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Outcomes Following Dynamic Shoulder Stabilization Interventions in Patients with Shoulder Girdle Pain: A Case Series

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Background and Purpose: Interventions to manage pain and improve function in patients with shoulder disorders include active, resistive stabilization exercises, to help carry out functional tasks at home and work. Former studies support the effectiveness of dynamic shoulder stabilization interventions, but they do not discuss the efficacy of the specific interventions demonstrated in this case series. The purpose of this case series is to describe the management of pain and functional deficits using a series of dynamic shoulder stabilization exercises in combination with standard of care. **Case Description**: Three patients with shoulder girdle pain were recruited at an orthopedic outpatient clinic for an 8-visit therapy session. Patients 1 and 2 were assigned to perform a group of 3 dynamic shoulder/scapular stabilization exercises including standard of care interventions, and Patient 3 was only given standard of care alone. All patients completed primary and secondary validated outcome measures at initial evaluation, post 4 visits, and post 8 visits to measure changes in pain, strength, and function. **Outcomes**: Results were based on meeting or exceeding each outcome measure's minimal clinical important difference (MCID) at or before the eighth visit. Patients 1 and 2 showed clinically significant change in function and pain and made observable strength improvements. Patient 3 scored lower than the MCID on all outcome measures due to his low levels of perceived pain and high levels of function at baseline. However, he made observable strength gains gradually over the course of care. **Conclusion and Clinical Relevance**: Patients 1 and 2 had observable strength gains and significant functional improvements whereas Patient 3 only had strength improvements.

Key Words: shoulder girdle pain, shoulder dysfunction, shoulder interventions, orthopedics, physical therapy

INTRODUCTION

Shoulder pain is the third most common musculoskeletal complaint reported to general practitioners in primary care settings[1]. Many patients with shoulder pain hope to receive conservative but effective treatment methods to avoid the financial and social cost of surgical intervention. Interventions provided by physical therapists to manage pain and improve function in patients with shoulder disorders include active, resistive stabilization exercises, which strengthen the muscles that surround the affected shoulder joint to help carry out functional tasks at home and work. However, to understand the rationale behind particular shoulder interventions, we will first review and discuss the functional anatomy of the shoulder complex.

The "intrinsic" muscles that contribute to the stability and movement of the shoulder, or glenohumeral joint (GHJ), include the four rotator cuff (RTC) muscles: supraspinatus, infraspinatus, teres minor, and subscapularis. It's a common misconception that the 4 rotator cuff muscles are separate entities. However, the four tendons insert only half an inch from each other in the humeral head and work in synergy by compressing the GHJ into the glenoid fossa for adequate stability in the shoulder girdle. This "force coupling" allows the humeral head to maintain in a neutral position[2]. The RTC is activated before the larger "extrinsic" muscles of the shoulder complex to execute proper movement without dysfunction[3]. Other "extrinsic" muscles that help with gross volitional movement of the shoulder complex include latissimus dorsi, deltoid, pectoralis major and minor that may be substituted when there's a shoulder pathology present. The scapular stabilizers or periscapular muscles, serratus anterior, middle and lower trapezius, stabilize the scapula against the ribcage. If compromised due to weakness and pain, the shoulder complex will also have a disrupted scapulohumeral rhythm, a kinematic relationship between the scapula and the humerus during functional movements of the upper extremity.

Dynamic shoulder stabilization exercises train the shoulder complex, including the scapula, to activate cohesively. Standard of care interventions that target muscles in isolation such as Hughston's Shoulder Protocol and RTC Thera-band activities are ubiquitous in the world of physical therapy. Although they are evidence-based and result in meaningful clinical change, other shoulder interventions that have the potential to work equally or better may be overlooked. In contrast, exercises that involve the entire shoulder complex permit better force coupling between the RTC and its other complimentary muscles, and hence, improve carry over to functional, work-related tasks[2].

Bury et al. conducted a systematic review including a meta-analysis and reviewed 4 randomized control trials to determine the efficacy of "scapula-focused approaches (SFA) verses "general approaches" for patients with RTC pathology[4]. Pain and function were the 2 main outcomes. There were statistical and clinically significant benefits with function in SFA verses general approaches in the short term (6 weeks), but not pain. However, the meta-analysis concluded that both improvements in pain and function outcomes favored SFA, despite heterogeneity among the studies.

