific exercise

A detailed description of the exercises found from each study can be found in Table 2 (Level I-IV) and Supplementary table 2 (Level V). Training intensity and volume varied among the level I-IV studies (appendix B) and it is unclear based on the authors reporting, who provided the interventions to the study participants.

The primary method of progression in the level I-IV studies was progressive overload and level V studies progressed patients in progressive phases for return to sport considering factors such as speed, load, and duration.

Outcome Measures

[Give details of each measure, maximum possible score and range for each measure, administered by whom, where]

- The reported outcomes varied between studies and primarily focused on measuring changes at the impairment level. The outcome measures used across the research-based studies included measures of pain and strength of the rotator cuff and periscapular muscles. The specific measures used varied widely.
- One of the included studies utilized the Shoulder Pain and Disability Index (SPADI): The SPADI is a 13-item patient-reported outcome measure used to assess pain and disability of patients with shoulder pathology in an outpatient setting. (The SPADI has demonstrated construct validity with other shoulder-specific questionnaires and is reliable (ICC>0.89).[14] It has also shown to be responsive and the MCID is 8 points. The SPADI score is converted to a score out of 100 with higher scores indicating greater disability.[14]
- No return to play outcomes were reported in any of the studies

Main Findings

[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. Use a table to summarize results if possible.]

- "An analysis of the effects of specific exercise components contained within the overall rehabilitation protocol was precluded due to insufficient data." (p.4)
- The authors identified 33 unique exercises from level I-IV studies and 102 unique exercises from level V studies.
- The strength of recommendations for the different exercise categories are included below in Table 1.
- Current exercise prescription for overhead athletes with shoulder pathology is dominated by expert opinion and is not backed by research-based evidence.
- Findings from each of the included research-based studies can be found in appendix b; they were not included here due to the heterogeneity of design, interventions, and outcomes used.

Table 1: Best evidence synthesis for exercise prescription in the overhead athlete with shoulder pathology

Exercise category	Recommendation	Strength of recommendation	Proportion of exercises found in included studies	
			Level I-IV studies	Level I-IV studies
Open Chain UE exercise below 90 degrees	UE exercises <90 degrees of shoulder elevation have consistent evidence from level II-III and V studies to support their use in overhead athletes with shoulder pathology	B	11/33 (33%)	20/102 (20%)
Open Chain UE exercise above 90 degrees	UE exercise >90 degrees of shoulder elevation have consistent evidence from level II-III and V studies to support their use in overhead athletes with shoulder pathology	C	3/33 (9%)	8/102 (8%)
Closed chain UE exercise	Closed chain UE exercises have consistent evidence from level II-III and V studies to support their use in overhead athletes with shoulder pathology	B	6/33 (18%)	10/102 (10%)
Unspecified upper extremity exercises*	N/A	N/A	13/33 (39%)	4/102 (4%)
Isokinetic exercise of the UE above and below 90 degrees	Experts recommended these exercises, no research-based data from higher is available to support or refute these recommendations	D	N/A	8/102 (8%)
Plyometric exercise below and above 90 degrees			N/A	17/102 (17%)
Kinetic chain/core/lower extremity exercise			N/A	20/102 (20%)
Sport-specific training			N/A	15/102 (15%)

** named exercises that did not include detail of shoulder-specific positioning and therefore couldn't be replicated or recommended (i.e. shoulder rowing, straight arm press)*

Original Authors' Conclusions

[Paraphrase as required. If providing a direct quote, add page number]

The "evidence for exercise interventions in overhead athletes with shoulder pathology is dominated by expert opinion (grade D)." (p.1) There is variability between treatment strategies used in the clinic and those studied in research settings. Level B evidence supports both single plane, open chain upper extremity exercises below 90 degrees of elevation with incorporation of elastic resistance and closed chain upper extremity exercises. Expert opinion studies had a greater focus on kinetic chain, lower extremity, and plyometric exercises as well as sport-specific programs. Existing research-based programs focus solely on the shoulder and fail to account for the complexity of sport activities and could contribute to high reinjury rates. Expert opinion studies advocate for "more advanced, global treatment approach consistent with the complex, multidimensional nature of sport." (p.1) However, there currently is insufficient level I-IV evidence to substantiate the inclusion of these components in rehabilitation programs for overhead athletes with shoulder pathology. "In the context of rehabilitation in the overhead athletes, we recommend the use of single-plane exercises below 90 degrees of shoulder elevation in the early phases of rehabilitation, with a graduated progression that addresses the regional (plyometrics) and global (dynamic, multiplanar activities) issues that adequately prepare the athlete for return to sport." (p.6)

Critical Appraisal

Validity

[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.]

