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Nonoperative Management of Shoulder Instability

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Title: Current Clinical Concepts: Nonoperative Management of Shoulder Instability

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Clinical Concepts: Nonoperative Management of Shoulder Instability

Abstract: 113 words

Non-operative management following a shoulder dislocation or subluxation remains a challenging and complex task. Accurate diagnosis of the condition, and shared decision-making regarding operative and non-operative management, as well as timing of return to play is required. This clinical concept paper introduces a shoulder instability framework that addresses these fundamental clinical dilemmas. Valid clinical prognostic tools which can predict recurrent shoulder instability are reviewed. The process of shared decision-making within the realm of shoulder instability is also presented. Finally, a framework for progressive rehabilitation that addresses deficits in motor control, strength, and endurance in scapula and shoulder musculature is presented to guide patients from an initial instability event, through to return to play.

Word Count = 4745

Introduction

Shoulder instability is defined as the inability to maintain the humeral head within the glenoid fossa.[1] Traditionally, the literature has focussed on both the assessment and outcomes of surgical management of shoulder instability.[2,3] While individual studies have reported rates of recurrence as high as 75-100%,[2,3] evidence from two systematic reviews identifies a much lower recurrence rate across all populations (21-39%).[4,5] Therefore, many patients would likely benefit and be appropriate for non-operative management. Unfortunately, there is limited literature that provides specific detailed non-operative interventions.[6,7] Additionally, some patients with chronic shoulder micro-instability are misdiagnosed and may have not responded to traditional shoulder rehabilitation programs. Ultimately, direct-access/first contact

clinicians face at least three clinical decisions; 1) to determine the patient's correct diagnosis, 2) to determine if the patient should be managed operatively or non-operatively (incorporating multiple biopsychosocial factors), and 3) if the patient chooses non-operative intervention, what interventions should be provided to maximize their outcome. The purpose of this clinical concept is to share a framework for the management of shoulder instability which addresses these three fundamental questions.

Shoulder Instability Framework

What is the diagnosis?

Patients with shoulder instability present with a spectrum of symptoms ranging from intermittent pain with activities due to micro-instability through to severe pain associated with complete or frequent shoulder dislocation. Recognition of a traumatic dislocation may be relatively simple to determine from observation and palpation. However, in instability without obvious deformity, a thorough subjective history and examination for signs of abnormalities in range of motion (ROM), strength, scapula control/strength and provocative special tests is required to determine the direction of instability and the potential for non-operative management. Detailed information on examination procedures and provocative tests are well described in the literature.[8,9] This assessment is important to differentiate shoulder pain from other sources, such as cervical, scapular, or neurological origins. From this examination, shoulder instabilities are typically classified by the frequency (single vs. multiple instability episodes), etiology (traumatic or atraumatic), direction of instability (anterior, posterior or multi-directional), and severity (micro-instability, subluxation, dislocation).[10,11] Physical impairments of motor control and strength in anterior, posterior rotator cuff, and scapular musculature are commonly identified through the

physical examination (Figure 1). Additionally, shoulder mobility limitations such as posterior shoulder tightness may be observed in overhead athletes. Once the diagnosis is made and impairments identified, then together the patient and clinician can decide on the appropriate management.

Clinical Decision-Making on management

Deciding between operative and non-operative management of shoulder instability is challenging. Historically, physically active males under 25 years have been considered good candidates for surgery to reduce re-dislocation risk,[12] but this can result in unnecessary surgery.[13] Recent prognostic research can help guide clinicians on prognosis following anterior shoulder instability events.[14,15] The key point of both prognostic tools is that additional factors other than sex and age should be considered in advising the patient on the likelihood of re-injury. Olds and colleagues[14] have published a predictive model that identified six factors that together were predictive of recurrent shoulder instability.

1. Presence of bony Bankart lesion
2. Age 16-25
3. Dominant shoulder involvement
4. Elevated Tampa Scale of Kinesiophobia
5. Elevated SPADI score, indicating more pain and dysfunction
6. Lack of immobilization

Clinicians can enter individual patient data into an online calculator at the free website (www.margieolds.com/pris) to help determine their patient's risk of a recurrent event.

Tokish and colleagues[15] also identified 6 factors that can be used to predict recurrent shoulder instability and created the Nonoperative Instability Severity Index Score (NISIS). This tool was originally developed to guide decision-making regarding operative or nonoperative treatment following a primary traumatic anterior shoulder dislocation in primarily high school athletes,[15] but has been also used to predict recurrent shoulder instability.[16] The authors weighted the six factors and patients deemed low risk (NISIS score <7) were managed successfully with non-operative treatment 97% of the time.[15] Patients classified as high risk (>7) were more likely to fail non-operative management (60.3%) than those classified as low risk (48.9%, p=0.03).[16] The six factors and weights are:

1. Collision sport = 3, Not a collision sport = 0
2. Age >15 = 2, Age under 15 = 0
3. Bone loss detectable on radiograph = 2, No bone loss on radiograph = 0
4. Dislocation = 1, Subluxation = 0
5. Dominant arm involved = 1, Non-dominant arm involved = 0
6. Male = 1, Female = 0

Patients' presenting with first time anterior dislocation should be stratified with either tool along with other contextual considerations that should be incorporated into the shared decision-making process regarding operative vs. non-operative management. (Figure 2) Shared decision-making involves providing an explanation of shoulder instability, outlining the natural history, discussion of the potential benefits and harms of operative and non-operative management, establishing the patient's values, preferences, and expectations. This process assists the patient to reach an informed decision about management of their condition.[17] Controversy exists in the literature regarding the management of subsequent dislocations/subluxations, and the

clinician is encouraged to share all relevant research with the patient so that the patient can make decisions regarding their treatment. Recurrent shoulder instability may also be a consequence of inadequate previous rehabilitation, defined as when patients have not regained strength, endurance and ROM within 10% of the unaffected side (accounting for a 10% strength effect for dominance).[18–21]