Mulligan et al. directed a randomized crossover trial that questions the effects of sequencing between periscapular and RTC exercise training in patients with subacromial impingement syndrome (SAIS)[5]. The study's purpose was to determine whether RTC strengthening should be given prior to or after scapular stabilization (SS) exercises. Forty SAIS patients were randomly allocated to begin the scapular stabilization exercises or RTC exercises within the first 4 weeks of treatment. The groups then switched interventions (SS or RTC) the second 4 weeks of treatment. Both groups had significant improvements in pain and function individually, regardless of intervention sequence ($p < 0.001$). However, no significant differences were found at 4, 8, or 16-week follow-up ($p > 0.05$)[5].

Heron et al. compared three methods of intervention in patients with RTC tendinopathy in a randomized controlled trial[6]. The Shoulder Pain and Disability Index (SPADI) measured change in shoulder function at baseline and post treatment. 120 patients with RTC tendinopathy were randomly assigned to either the open kinetic chain group (OKC), the closed kinetic chain group (CKC), or the minimally loaded range of motion group (ROM) for 6 weeks of treatment time. OKC interventions included resistive internal rotation, external rotation, and abduction with a Thera-band, and CKC interventions included a double-arm wall press up, a press up in four-point kneeling, and a chair press up, lifting one's body off the seat. The study concluded that most subjects in all intervention groups had a clinically significant change in shoulder function, but there was no difference between groups.

Even though there is variability among the above studies, conservative methods of treatment can benefit patients with shoulder girdle pain regardless of the diagnosis because the clinical presentation remains the same[1]. These former studies support the effectiveness of dynamic shoulder stabilization interventions in general, but they do not discuss the efficacy of the specific interventions demonstrated in this case series that can potentially benefit functional outcomes in patients with shoulder girdle pain. To bridge the gap, the student examiner examined three dynamic shoulder stabilization exercises, "Wall Ball," Scapular Clock," and "Spiderman" that were performed several times in the clinic with orthopedic therapists who have had 5-15 years of clinical experience. These therapists also used these interventions on past patients with positive results, despite the clarity in the literature. The purpose of this case series is to describe the management of pain and functional deficits with conservative interventions using a series of dynamic shoulder stabilization exercises in combination with standard of care.

CASE DESCRIPTION

Three workmen's compensation patients were recruited at Orlando Orthopedic outpatient clinic to begin an 8-visit therapy session with the PT student examiner in order to manage and treat their shoulder pain. Even though previous studies including Bury et al. and Heron et al. conducted a study within a 6-week time frame, resulting in clinically significant outcomes, all 8 visits were administered within a 4-week time frame secondary to time limitations and feasibility[4,6]. The patients were included based on having a traumatic mechanism of injury at work that resulted in functional/work deficits, muscle weakness, and/or range of motion (ROM) limitations. Also, it was required that their primary language was English secondary to several other workmen's compensation patients needing a translator at this clinic location, which could influence time and efficiency of the study. The patients were excluded if they reported previous shoulder surgeries and showed signs and symptoms consistent to cervical radiculopathy. To rule out impairments originating from the neck, cervical ROM had to be within normal limits (WNL) without pain production, and special tests including Spurling's, ULTT, and Distraction all had to reveal negative findings.

Patient 1 and Patient 2 were assigned to perform a series of 3 dynamic shoulder/scapular stabilization exercises including Wall Ball, Scapular Clock, and Spiderman, which will be explained in further detail under "Intervention." These 2 patients were also given standard of care exercises and a home exercise program (HEP) to further manage impairments outside of therapy. Patient 3 was only given standard of care exercises and HEP alone. Frequency and intensity were prescribed differently among patients depending on irritability and severity of symptoms. Each patient's information will be presented separately including history, demographics, and examination.