AMSTAR: **6/11**; a priori design provided: no; two independent data extractors: yes; comprehensive search: yes; grey literature: no; list of included/excluded studies: no; characteristics of included studies: yes; quality assessment: yes; quality assessment used in conclusions: yes; methods appropriate to combine studies: yes; publication bias: no; conflict of interest: no

Strengths:

- **Quality Assessment**: The authors clearly describe their methods for quality assessment and the instrument they used (modified downs and black checklist). While there is no quality assessment tool for expert opinion pieces, the authors included their definition of expert through years of experience or credentialing. Both authors individually reviewed each study, discussed rating discrepancies and included a third researcher if disagreements could be resolved through discussion. They use their quality assessment to inform their own conclusions from each individual study and the included articles as a whole. They list trends in the methodological shortcomings of included studies (p.4).
- **Selection Bias**: This study had at least 2 researchers screen title/abstract and full text articles. The searched multiple electronic databases, performed hand searches of non-included systematic reviews, abstracts, and the authors' private collections.
- **Search Strategy**: The search strategy was sensitive as "shoulder" was the only shoulder-specific term used. Other terms such as "rehabilitation" and "physical therapy" were used which improves the relevance of the search yield in the context of the present clinical scenario.
- **Discussion of Results**: The authors acknowledge that the available evidence is limited and provide a best evidence synthesis of the available literature. Future research priorities are suggested to improve the quality of objective data.
- **Presentation of Data**: The authors presented the available evidence in tables. Evidence from level I-IV studies was documented in a descriptive format in appendix b including information on study design, patient demographic, outcome measures, interventions, and outcomes. The quality assessment of each of the included research-based studies was displayed in Table 1. Due to the heterogeneity of study designs and limitations with including data from expert opinion pieces the authors were able to make qualitative judgements about the strength evidence which is presented in Table 3.[15]
- **Discussion of limitations**: The authors discuss the limitations of the review including low quality of included studies and issues with publication bias.

Weaknesses:

- **Quality of selected studies**: The main weakness of this review lies with the quality of the included studies. All of the studies had moderate to high risk of bias and the bulk of the literature is expert opinion (level V) which is inherently biased. Only 2 of the 6 level I-IV studies included a control group. There was insufficient data to report the effects (mean change or p value) of individual exercises. This greatly limits the ability to determine the effectiveness of the exercises in overhead athletes with shoulder pathology. There were no studies that were level I evidence. Only one study used a validated self-report measure (SPADI) and others reported on variations of pain and strength measures.
- **Publication bias**: The authors limited the search to published articles and English language. During the full-text screening this exclusion criterion eliminated 50 articles. Thus, this review may have missed out on a wealth of important data. Grey literature was also not explicitly included.

Internal validity: The included studies have weak internal validity study bias as most of the participants and assessors were unblinded. There were no treatment effect sizes or confidence intervals available for any of the exercises and outcome measure use was mainly focused on strength and pain, not function.

External Validity: The generalizability of these findings is limited due to the heterogeneity of the included studies and participants, lack of evidence regarding treatment effects for specific exercises, and low quality of available evidence.

Overall Quality of Evidence: Overall, this is a good quality study despite the limitations mentioned above with the included studies. This study identified a gap in the research and made recommendations based on the best available evidence.

Interpretation of Results

[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.]

The evidence supporting exercises for overhead athletes with shoulder pathology is currently dominated by expert opinion and low-quality research studies. It's possible that higher quality studies not published in English could have provided more substantial evidence—however these were not included. The findings form the available evidence are limited to qualitative recommendations (grades of evidence) secondary to the heterogeneity of the included studies. Based on the available evidence, open chain exercises below 90 degrees of abduction and closed chain exercises have the best support (grade B) for use in athletes with shoulder pathology.