Non-operative Management of Shoulder Instability

Once patients have decided to proceed with non-operative management, deficits that were identified in the clinical assessment (Figure 1) are incorporated into treatment in a staged, progressive manner. The authors' perspective of rehabilitation intervention is based on direction of instability, mobility limitations, and common muscular deficiencies found with shoulder instabilities which is the primary focus of this article. (Figure 3)

Acute shoulder instability

First-time acute anterior shoulder subluxation/dislocation requires specific management within the initial 6 weeks following an injury to maximize patient outcomes. The shoulder should be immobilized following reduction for a length of time that is dependent upon symptoms.[22] For people with an anterior dislocation, there is inconsistent evidence whether immobilization should be in external or internal rotation.[23] While there is no evidence that immobilization for greater than 1 week reduces the risk of recurrent shoulder instability,[23] the authors advise immobilizing for pain and symptoms as required, but not beyond three weeks. People with recurrent instability should be immobilized as symptoms require. There is no evidence regarding the length of time for immobilization in this recurrent population, and clinicians should use symptoms and presentation to guide their

management. People with micro-instability seldom require immobilisation. Indeed, these people commonly presents with restriction in movement in the posterior shoulder and require stretching or mobilisation of these structures. People with acute traumatic posterior instability may be immobilized although there is limited research examining outcomes, position or length of immobilisation in this population. People with Multi-directional instability typically tend to have less hemarthrosis and joint pathology and may benefit from short period of immobilization (1-3 days) if symptomatic. Again, there is limited rigorous evidence which has examined immobilisation with people with MDI.

Clinicians should focus on early resolution of strength impairments as acute symptoms allow.[24] Low-level isometric contractions can often be performed in pain-free positions, in multiple directions to facilitate shoulder neuromuscular control. Patients should then slowly regain their active range of motion. Early resolution of full shoulder ROM following traumatic subluxation/dislocation is not thought to be clinically advantageous. The symptoms and impairments experienced after an episode of shoulder instability vary greatly. Therefore, criterion-based progression using functional milestones with specific endurance and strength-based criterion (provided in **Table 1**), instead of more time-based protocols. A general consideration for posterior instability is that patients initially tolerate mobility exercises in the frontal or scapular plane. Patients with anterior instability initially tolerate mobility exercise in the sagittal or scapular plane. Regardless of the specific direction of the instability there are often several question from the patient, family, and other interested parties. Therefore, education on the pathoanatomy, risk of recurrence, return to activity and treatment options should be discussed. Kinetic chain deficits may contribute to shoulder instability through alterations in muscle activity and positioning of the

scapula and trunk (e.g. with decreased contralateral gluteal and/or trunk rotation strength) should be assessed, and treatment to address these deficits commence.

Sub-acute and End-stage Rehabilitation: Directional Specific Interventions

A direction-specific approach is required in rehabilitation of instability as the pathology and impairments (such as strength and ROM) differ depending upon the direction of instability. Therefore, treatment in the sub-acute stages follows a staged progression based on the primary direction of instability using the anterior rotator cuff, posterior rotator cuff and co-contraction protocols as outlined in figure 3. Rehabilitation consists of a staged construct of re-establishing motor control and strength of the key shoulder musculature (Stages 1 & 2). Then dynamic exercises are added to facilitate the Position, Amplitude of motion, Loads and Speed (PALS) (Stage 3) of movement. Finally, internal/external perturbations and unexpected movements (Stage 4) are integrated and then readiness to return to sport is examined. All stages have a direction-specific focus to facilitate particular muscle activation, and treatment for anterior and posterior instability may or may not include both anterior and posterior directions dependent upon patient deficits. All criteria to progress for each protocol are summarized in **table 1**. Incorporation of scapula muscle strengthening can begin when patients can perform exercises pain free and are outlined in the appendix. Discussions regarding any fear of reinjury or decreased confidence and/or referral to appropriate health care provider is also appropriate.

Anterior Rotator Cuff Protocol

This protocol is primarily for anterior instability pathology and principally develops motor control and strength of subscapularis (Figure 3). The subscapularis muscle blends with the anterior shoulder capsule and is an important dynamic anterior stabilizer for the glenohumeral joint.[25] Clinicians should initially incorporate motor

control training in order to differentiate subscapularis activity from the often compensating latissimus dorsi and pectoralis major and can palpate subscapularis activity at the base of the axilla to determine the level of activation.[26] Furthermore, forces created by pectoralis major and latissimus dorsi may increase anterior translation of the humeral head on the glenoid.[27] If patients with anterior instability also present with posterior rotator cuff impairments, then clinicians should address this deficit using the posterior rotator cuff protocol, once Stages 1and 2 of the anterior protocol are completed.

Some patients with micro-instability in an anterior direction present with restrictions in PROM in horizontal flexion, internal rotation at 90° of abduction or end range elevation. Several treatment approaches[28,29] can be used to normalize ROM posterior shoulder mobility including but not limited to; sleeper stretch, cross body stretching, massage, contract-relax, and mobilization. When posterior shoulder restriction is identified, it should be addressed in the early stages and throughout rehabilitation of the anterior rotator cuff protocol to ensure full mobility and function is restored (Figure 3).