History/Demographics

Patient 1

A 55-year-old male insurance adjustor complained of subacute left anterior shoulder pain after a motor vehicle accident on the job. His work truck was rear-ended and decided to visit an orthopedic specialist 2 days post-accident due to his symptoms worsening. The patient was given diagnostic imaging of his left shoulder, which showed a full thickness supraspinatus tear at the insertion point. He was referred for examination by a physical therapist and wore a sling for 2 weeks until then. The patient denied any other previous shoulder injuries or surgeries. He also denied taking any injections and only used oral anti-inflammatory medications as prescribed for pain. He is also right hand dominant. Pain intensity was rated 10/10 at worst and 0/10 at best with medication. He described his pain as sharp but denied any numbness or tingling down the involved arm. Aggravating factors include overhead activities and sleeping, and alleviating factors include rest and medication. Additional medical history includes history of hypertension (HTN) and thyroid disease that are also controlled with medication.

Patient 2

A 36-year-old female claims adjustor complained of subacute left posterior shoulder pain after a closing elevator hit her left shoulder at work after a meeting. She reported that the elevator had no sensor, and she rebounded into her right shoulder after being hit from the left side. Her symptoms worsened and reported to the hospital where they performed diagnostic imaging. They found no significant findings and cleared the cervical and thoracic spine. However, the MD script noted that she was diagnosed with scapular dyskinesia and periscapular muscle strain. She denied any previous shoulder injuries or surgeries. She is right hand dominant. Pain intensity was rated 7/10 at worst and 1/10 at best. She described her pain as dull and reported numbness and tingling in the left scapular region down to the axilla. Aggravating factors include lifting, carrying, pushing, pulling, and sleeping. Alleviating factors included rest and heat. She had an unremarkable past medical history and no red flags, which revealed no contraindications to discontinue with intervention provided by a physical therapist.

Patient 3

A 53-year-old male theme park prop/set designer complained of subacute right anterior shoulder pain after moving models from a truck on a windy day. He reported that him and the model were both taken with a strong gust. Following his injury, he visited an orthopedic specialist and found positive diagnostic imaging results including a partial supraspinatus and subscapularis tear, tenodesis of the long head of the biceps tendon, and contusion of the greater tubercle in the right shoulder. He denied any previous shoulder surgeries but has had a previous dislocation on the same shoulder 30 years ago. He used oral anti-inflammatory medications for pain but denied taking any injections. He is also right hand dominant. Pain intensity was rated 4/10 at worst and 0/10 at best. Aggravating factors include higher level work activities such as lifting/carrying objects over 50 lbs, lifting heavy objects overhead, and using a spray gun which requires continuous horizontal adduction/abduction movements at shoulder height. He has an unremarkable past medical history and no red flags, which revealed no contraindications to discontinue with intervention provided by a physical therapist.

Examination

Each patient was examined for shoulder passive and active range of motion (AROM/PROM) using a standard goniometer, strength of the rotator cuff (RTC) muscles and scapular stabilizers using Manual Muscle Testing (MMT), posture, and palpation. Intra-rater reliability for goniometry of the shoulder is excellent with an intraclass correlation coefficient (ICC) greater than 0.94, and concurrent validity is also good with a correlation value greater than 0.85[7]. Planes of motion assessed included flexion, abduction, external rotation, and internal rotation.

Muscles assessed during MMT included serratus anterior, middle trapezius, lower trapezius, infraspinatus, teres minor as well as gross shoulder flexion, abduction, and external/internal rotation. Noreau et al. discovered adequate to excellent construct validity between MMT and myometry in patients with spinal cord injury ranging from C3 to L5 levels of injury[8]. According to Herbison et al., interrater reliability was also excellent in patients with spinal cord injuries. However, the evidence is lacking pertaining to validity and reliability in orthopedics[9]. Youdas et al. found excellent interrater reliability (ICC = 0.97) in patients with hip osteoarthritis, but MMT psychometric measures remain inconclusive about patients with shoulder diagnoses specifically[10].