An inherent limitation in searching for return to sport interventions is that these interventions are specific to each sport and each athlete's needs. Thus, as the athlete begins to transition out of the acute rehabilitation phases, the interventions increase in complexity, making it harder to control for confounding variables and measure treatment effects. Consequently, the complex, sport-specific exercises are sparse in the literature.

In Table 1 (above), the "type of exercise" is logically organized to mirror the common clinical phases of progression for overhead athletes with shoulder pathology. Upon examining the strength of recommendations, it appears that the earlier phases of rehabilitation (open below 90 and closed chain) have significantly better support from level I-IV studies than later stage interventions (i.e. plyometrics, sport-specific training). It's interesting that exercise >90 degrees of shoulder elevation only had C level evidence as this is a frequent position for an overhead athlete. This is further support for a gap in the literature between research evidence and clinical practice that should be addressed in future research.

No conclusions can be drawn from this study about the comparative effectiveness of open versus closed chain exercise for overhead athletes with shoulder pathology. However, this review synthesized both clinical expertise and the best available research evidence to provide B-C level recommendations for open and closed chain exercises in athletes with shoulder pathology. Lastly, it's important to note that these recommendations were made based on studies with moderate to high risk of bias with a high degree of variability in outcomes and interventions used. Thus, while greater strengths of recommendation were given to open chain exercises below 90 degrees and closed chain exercises, the low quality of studies for which these recommendations were drawn should be considered when applying these results.

Applicability of Study Results

[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.]

Relevance and Applicability:

- While this study explored different categories of exercise relevant to my clinical question, the population of patients did not explicitly include patients with glenohumeral MDI. Furthermore, while my patient did play basketball once per week, his primary sport was boxing. None of the included subjects participated in boxing further threatening this study's relevance to my clinical scenario. The patient in the clinical scenario was active in sports and within the age range of the included participants.
- "Shoulder pathology" is a broad term. In this study, shoulder pathology included shoulder impingement, pain, and inhibition due to pain. The recommendations may assume that all overhead athletes with shoulder pathology can be rehabilitated with the same exercises—which may not represent needs across the full spectrum of shoulder injuries incurred in overhead sports or account for the complexity of sporting activities.
- The recommendations for dosage are limited to a "graduated progression" which limits the ability to applicability to exercise prescription in the clinic and the current clinical scenario.
- Open chain and closed chain exercises were not compared. However, both were recommended by B level evidence for use in patients with shoulder pathology. These recommendations were not specific to any shoulder pathology. The included studies did not report any diagnosis of glenohumeral MDI limiting the direct application to the clinical scenario in question.
- Due to the aforementioned limitations, the results of this study have low relevance and limited applicability to the current patient scenario. It may reasonable to believe that there is some overlap in the exercises utilized in rehabilitation for glenohumeral MDI and the shoulder pathologies mentioned in the included articles. Thus, while these results aren't specific to a patient with MDI, the findings from this study could be used in conjunction with other studies specific to patients with glenohumeral MDI to make recommendations that are more applicable to the patient scenario in question.

Practicality and Feasibility:

- The authors organized the exercises into tables that included the studies which they were used in; and differentiate between those used in research-based and level V studies. All of these exercises fall into the PT scope of practice and are practical and feasible to implement in patients with shoulder pathology. The authors essentially developed a reference list of exercises which could be useful in designing a rehab program for an athlete with shoulder pathology. However, this limits the ability to set outcome expectations and treatment effects for specific exercises with this population.
- The variety and relative paucity of outcome measures used give little insight into what measures should be used with this population and what functional outcomes should be expected.

SYNTHESIS AND CLINICAL IMPLICATIONS

[Synthesize the results, quality/validity, and applicability of the two studies reviewed for the CAT. Future implications for research should be addressed briefly. Limit: 1 page.]