Stage 1 Anterior Rotator Cuff Motor Control and Strengthening

The authors advocate the use of exercises which bias the activation of the subscapularis over the pectoralis major and latissimus musculature. This is performed in supine with the arm abducted comfortably to allow the clinician to palpate the subscapularis. Patients are instructed ‘draw the shoulder into its socket’ or internally rotate the humerus without humeral adduction or horizontal flexion without activating the other internal rotators.[41] (Video 1). Light distraction of humeral head from the glenoid can be used to facilitate subscapularis activation. Patients are then instructed to ‘draw the shoulder into its socket’ and/or internally rotate the

humerus. Clinicians can use gentle isometric shoulder abduction or horizontal extension, to reciprocally inhibit the adductors (predominantly latissimus dorsi) and horizontal flexors (predominantly pectoralis major). This allows the patient to contract subscapularis with decreased contribution from other muscles.[30] The clinician instructs the patient to palpate the subscapularis during this exercise to facilitate motor control feedback (Video 1).

The strength-based approach to increase the strength and activation of subscapularis, utilizes a prone lift-off position. This position decreases the contribution of latissimus dorsi and pectoralis major because of their anatomical constraints. Patients should lie prone with their wrist over L4 and lift the hand from the back (no more than 1 inch) and hold for 30 seconds. If this exercise is painful, clinicians can modify by moving hand down to over the buttock or use a belly press exercise. As they are able, patients should progress toward the prone lift-off L4 position. The exercise is performed to promote subscapularis fatigue and should not be painful to perform. (Figure 4) Ideally, both the motor control and strength criteria will be achieved before moving to stage 2, but the strength-based goal must be achieved. (**Table 1**)

Stage 2 Anterior Rotator Cuff Motor Control and Strengthening (ACMC)

Once the patient can activate subscapularis more independently, then the focus of rehabilitation is concentric and eccentric subscapularis control through range of motion. This can be performed in supine with arm abducted, so the clinician or patient can palpate subscapularis (Video 2). If this position is painful, the arm should be moved to the scapular plane with a towel under the distal humerus and range limited to painfree movement.[27] Light weight or elastic bands should be used for daily home exercises to increase patient control of subscapularis through range.

Progression of the strength-based approach is achieved by using a 1-meter long resistance band fixed to the wall in front of the patient standing 1 meter away. The band is passed around the opposite side of the body so the patient grasps with their affected hand behind their back. The patient then lifts their hand away from the back 1-2 inches to perform an isometric hold for 3 x 10 seconds. Progress exercise up to 30 seconds and level of resistance until reaching goal to progress. Clinicians should educate patients to maintain load through internal rotation without pain and not compensate with shoulder extension or wrist flexion. Often patients with anterior instability also need posterior rotator cuff strengthening once they have established subscapularis control to balance the glenohumeral joint.

Stage 3 – Anterior Rotator Cuff Position, Amplitude, Load, Speed (PALS)

This is the dynamic stage which the individual sport or job demands of the patient result in rehabilitation tailored by altering the position, amplitude, load, and speed (PALS) of the exercise. This protocol has similarities across all three directions of instability, although focus should remain on the specific direction of instability. Once patients with anterior instability have progressed through Anterior Rotator Cuff Motor Control and strengthening Stage 1 and 2, clinicians should assess for any deficits in posterior rotator cuff motor control and strength. Any posterior rotator cuff deficits detected on assessments should now be addressed by adding Posterior Rotator Cuff Stage 1 and 2 to rehabilitation.

Patients that are required to lift heavy loads, should focus on increasing the loads in the relevant range of motion. Patients that require to return to quick movements, should focus on increasing the speed of the movement in positions, amplitudes, and loads that replicate their requirements. The use of a metronome provides external pacing and monitors progression. Initially, start exercise with no pace to allow for

proper execution. The authors recommend starting at 30 bpm progressing up to 120 bpm for 30 seconds at 20 bpm steps. Assuming a 90° arc of motion is covered this would progress patients speed from 45°/sec to 180°/sec. The key is humeral head movement without scapula or trunk movement, and pace maintained without substitution prior to progression. The anterior rotator cuff protocol will focus on internal rotation strength once stage 2 criteria are met.

Patients should begin internal shoulder rotation strengthening with arm at side going through a full arc of internal rotation of the humerus without scapular substitution using an elastic resistance. Patients will often have muscle weakness and difficulty near end range due to muscular control. Therefore, the exercises should be modified to focus on the specific arc with stability deficits until the patient has strength through the entire arc of motion. When the patient can demonstrate smooth control of concentric and eccentric motion provided by the elastic resistance through the full arc for 30 seconds then incorporation of pace with a metronome can commence (beginning at 30 bpm). Typically, as the patient demonstrates the third level in the progression (approximately 70bpm), without scapula or trunk movement, then a more challenging rotation exercise with more arm elevation can be initiated. For the anterior rotator cuff protocol, patients progress toward arm abducted to 90° in the scapular plane and then the frontal plane. Speed and resistance should be based on the patient's physical activity requirements. **Table 1** provides a typical progression for both the anterior and posterior rotator cuff musculature protocols. Painfree weight room activities are typically started in this stage, although may require limitations in arcs of motions (e.g. bench press from the floor to limit horizontal extension).

Stage 4 – Motor pattern integration /Perturbation Training.

Once patients have acquired the ability to activate specific musculature and have acquired speed-endurance of subscapularis, further overload of the shoulder is required. This stage should include expected and unexpected directional perturbations, beginning with expected motions (eyes open) and progressing to unexpected activities (eyes closed). Patients following the anterior rotator cuff protocol can begin in supine, with a light weight (0.5kg) dropped into their hand in abduction/external rotation with their eyes open, and progress in this position with their eyes closed. They can then move to an upright position and receive perturbations from the clinician into ER or horizontal extension, in a position of abduction/external rotation with the instruction “don’t let me move you”. Further progressions include moving from a stable to unstable surface (e.g. kneeling on a Swiss ball) and elastic resistance bands / straps can be used to increase the force applied.