Validated special tests included Hornblower Sign, Belly Press, and Drop Arm to rule in or out RTC pathology; Obrien's and Bicep Load II Test for shoulder instability; and Hawkins-Kennedy and Neer's Test for impingement. For ruling in or out RTC pathology, Hornblower Sign, Belly Press, and Drop Arm test's sensitivity and specificity are 100% and 93%, 40% and 98%, and 27% and 88%, respectively[11, 12, 13]. For diagnostic confirmation of shoulder joint instability, sensitivity and specificity for the Obrien's test is 47% and 55% respectively[14], and for the Biceps Load II test is 90% and 97%, respectively[15]. For impingement, the meta-analysis conducted by Hegedus et al. revealed that the pooled sensitivity and specificity for the Neer's test was 79% and 53%, respectively, and for the Hawkins–Kennedy test was 79% and 59%, respectively[16]. Not all special tests were executed on each patient, and the student examiner chose the most appropriate set of tests based previous patient interview and objective findings.

To clear the cervical spine and reassure that each patient's symptoms are not originating from the neck, cervical ROM and special tests including Spurling's, Upper Limb Tension Test (ULTT), and Distraction Test were all administered to determine subject inclusion or exclusion into this case series. Test-retest reliability for cervical inclinometry to test cervical ROM is good with an ICC ranging from 0.84 to 0.94 in all planes of motion[17]. Sensitivity and specificity of Spurling's test is 50% and 88% respectively[18]. Distraction test has a low to moderate sensitivity of 44% and a high specificity of 90%, and ULLT has a high sensitivity of 97% and a low specificity of 22%[19]. The student examiner chose to perform median nerve bias on all three patients for consistency and brevity of the study.

Patient 1

He presented with forward head posture and no scapular winging bilaterally after postural assessment. He also reported pain and tenderness at the left supraspinatus tendon upon palpation. AROM and PROM revealed limited in flexion, abduction, external rotation, and internal rotation in the involved limb compared to the uninvolved limb. He could complete full active flexion and external rotation but could not perform full active abduction or internal rotation due to worsening of symptoms. His left shoulder strength showed 4+/5 in flexion, 4/5 in abduction and external rotation, and 3+/5 in internal rotation. More specifically, infraspinatus and teres minor revealed 4/5 and 4-/5 strength respectively. Scapular stabilizers including middle and lower trapezius revealed 4/5 strength bilaterally. Hawkins Kennedy was positive, and Belly Press and Drop Arm tests were negative. Cervical ROM was within normal limits (WNL) and all cervical radicular special tests were negative.

Patient 2

She presented with left static and dynamic scapular winging compared to the uninvolved side especially in abduction. It was tender to palpate her periscapular muscles at middle and lower trapezius on the left side. AROM and PROM revealed WNL and only reported pain at end range during passive abduction in her involved limb. Strength grossly revealed 4/5 in external rotation, and all other planes of motion were WNL. More specifically, teres minor, middle and lower trapezius resulted in 4/5 strength and infraspinatus 4+/5. Hawkins Kennedy and Biceps Load II test was negative; Hornblower Sign was positive. She reported some numbness and tingling in the left scapular region, but it did not remain consistent with signs and symptoms of cervical radiculopathy after performing cervical ROM and special tests.

Patient 3

He presented with rounded shoulders bilaterally and no scapular winging after postural assessment. There was no reported pain or tenderness in any areas palpated. AROM and PROM revealed WNL except for active and passive internal rotation on the ride side compared to the left. Gross strength was all WNL until the student examiner assessed specific muscles including infraspinatus (4+/5), teres minor, middle trapezius, and lower trapezius (4/5). All special tests were negative including Belly Press, Drop Arm, Obrien's, and Hawkins Kennedy. Cervical ROM was WNL and all cervical radicular special tests were negative.

Outcome Measures

Patients 1, 2, and 3 completed the following validated outcome measures at initial evaluation, post 4 visits, and post 8 visits.

Primary

The Shoulder Pain and Disability Index (SPADI): A 13-item interval questionnaire that is divided into 2 sections dedicated to pain severity (5 items) and disability (8 items) based on common shoulder functional tasks. Reliability is strong with reliability coefficient ICC = 0.91 for shoulder disorders, ICC = 0.84 if nonsurgical, and ICC = 0.86 for impingement specifically[20]. Comparing SPADI to Disabilities of Arm, Shoulder, and Hand (DASH), the Pearson correlation coefficient is strong (r = 0.88)[21]. This measure has been used for upper extremity disorders in general as well as rotator cuff pathology, adhesive capsulitis, osteoarthritis, rheumatoid arthritis, and post total shoulder arthroplasty (TSA). Minimally Clinical Important Difference (MCID) is a 13.2-point deduction from baseline for general musculoskeletal upper extremity conditions[22].