Synthesis of Evidence

The evidence presented in this literature review suggests that both open and closed chain exercises can be used in the rehabilitation of active patients with glenohumeral MDI to improve pain, strength, and function. There is no evidence directly comparing open versus closed chain exercises and none to suggest that one is superior to the other for this population. The review by Wright et al. suggested that both open chain exercises performed below 90 degrees and closed chain exercises could be recommended for use in overhead athletes with shoulder pathology. However, the recommendations were based on weak evidence and not specific to patients with glenohumeral MDI. Warby et al.[2] provides the highest available level of evidence in support of the Watson MDI program to guide treatment for patients with glenohumeral MDI. The Watson MDI protocol consists almost exclusively of open chain exercises.[2] Thus, given the positive treatment outcomes with this program compared to the Rockwood program[2]—which included both open and closed chain exercises—it could be hypothesized that open chain exercises should be at the core of a program for patients with glenohumeral MDI. While the patients in Warby et al.[2] had favourable outcomes, it isn't clear if the patients had a successful return to sport. Similar findings were drawn by Wright et al,[10] suggesting a gap in the literature for active patients with shoulder pathology.

The overall body of evidence for conservative and surgical management of glenohumeral MDI is weak owing to poor study design and high risk of bias.[3-9,16] However, a high-quality study by Warby et al.[2] and extrapolations made from Wright et al.[10] suggest that a 34-year-old recreationally active male hoping to return to martial arts and basketball would benefit from a program incorporating scapular motor control, proprioception, rotator cuff and periscapular strengthening, and sport-specific training—which may include plyometric activities above and below 90 degrees, kinetic chain, and lower body exercises. The program should progress open chain exercises from below 90 degrees to above 90 degrees of abduction. Closed chain exercises may or may not be indicated based on the patient's sporting and occupational needs. The Watson MDI program incorporates these components and is currently the best conservative treatment protocol for patients with glenohumeral MDI.

Implications for Clinical Practice

Patients seeking to undergo conservative treatment for glenohumeral MDI should be advised that the best functional improvements can take a significant time to achieve.[2] Thus, compliance and long-term adherence may be important mediating factors to see results. Patients should also be advised treatment options should conservative management be unsuccessful. While both the Watson MDI and Rockwood protocols resulted in good outcomes, the Watson MDI was superior and should be implemented into clinical practice.

Watson MDI[2]	
Stage	Stage 1: Scapular motor control, controlling arcs of motion (0-45 degrees elevation) Stage 2: Posterior glenohumeral joint muscle bulk Stage 3: Sagittal plane motor control Stage 4: Controlling ranges of motion (45-90 degrees of elevation) Stage 5: Specific Deltoid strengthening Stage 6: Function and sport-specific
Dose	Prescription based on patient needs; Repetitions held for 3 seconds Motor control: 3x20 2 times/day; Endurance: 3x10-15 2 times/day; Strength: 4x8-12 alt. days

While this program provides a useful framework, treatment for each patient should be individualized and tailored according to their specific needs.

Implications for Future Research

Future research efforts should recruit larger cohorts of patients with glenohumeral MDI and compare the long-term effects of the Watson MDI program to other programs. Bateman et al.[6] recently recorded promising results for the Derby shoulder Instability program in patients with MDI, however, this program has not yet been compared to the of Watson or Rockwood protocols. These programs should be compared in order to further guide clinical practice and treatment for glenohumeral MDI.

The question as to whether open or closed chain exercises are more effective can't be answered by the current body of literature. Given the complexity of sport and heterogeneity of individual's needs, it's likely not a question of "open or closed chain", and more likely to be a question of "when" each should be incorporated into the rehabilitation program. Nonetheless, it may be worth exploring in more well-controlled studies that allow for analysis of individual exercise treatment effects. This could certainly help to inform, modify and improve existing rehab programs.

More globally, there is a gap in the literature to guide return to sport efforts in athletes with overhead shoulder pathology.[10] Sports are complex and as rehabilitation progresses it becomes more individualized.[2,10] However, in order to guide clinical practice, well-controlled studies are needed to ascertain the treatment effects of late stage rehab interventions including specifics for speed, duration, and loading patterns.

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