Weight room exercises should be progressed, incorporating training multiple movement patterns that simulate patient’s sport or work involving the entire kinetic chain. Targeted gym strengthening for the shoulder can progress with supine flies/bench press and prone rollouts. At the conclusion of this stage, patients should demonstrate movement through range without pain, with added visual (movement in peripheral vision) /verbal (distracting noise) /tactile (altered surface) distraction without opponents/other players. Clinicians should limit verbal or visual feedback during this stage to encourage patients’ cognitive processing and problem-solving.[45] This is the final stage to prepare the patient for criterion-based return to sport testing.

Criteria to progress to return to sport testing requires both rotator cuff and scapula strength. Patients should also have progressed through scapula rehabilitation, so

they are able to perform painfree push-ups and side planks on an extended arm for 3 repetitions of 30 seconds (Appendix). Patients should be able to withstand one minute of perturbations in abduction/external rotation with no pain before they attempt return to sport testing.

Posterior Rotator Cuff Protocol

The key to rehabilitation of the posterior rotator cuff depends upon activating the external rotators without excessive compensatory scapular motion. From clinical experience, the emerging pattern of compensatory movement is excessive posterior scapula tilt and retraction of the scapula in the absence of isolated external rotation of the humerus particularly when the infraspinatus is short in terminal external rotation. This protocol is the mainstay of treatment for people with posterior shoulder instability. This protocol can also be added after Stage 2 for patients with anterior and multi-directional instability when a lack of strength/motor control in external rotators is identified.

Stage 1 Posterior Rotator Cuff Motor Control and Strengthening

The key to this first stage is establishing whether the patient can externally rotate their humerus without scapular posterior tilt or retraction. This is evaluated and treated in prone with folded towel placed under the anterior proximal humerus (Video 3). The patient performs one repetition of external rotation to 90° without pain or scapular substitution. If the patient cannot externally rotate to 90° without scapula movement, then they are instructed to perform an isometric external rotation hold at the limit of external rotation, prior to scapula movement. Isometric contractions should be held for 30 seconds for 3 repetitions. Clinicians should provide verbal, visual, and tactile feedback so that there is minimal scapula movement in this stage.[31,32] This position can be modified initially into scaption, if pain is present.

The strength-based approach to increase infraspinatus strength is initiated with the patient in side-lying with their elbow supported on a towel and bent to 90°. Patients should hold a 1 kg weight isometrically, parallel to the floor for 30 seconds for 3 repetitions. This is progressed by having patients support their distal humerus at 45° of flexion with their opposite hand and repeating the isometric exercise with no scapular substitution. The exercise is performed to promote infraspinatus endurance and should not be painful. Ideally, both motor control and strength criteria will be achieved before moving to stage 2, but the strength-based goal must be achieved. **(Table 1)**

Stage 2 Posterior Rotator Cuff Motor Control and Strengthening

This goal of this stage is to facilitate the motor control of external rotators through range, both concentrically and eccentrically. The patient moves through a 90° arc of motion in side-lying then progress to prone with manual resistance or light resistance (0.5 – 1kg) without symptoms and scapular compensation. To continue isometric strengthening, arm elevation is progress to 90° and 135° if needed, with the same load and exercise parameters laid out in stage 1 (Figure 4).

Stage 3 – Posterior Rotator Cuff Position, Amplitude, Load, Speed (PALS)

This stage is similar to that previously described in Stage 3 of the anterior rotator cuff protocol, but instead progressively loads the posterior rotator cuff. Patients with posterior instability can start with external rotation with arm at side and be progressed to more elevated arm positions once they can hold the resistance in end range of external rotation for 30 seconds (Table 2). Typical progressions move into more elevation in the frontal plane and then the sagittal plane and overhead. A common error is to start this stage too early without adequate strength and isolation of humeral external rotation on a stable scapula.

Stage 4 Motor pattern integration/perturbations.

This stage also has similarities with the anterior rotator cuff protocol, although again, the direction of load is reversed. Patients lie prone performing drop catches with a light weight with shoulder positioned in 90°/90° to eccentrically load their posterior rotator cuff. Perturbations from the clinician pushing the hand in internal rotation in this same position or moving into more sagittal plane to prepare for functional activities. The complexity of the tasks can be increased as in Stage 4 of the anterior rotator cuff protocol, by incorporating multiple stimuli such as distraction, noise, altering surfaces for enhanced stability and incorporating opponents. The exercise interventions are detailed above and follows a similar criterial to progress.

Co-contraction Protocol

Patients with multidirectional instability may not respond to a specific directional muscular protocol due increased generalized capsular laxity. The transverse force couple of the subscapularis and infraspinatus often does dynamically center the humeral head on the glenoid during work or sport or activities of daily living, creating the instability.[33,34] The co-contraction protocol can also be used if loading either the anterior or posterior shoulder is painful or ineffective. This principle uses the axial compressive load through the humerus to facilitate joint stability by placing the patient in a position which centers the humeral head on the glenoid. With the humeral head centered, then co-contraction of the anterior and posterior rotator cuff can be used to stabilize the humeral head, rather than using these muscles to effect rotation of the humerus on the glenoid.

STAGE 1 Co-contraction: The patient begins in side-lying with the affected arm at approximately 90° with no weight. The patient is instructed to hold their arm in neutral. Initially, this may be for 10 seconds for 10 repetitions, and progressed to 30

seconds for 3 repetitions. Conceptually, the patient is centering their humeral head on the glenoid (Figure 5-1)

STAGE 2 Co-contraction: The patient performs small circles within the pain-free range of motion in either direction. Previous EMG research has demonstrated that creating a circular motion facilitates activity of both prime movers (e.g. pectoralis major and deltoid) and rotator cuff to stabilize the humeral head.[54] The exercise is progressed by loading the humerus axially with a 3kg, then a 5 kg load for 30 seconds (Figure 5-2). Patients can be encouraged to reach for the ceiling as glenohumeral stability/strength increases, to activate scapula musculature.