Secondary

Quick Disabilities of Arm, Shoulder, and Hand (QuickDASH): An 11-item ordinal questionnaire that rates a patient's level of disability based on common upper extremity functional tasks. In addition, there are optional work and sports/performing arts sections, and all 3 patients completed the 4-item work section. Each item is rated from 1-5 with 1 = no difficulty to 5 = unable/extreme difficulty. Internal consistency for reliability is excellent with Cronbach's alpha = 0.92-0.95 and interclass correlation coefficient (ICC) = 0.90-0.94[23]. Construct validity is strong with Pearson's correlation (r = 0.84), comparing QuickDASH to SPADI[24]. MCID is an 8-point deduction from baseline[25].

Numeric Pain Rating Scale (NPRS): A 0-10 pain rating scale that represents level of perceived pain severity with 0 = no pain and 10 = worst pain imaginable. The NPRS is used universally across all types of musculoskeletal, neurological, and other systemic pathologies to measure pain. Internal consistency in healthy adult populations is good with a Cronbach's alpha = 0.88, and validity is strong with a high Pearson correlation coefficient (r = 0.86) compared to the Visual Analog Scale (VAS), another common validated measure for pain severity[26]. MCID for shoulder pain is a 2.17-point deduction post 3-4 weeks of rehab compared to baseline[27].

Manual Muscle Testing (MMT): A standardized procedure to measure individual muscles and muscle groups based on an examiner's manual resistance against the forces of gravity. A score of 5/5 is the highest score one can achieve. There's minimal evidence pertaining to reliability and validity for MMT, especially in an outpatient orthopedic setting where most patients can contract the muscle against gravity, scoring at least a 3/5. Due to this matter, patients were required to achieve at least ½ increase in muscle grade post 8 visits for it to be an observable change in strength gains. (Example: Patient scored 4/5 strength at baseline and achieved 4+/5 strength post 8 visits.)

Intervention

Patients 1 and 2 were given the following 3 dynamic shoulder stabilization exercises to perform at each therapy session with supervision (8 total sessions). The rationale behind prescribing these 3 interventions is that they elicit "force coupling" between the RTC and periscapular muscles as explained in Parsons et al., which is more analogous to daily functional tasks at home and work[21]. Edwards et al. also discussed that shoulder pathology, regardless of the diagnosis, can be treated with the same intervention due to similar impairments[6]. Therefore, these 3 interventions were given to a patient with RTC tear and a patient with periscapular strain and dyskinesia in hopes of positive outcome for both cases.

The dynamic shoulder stabilization interventions were never implemented in each patient's home exercise program (HEP) due to importance of proper and consistent form. Frequency, such as number of sets/repetitions, was prescribed differently between patients depending on level of pain and function. Patients could take breaks in between each set. Intensity also varied between patients such as ball weight and level of Thera-band resistance. *To maintain the patients' privacy, the following visual aids are pictures of the student examiner, and not patients.*

Wall Ball: Six stickers were evenly spaced about 12 inches apart in a semicircle on a wall. The patient used a 1-2 lb medicine ball to complete small circles clockwise and counterclockwise on each point. The right half of the semicircle was dedicated to the right upper extremity and the left half to the left upper extremity. Table 1 depicts progression of frequency and intensity.

Scapular Clock: Using the same setup at "Wall Ball," the patients placed one hand on the lower center point with a Thera-band looped around both wrists. While the one extremity remained on the lower center point to stabilize, the other extremity reached to all other points on the right and left side, depending on which extremity was used to stabilize or mobilize. Reaching to all three points up and down on one side represented one repetition. Patients required frequent verbal cuing to maintain full elbow extension and shoulder depression/retraction during the exercise. Table 2 depicts progression of frequency and intensity.

Spiderman: Patients began with hands shoulder width apart on the wall with body angled flat to elicit light weight bearing evenly through both hands. The Thera-band was again looped taut around both wrists. Then the patients were instructed to crawl up and down the wall three times in both directions. Three times upwards and three time downwards represented one repetition. Frequent verbal cuing was utilized to initiate shoulder horizontal abduction to flexion going up or horizontal abduction to extension going down in a "C" curve fashion. Table 3 depicts progression of frequency and intensity.

Table 1: Patients 1 & 2 Progression of Frequency and Intensity for Wall Ball

	Visits 1-2	Visits 3-4	Visits 5-6	Visits 7-8
Patient 1	**Frequency:** 10 CW/ 10 CCW x 1 set at each point **Intensity:** Tennis Ball (about ¼ lb)	**Frequency:** 15 CW/15 CCW x 1 set at each point **Intensity:** Tennis Ball (about ¼ lb)	**Frequency:**15 CW/15 CCW x 1 set at each point **Intensity:** 1 lb medicine ball	**Frequency:** 20 CW/20 CCW x 1 set at each point **Intensity:** 1 lb medicine ball
Patient 2	**Frequency:** 15 CW/15 CCW x 1 set at each point **Intensity:** 1 lb medicine ball	**Frequency:** 20 CW/20 CCW x 1 set at each point **Intensity:** 1 lb medicine ball	**Frequency:** 20 CW/ 20 CCW x 2 sets at each point **Intensity:** 1 lb medicine ball	**Frequency:** 20 CW/20 CCW x 1 set at each point **Intensity:** 2 lb medicine ball

Table 2: Patients 1 & 2 Progression of Frequency and Intensity for Scapular Clock

	Visits 1-2	Visits 3-4	Visits 5-6	Visits 7-8
Patient 1	**Frequency:** 6 reps x 2 sets **Intensity:** Yellow Thera-band (light resistance)	**Frequency:** 6 reps x 3 sets **Intensity:** Yellow Thera-band (light resistance)	**Frequency:** 6 reps x 3 sets **Intensity:** Orange Thera-band (light-moderate resistance)	**Frequency:** 8 reps x 3 sets **Intensity:** Orange Thera-band (light-moderate resistance)
Patient 2	**Frequency:** 6 reps x 2 sets **Intensity:** Orange Thera-band (light-moderate resistance)	**Frequency:** 6 reps x 3 sets **Intensity:** Orange Thera-band (light-moderate resistance)	**Frequency:** 6 reps x 3 sets **Intensity:** Green Thera-band (moderate resistance)	**Frequency:** 8 reps x 3 sets **Intensity:** Green Thera-band (moderate resistance)

Table 3: Patients 1 & 2 Progression of Frequency and Intensity for Spiderman

	Visits 1-2	Visits 3-4	Visits 5-6	Visits 7-8
Patient 1	**Frequency:** 6 reps x 2 sets **Intensity:** Against gravity (no resistance)	**Frequency:** 6 reps x 2 sets **Intensity:** Yellow Thera-band (light resistance)	**Frequency:** 6 reps x 3 sets **Intensity:** Yellow Thera-band (light resistance)	**Frequency:** 8 reps x 3 sets **Intensity:** Orange Thera-band (light-moderate resistance)
Patient 2	**Frequency:** 6 reps x 3 sets **Intensity:** Yellow Thera-band (light resistance)	**Frequency:** 6 reps x 3 sets **Intensity:** Orange Thera-band (light-moderate resistance)	**Frequency:** 8 reps x 3 sets **Intensity:** Orange Thera-band (light-moderate resistance)	**Frequency:** 8 reps x 3 sets **Intensity:** Green Thera-band (moderate resistance)

Standard of Care Interventions

All 3 patients were given standard of care interventions at all 8 therapy sessions with supervision. These therapeutic activities were assigned to each patient to perform at home as well. Frequency and intensity varied depending on each patient's pain severity/irritability, strength, and functional level. Hughston's Shoulder Protocol is a series of RTC exercises performed in prone off the edge of a bed or table. There are Y, T, I, and W arm positions that target or isolate certain muscles. Tables 4 and 5 depict progression of frequency and intensity of these exercises.