Once patients with multi directional instability can support their upper torso bodyweight in a closed chain position of one hand/elbow and hips (Figure 5-3), they should be re-assessed for their primary direction of instability and treated as per the protocols above. Scapula strengthening should commence once patients can adopt positions pain free and continue throughout rehabilitation. (Appendix)

Return to Sport Clinical Tests

In stage 4 of the protocols described above, return to sport activities are incorporated to prepare the athlete to return to sport. This concept paper has identified criteria at the end of each stage to progress to the next stage and return to sport is the final criterion. Incorporation of psychological readiness and various physical performance based on direction of instability, sporting demand, and level of endurance is necessary to transition back to full sport activities. Clinicians are advised against attempting return to sport testing without meeting the previous rehabilitation milestones.

Since the 2016 international consensus statement on return to play publication indicated there are limited assessment tests for the upper extremity.[35] Several conceptual models of returning an athlete to sport exist that clearly identify multiple factors must be taken into consideration prior to return to sport.[36,37] Some components that should be incorporated are; pain, mobility, strength, physical performance, time of season, level of competition, and psychological readiness. The Shoulder Instability-Return to Sport after injury (SIRSI) is a valid scale to measure psychological readiness scale in patients following shoulder instability events.[38,39] The SIRSI has been found to successfully discriminate who is ready to return and who is likely not with a cut point of 55.[40]

Several reliable physical performance tests have been described. After a shoulder injury (e.g. ASH test, upper limb rotation test, line hops and push-ups).[20,41,42] Conceptually, many of the physical performance tests are progressions from rehabilitation. Unfortunately, these physical performance tests have not established validity for return to sports. The physical performance readiness must take into consideration the classic measures of impairment such as range of motion, pain, and strength measured objectively with an isometric or isokinetic dynamometer. Physical performance tests should be selected based on sport demand and direction of instability.[43] Nearly all the physical performance test have been found to be reliable but the key decision is what tissues are being challenged and what loads have to be controlled during sport performance. Biomechanical studies examining muscle activity, forces, and moments around the shoulder have demonstrated that the Closed Kinetic Chain Upper Extremity Stability test, [44] Push-ups,[41] Side-Hold Rotations,[45] Line Hops[45] activate the serratus anterior and infraspinatus maximally, while primarily placing posterior translation forces on the shoulder for posterior

instability assessment. Test that stress the anterior stabilizers includes the ASH test,[46] upper limb rotation test.[42] and side-hold rotation test[45] should be considered for athletes requiring anterior stabilization to return to sport. In those athletes returning to overhead sport that have endurance requirements of the posterior shoulder, clinicians should consider inclusion of the posterior shoulder endurance test,[47] and the shoulder endurance test.[48] No one single test is likely to evaluate all the demands of a particular athlete. Therefore, a battery of tests needs to be organized based on patients' physical demands. Each athlete and sport demands are different, therefor the testing battery will likely differ, but we have offered suggested test batteries in figure 6. Ultimately, the decision is the athletes, but the athlete will seek out multiple inputs from their family, coaches, and sports medicine team. Using an approach of shared decision-making to ensure the patient is empowered to make successful short and long-term decisions regarding return to sport is optimal.

Conclusions

The treatment of shoulder instability has advanced considerably in recent years and this clinical commentary highlights the authors' current opinion of rehabilitation across the continuum of acute instability through to return to sport decision making, including incorporation of psychosocial and personal factors. Clinicians should remain abreast of recent developments in surgical/non-surgical decision-making and should include concepts of motor control and motor programming into their rehabilitation programs. Future research should examine clinical outcomes of patients using this motor control/motor programming approach. Many patients can have successful rehabilitation that returns them to their previous level of activity

without surgical intervention and clinicians should maximize patient outcomes and reduce the risk of recurrent shoulder instability using contemporary rehabilitation.

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Table Legends

1. Motor Control and strength criteria to progress through rehabilitation stages

2. Progression of concentric and eccentric internal and external rotation with numerical values representing metronome beats per minute (bpm). Patient is to perform exercise for 30 seconds on pace with proper form and no substitutions, prior to moving to next level speed or level.

Video Legend

1. Anterior Rotator Cuff Motor Control Stage 1. Activation of subscapularis with minimal pectoralis major or latissimus dorsi

2. Anterior Rotator Cuff Motor Control Stage 2. Eccentric and concentric subscapularis contraction through range with clinician and home exercise

3. Posterior Rotator Cuff Stage 1 and 2. Humeral external rotation without scapula movement

Figure Legend

647 Figure 1 Spectrum, symptoms, and assessment of shoulder instability

648 Figure 2: Decision-Making regarding surgical vs. surgical management after a
649 shoulder dislocation

650 Figure 3. Progressive rehabilitation intervention from sub-acute to end-stage, based
651 on direction of instability, mobility limitations and common muscular deficiencies

652 Figure 4. Isometric external rotation strengthening at 90 and 135 degrees of flexion

653 Figure 5: Side Hold progressions that keep the humeral head centered in the glenoid
654 in the patient with multi-directional shoulder instability