Table 4: Hughston's Shoulder Protocol Progression of Frequency and Intensity

	Visits 1-2	Visits 3-4	Visits 5-6	Visits 7-8
Patient 1	**Frequency:** Y, T, I 10 reps x 1 set each **Intensity:** 0 lb	**Frequency:** Y, T, I 15 reps x 1 set each **Intensity:** 0 lb	**Frequency:** Y, T, I 15 reps x 1 set each **Intensity:** 1 lb	**Frequency:** Y, T, I 15 reps x 2 sets each **Intensity:** 1 lb
Patient 2	**Frequency:** Y, T, I 10 reps x 1 set each **Intensity:** 1 lb	**Frequency:** Y, T, I 15 reps x 1 set each **Intensity:** 1 lb	**Frequency:** Y, T, I 15 reps x 1 set each **Intensity:** 2 lb	**Frequency:** Y, T, I 15 reps x 2 sets each **Intensity:** 2 lb
Patient 3	**Frequency:** Y, T, I 10 reps x 2 sets each **Intensity:** 1 lb	**Frequency:** Y, T, I 10 reps x 2 sets each **Intensity:** 2 lb	**Frequency:** Y, T, I, W 15 reps x 1 sets each **Intensity:** 2 lb	**Frequency:** Y, T, I W 15 reps x 2 sets **Intensity:** 2 lb

Table 5: RTC Thera-band Exercise Progression of Frequency and Intensity

	Visits 1-2	Visits 3-4	Visits 5-6	Visits 7-8
Patient 1	**Frequency:** Ext, ER 10 reps x 2 sets each (Abd, IR painful upon initial exam) **Intensity:** Orange T-band (light-moderate resistance)	**Frequency:** Ext, Abd, ER, IR 10 reps x 2 sets each **Intensity:** Orange T-band (light-moderate resistance)	**Frequency:** Ext, Abd, ER 10 reps x 3 sets each; IR 10 reps x 2 sets each **Intensity:** Orange T-band (light-moderate resistance)	**Frequency:** Ext, Abd, ER, IR 10 reps x 3 sets each **Intensity:** Green T-band (moderate resistance)
Patient 2	**Frequency:** Ext, Abd, ER, IR 10 reps x 3 sets each **Intensity:** Orange T-band (light-moderate resistance)	**Frequency:** Ext, Abd, ER, IR 10 reps x 3 sets each **Intensity:** Green T-band (moderate resistance)	**Frequency:** Ext, Abd, ER, IR 12 reps x 3 sets each **Intensity:** Green T-band (moderate resistance)	**Frequency:** Ext, Abd, ER, IR 12 reps x 3 sets each **Intensity:** Blue T-band (strong resistance)
Patient 3	**Frequency:** Ext, Abd, ER, IR 10 reps x 3 sets each **Intensity:** Green T-band (moderate resistance)	**Frequency:** Ext, Abd, ER, IR 12 reps x 3 sets each **Intensity:** Green T-band (moderate resistance)	**Frequency:** Ext, Abd, ER, IR 12 reps x 3 sets each **Intensity:** Blue T-band (strong resistance)	**Frequency:** Ext, Abd, ER, IR 15 reps x 3 sets each **Intensity:** Blue T-band (strong resistance)

OUTCOMES

Results were based on meeting or exceeding the minimal clinical important difference (MCID) from the above listed validated outcome measures at or before the eighth visit. The SPADI was the primary outcome measure, and the QuickDASH, NPRS, and MMT for RTC and scapular stabilizers were all secondary outcome measures. As stated previously, there's minimal evidence pertaining to reliability and validity for MMT if the patient can achieve full muscle contraction against gravity, scoring at least a 3/5. Therefore, patients were required to achieve at least ½ increase in muscle grade post 8 visits to determine observable improvements in muscle strength. Tabl 6 is attached to explain the progression of scoring in further detail.

Patient 1: He exceeded the MCID on QuickDASH post 4 visits (2 wks), and met the MCID for SPADI post 8 visits (4 wks). After 4 therapy sessions, he had strength gains in the following muscles or gross movements of the involved upper extremity: flexion, abduction, external rotation, infraspinatus, and teres minor. After 8 therapy sessions, he achieved observable improvements in scapular stabilizer strength including both middle and lower trapezius, and he increased in teres minor strength even more during the second half of care. All other muscles and gross motor strength remained the same during the second half with no decline in strength.

Patient 2: She exceeded MCID post 4 visits on SPADI and QuickDASH, and NPRS MCID was met post 8 visits. Strength in the involved limb improved post 4 visits, specifically gross external rotation and middle trapezius. Even though gross external rotation improved, infraspinatus and teres minor remained the same score compared to baseline. However, abduction decreased ½ muscle grade post 4 visits compared to baseline. There was an observable change in teres minor strength post 8 visits, and all other maintained the same scores from 4 visits prior.

Patient 3: He scored lower than MCID on SPADI, QuickDASH, and NPRS at baseline due to his low levels of perceived pain and high levels of function. However, he made observable strength gains from baseline. After 4 and 8 visits, he improved in scapular stabilizer strength and then RTC strength respectively. More specifically, he gained middle and lower trapezius strength post 4 visits and infraspinatus and teres minor strength post 8 visits. Table 6 depicts when all patients met or exceeded the MCID of the primary and secondary outcome measures at baseline, post 4 visits, and post 8 visits.

Table 6: Change in Outcomes.

	Measure	Baseline	Post 4 visits	Post 8 visits
Patient 1	SPADI Pain + Disability (%)	60	54.6	43.1*
	QuickDASH	81.8	31.8*	34.1
	QuickDASH (Work section))	75	18.8*	31.3
	NPRS	6/10	6/10	4/10
Patient 2	SPADI Pain + Disability (%)	41.5	26.2*	14.6
	QuickDASH	47.7	31.8*	27.3
	QuickDASH (Work section))	12.5	6.25	6.25
	NPRS	5/10	4/10	2/10*
Patient 3	SPADI (Pain + Disability (%))	2.31	0.77	0.77
	QuickDASH	6.82	4.55	0
	QuickDASH (Work section)	0	0	0
	NPRS	0/10	0/10	0/10

*MCID met or exceeded

Discussion

Despite the variability in treatment assignments, all 3 patients with shoulder pain obtained meaningful clinical changes throughout the course of care, some outcomes earlier than others. Patients 1 and 2 had observable strength gains and significant functional improvements based on valid and reliable outcome measures whereas Patient 3 only had strength improvements. To execute better interpretation of the results, the student examiner hoped to find a patient with more impairments and functional deficits in replacement of Patient 3, who initially had minimal complaints and low outcome scores at baseline. Hence, she could have determined whether standard of care interventions resulted in worse, equal, or better change compared to the dynamic shoulder stabilization exercises assigned to Patients 1 and 2. However, due to time limitations, it was not feasible to recruit another patient by the end of the 4-week window.

Other limitations of this case series include: 1) variability in frequency and intensity prescribed by the student examiner, 2) lack of data pertaining to long term vs, short term affects, 3) inability to determine whether 1 of the 3 dynamic shoulder stabilization interventions alone demonstrated better outcomes compared to the other two treatments. In our profession, there remains a grey area as to how much or how little to perform an intervention even in a patient population that exhibits similar impairments. However, the student examiner would like to delve into the effects of frequency and intensity of dynamic shoulder stabilization interventions in a separate study.

Since all 3 subjects were treated within 4 weeks (8 visits), the student examiner observed only short-term meaningful changes in these patients, and several questions arise. Will the effects of dynamic shoulder stabilization intervention carry over in the long term and for how long? Another limitation in this case study is that all 3 interventions were prescribed to Patients 1 and 2 together as a group and not separately. The student examiner expresses interest in comparing the effects of pain and function between "Wall Ball" verses "Spiderman" or "Scapular Clock" vs. "Spiderman", etc. in a randomized control trial. A clinical research question would be phrased as follows: What is the difference in pain and functional outcomes comparing two dynamic shoulder exercises in patients with shoulder girdle pain?

In conclusion, patients with shoulder girdle pain demonstrated significant improvements after therapy interventions despite the intervention being dynamic shoulder stabilization exercises or standard of care exercises. The student examiner will continue to implement all the above interventions in her practice based on the positive clinical findings found in this case series and will appreciate the above limitations as stated.

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