655 Figure 6: Return to Sport tests by sport and pathology

656

Table 1. Criteria to progress for each phase

Anterior Rotator Cuff Protocol		Posterior Rotator Cuff Protocol	Co-contraction Protocol
Stage 1	-Motor Control: Patients demonstrates good motor control by activating and relaxing the subscapularis isometrically 15 times without difficulty. -Strength-based: Patient sustains 3 x 30-second isometric contraction in the prone lift-off position	-Motor Control: Patient in prone can hold their arm at 90° of abduction and 90° of external rotation for 30 seconds with no weight with minimal scapula movement to achieve this position. -Strength-based: Patient can hold 1kg in 45 degrees of flexion for 30 seconds with 3 repetitions	Progression from Stage 1 can occur when the patient can hold their shoulder at 90 degrees of abduction in side-lying for 3 sets of 30 seconds
Stage 2	-Motor Control: Patient should be able to demonstrate smooth eccentric and concentric movement through 0-90° with the arm abducted to 90° in supine with 1-1.5kg (2-3 pounds) load for 15 repetitions with continuous palpable subscapularis contraction. Strength-based: The patient can lift and hold their hand away from their spine (1-2 inches) using a 1-meter heavy resistance band (blue or black) for 30 seconds without losing control and pain free.	-Motor Control: Patients can perform 30 repetitions in prone from 0-90° with 1 kg weight. It is critical that the scapular remains relatively still and the motion of the HH is differentiated from scapula compensation. -Strength-based: Patient can hold 1kg at 90 degrees of flexion for 3 sets of 30 seconds	Patient can hold 5 kg for 3 sets of 30 seconds and control clockwise and anticlockwise circles with scapula protracted.
Stage 3	Patient perform elastic resistance of concentric and eccentric internal rotation for 30 seconds, before the speed is increased. Patients can usually increase their speed of movement every 5-7 days or every couple of visits based on patients' level of function and motor control.	Patient perform elastic resistance of concentric and eccentric external rotation for 30 seconds, before the speed is increased. Patients can usually increase their speed of movement every 5-7 days or every couple of visits based on patients' level of function and motor control.	Patient can hold side hold on hand and hips for 3 sets of 30 seconds with body weight supported on hand

Stage 4	Patients should be able to withstand one minute of perturbations with no pain before they attempt return to sport testing	Patients should be able to withstand one minute of perturbations with no pain before they attempt return to sport testing	

Table 2: Progression of concentric and eccentric internal and external rotation with numerical values representing metronome beats per minute (bpm). Patient is to perform exercise for 30 seconds on pace with proper form and no substitutions, prior to moving to next level speed or level.

Anterior Rotator Cuff Protocol												
IR at side through pain-free arc (bpm)	Self-pace	30	50	70	90	120						
IR in scapula plane 0-90° (bpm)				No pace	30	50	70	90	120			
IR in frontal plane 0-90° (bpm)							No Pace	30	50	70	90	120
Posterior Rotator Cuff Protocol												
ER at side through pain-free arc (bpm)	Self-pace	30	50	70	90	120						
ER in frontal plane at 90° of abduction thru 0-90° (bpm)				30 sec. holds†	30	50	70	90	120			
ER in frontal plane at 135° of abduction thru 0-90° (bpm)							30 sec. holds†	30	50	70	90	120
Assuming a 90° arc of motion 30 bpm = 45°/sec, 90 bpm = 135°/sec, 120 bpm = 180°/sec † 30 second holds with elastic band (blue/black) in the described position												

Spectrum, Symptoms & Assessment of Shoulder Instability

SPECTRUM

Micro-instability → **SYMPTOMS**: Intermittent pain

Subluxation → **SYMPTOMS**: Intermittent pain +/- sensation of slipping and sliding. May have 'dead arm' / loss of feeling

Dislocation → **SYMPTOMS**: Pain +/- dead arm / loss of feeling → Immobilisation period varies

Multiple episodes of instability (dislocation & subluxation → **SYMPTOMS**: Recurrent episodes of instability - may occur with decreasing levels of external force → Immobilisation period varies

SIGNS

Patient Presents with subjective history of instability or after acute dislocation immobilisation period

- Screen & exclude patients with cervical dysfunction, referred pain and neurological symptoms
- Assessment
  - Assess ROM
  - Assess RC strength
  - Assess Special Tests / Symptom Modification
  - Assess Scapula Control & Strength

Patient diagnosed with shoulder instability in one or more directions through combination of clinical history and instability tests

DIRECTION

- Anterior
- Anterior, Posterior & Inferior
- Posterior
- +/- Patient symptoms are substantially altered by addressing scapula position

Management of Shoulder Instability

Number of Instability Events

First Time Shoulder Dislocation

Second Dislocation

3 or more dislocations / dislocating in sleep

PRIS / NISISTool

Decision Making

Low Risk

High Risk

Insufficient previous rehabilitation

Adequate/good previous rehabilitation

Rarely used

Management Options

Conservative Manangement

Shared Decision Making re: surgery / No surgery

Surgery

DIRECTION

Anterior

Anterior, Posterior & Inferior

Posterior

+/- Patient symptoms are substantially altered by addressing scapula position

Anterior with posterior shoulder restriction

Anterior without posterior restriction

Assess Lower Trapezius Strength

Assess Serratus Anterior Strength

TREATMENT

Co-contraction Protocol

Co-contraction Stage 1

Co-contraction Stage 2

Anterior Cuff Protocol

Posterior Cuff Protocol

Lower Trapezius Strengthening Protocol

Serratus Anterior Strengthening Protocol

Address posterior restriction

Anterior Cuff Motor Control Stage 1

Anterior Cuff Strength Stage 1

Anterior Cuff Motor Control Stage 2

Anterior Cuff Strength Stage 2

Anterior Cuff Stage 3

Anterior Cuff Stage 4

Posterior Cuff Motor Control Stage 1

Posterior Cuff Strength Stage 1

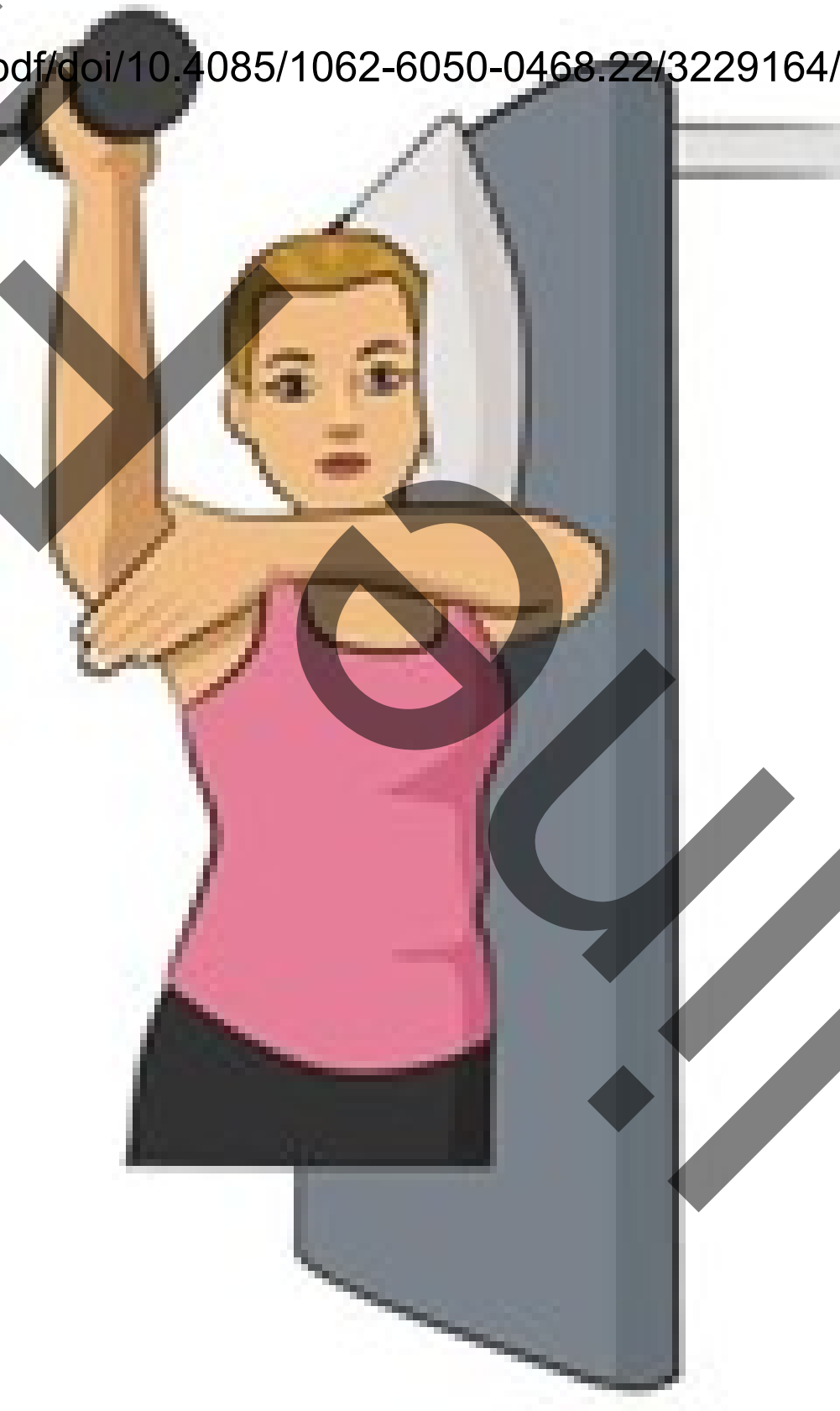
Posterior Cuff Motor Control Stage 2

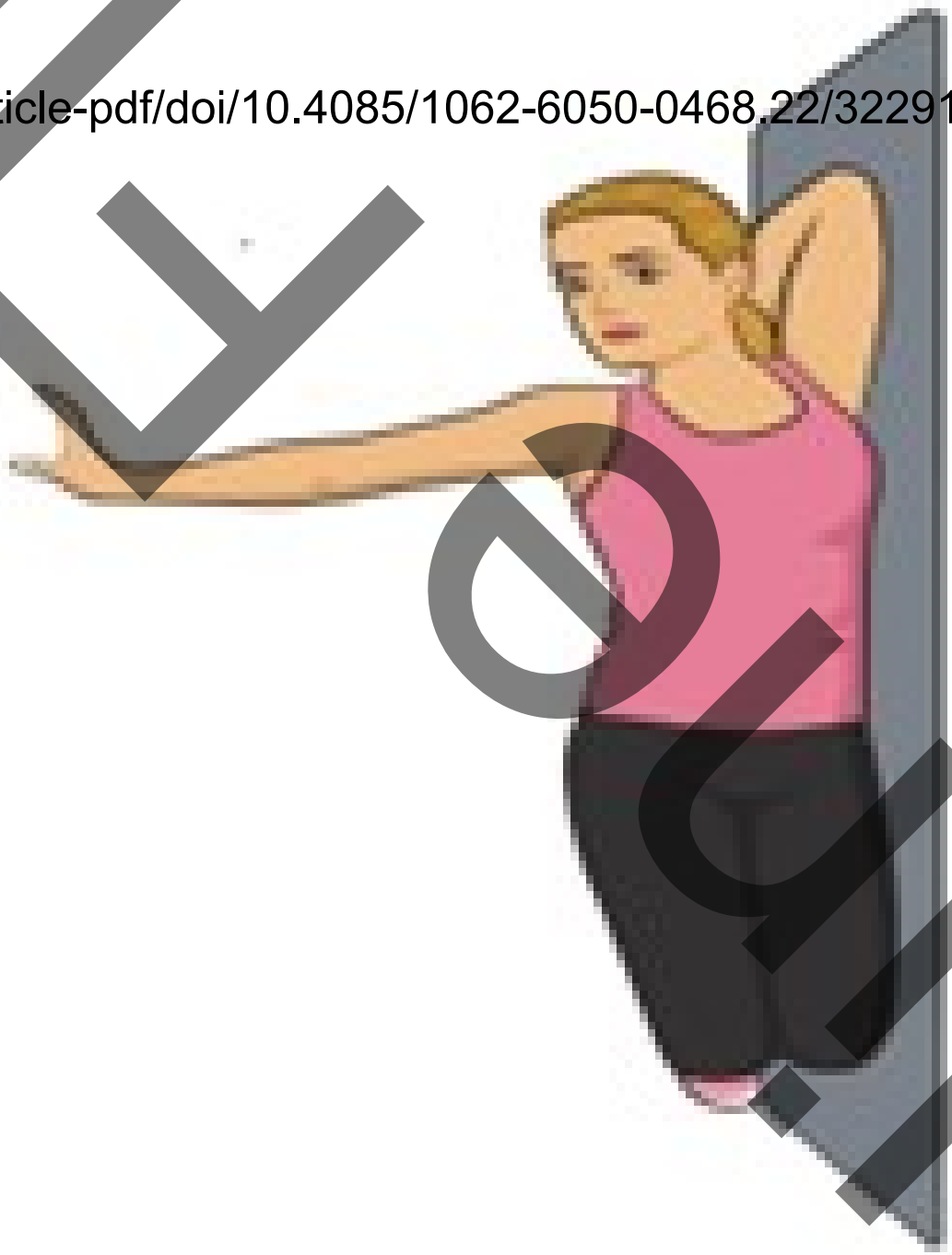
Posterior Cuff Strength Stage 2

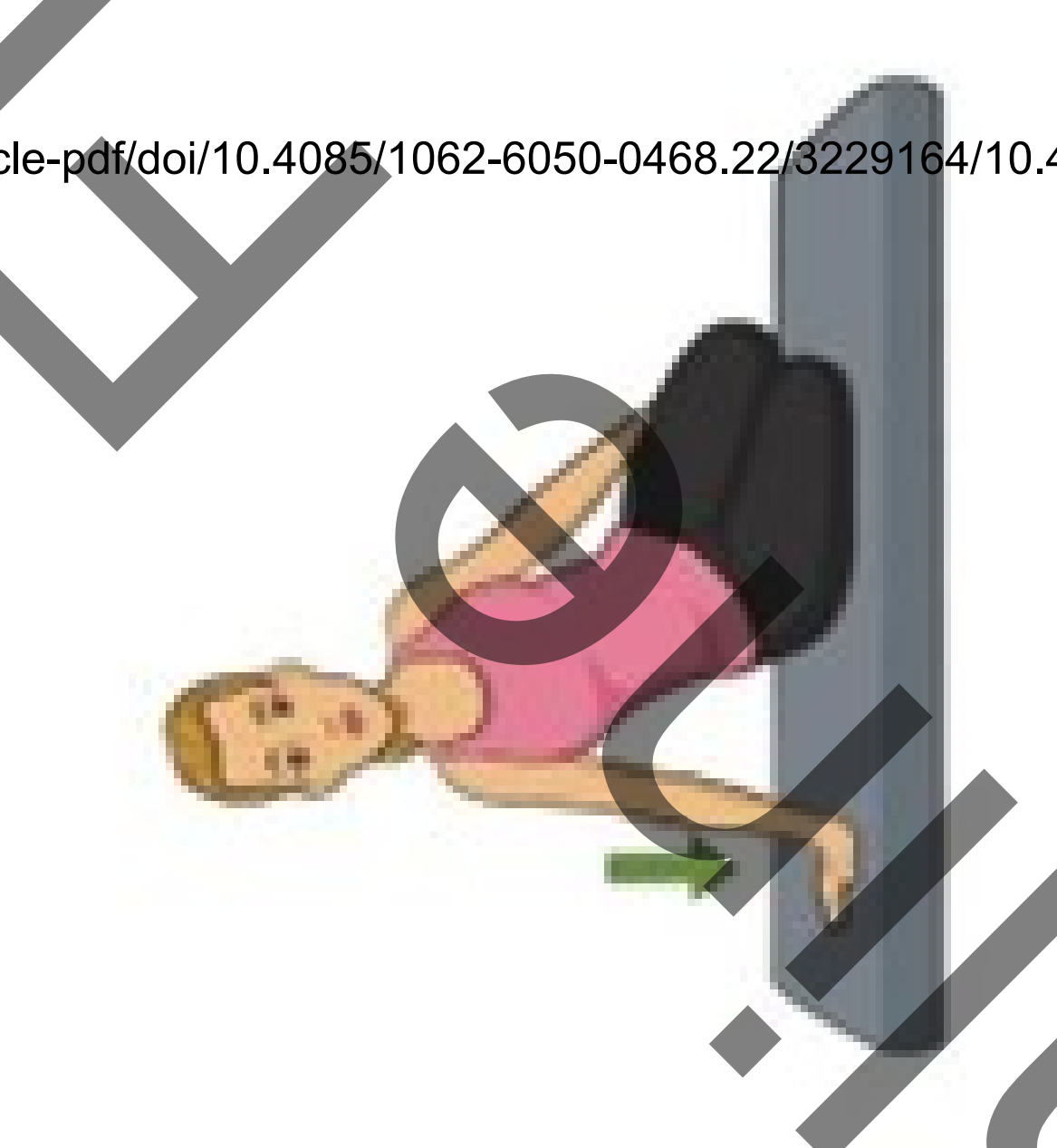
Posterior Cuff Stage 3

Posterior Cuff Stage 4

Monitor posterior restriction







Summary of Return to Sport Tests by sport type and pathology