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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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1 Clinical Concepts: Nonoperative Management of Shoulder Instability

2 **Abstract:** 113 words

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

13 Word Count = 4745

14 Introduction

15 Shoulder instability is defined as the inability to maintain the humeral head within the
16 glenoid fossa.¹ Traditionally, the literature has focussed on both the assessment and
17 outcomes of surgical management of shoulder instability.^{2,3} While individual studies
18 have reported rates of recurrence as high as 75-100%,^{2,3} evidence from two
19 systematic reviews identifies a much lower recurrence rate across all populations
20 (21-39%).^{4,5} Therefore, many patients would likely benefit and be appropriate for
21 non-operative management. Unfortunately, there is limited literature that provides
22 specific detailed non-operative interventions.^{6,7} Additionally, some patients with
23 chronic shoulder micro-instability are misdiagnosed and may have not responded to
24 traditional shoulder rehabilitation programs. Ultimately, direct-access/first contact

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

32 [Shoulder Instability Framework](#)

33 [What is the diagnosis?](#)

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

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

54 **Clinical Decision-Making on management**

55 Deciding between operative and non-operative management of shoulder instability is
56 challenging. Historically, physically active males under 25 years have been
57 considered good candidates for surgery to reduce re-dislocation risk,¹² but this can
58 result in unnecessary surgery.¹³ Recent prognostic research can help guide
59 clinicians on prognosis following anterior shoulder instability events.^{14,15} The key
60 point of both prognostic tools is that additional factors other than sex and age should
61 be considered in advising the patient on the likelihood of re-injury. Olds and
62 colleagues¹⁴ have published a predictive model that identified six factors that
63 together were predictive of recurrent shoulder instability.

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

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

73 Tokish and colleagues¹⁵ also identified 6 factors that can be used to predict recurrent
74 shoulder instability and created the Nonoperative Instability Severity Index Score
75 (NISIS). This tool was originally developed to guide decision-making regarding
76 operative or nonoperative treatment following a primary traumatic anterior shoulder
77 dislocation in primarily high school athletes,¹⁵ but has been also used to predict
78 recurrent shoulder instability.¹⁶ The authors weighted the six factors and patients
79 deemed low risk (NISIS score <7) were managed successfully with non-operative
80 treatment 97% of the time.¹⁵ Patients classified as high risk (>7) were more likely to
81 fail non-operative management (60.3%) than those classified as low risk (48.9%,
82 $p=0.03$).¹⁶ The six factors and weights are:

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

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

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

103 Non-operative Management of Shoulder Instability

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

110 Acute shoulder instability

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

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

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

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

149 [Sub-acute and End-stage Rehabilitation: Directional Specific Interventions](#)

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

167 [Anterior Rotator Cuff Protocol](#)

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

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

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

188 Stage 1 Anterior Rotator Cuff Motor Control and Strengthening

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

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

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

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

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

222 Progression of the strength-based approach is achieved by using a 1-meter long
223 resistance band fixed to the wall in front of the patient standing 1 meter away. The
224 band is passed around the opposite side of the body so the patient grasps with their
225 affected hand behind their back. The patient then lifts their hand away from the back
226 1-2 inches to perform an isometric hold for 3 x 10 seconds. Progress exercise up to
227 30 seconds and level of resistance until reaching goal to progress. Clinicians should
228 educate patients to maintain load through internal rotation without pain and not
229 compensate with shoulder extension or wrist flexion. Often patients with anterior
230 instability also need posterior rotator cuff strengthening once they have established
231 subscapularis control to balance the glenohumeral joint.

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

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

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

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

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

270 Stage 4 – Motor pattern integration /Perturbation Training.

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

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

292 This is the final stage to prepare the patient for criterion-based return to sport testing.

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

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

299 [Posterior Rotator Cuff Protocol](#)

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

309 [Stage 1 Posterior Rotator Cuff Motor Control and Strengthening](#)

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

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

328 **(Table 1)**

329 Stage 2 Posterior Rotator Cuff Motor Control and Strengthening

330 This goal of this stage is to facilitate the motor control of external rotators through
331 range, both concentrically and eccentrically. The patient moves through a 90° arc of
332 motion in side-lying then progress to prone with manual resistance or light resistance
333 (0.5 – 1kg) without symptoms and scapular compensation. To continue isometric
334 strengthening, arm elevation is progress to 90° and 135° if needed, with the same
335 load and exercise parameters laid out in stage 1 (Figure 4).

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

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

345 Stage 4 Motor pattern integration/perturbations.

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

355 Co-contraction Protocol

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

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

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

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

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

384 [Return to Sport Clinical Tests](#)

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

393 Since the 2016 international consensus statement on return to play publication
394 indicated there are limited assessment tests for the upper extremity.³⁵ Several
395 conceptual models of returning an athlete to sport exist that clearly identify multiple
396 factors must be taken into consideration prior to return to sport.^{36,37} Some
397 components that should be incorporated are; pain, mobility, strength, physical
398 performance, time of season, level of competition, and psychological readiness. The
399 Shoulder Instability-Return to Sport after injury (SIRSI) is a valid scale to measure
400 psychological readiness scale in patients following shoulder instability events.^{38,39}
401 The SIRSI has been found to successfully discriminate who is ready to return and
402 who is likely not with a cut point of 55.⁴⁰

403 Several reliable physical performance tests have been described. After a shoulder
404 injury (e.g. ASH test, upper limb rotation test, line hops and push-ups).^{20,41,42}
405 Conceptually, many of the physical performance tests are progressions from
406 rehabilitation. Unfortunately, these physical performance tests have not established
407 validity for return to sports. The physical performance readiness must take into
408 consideration the classic measures of impairment such as range of motion, pain, and
409 strength measured objectively with an isometric or isokinetic dynamometer. Physical
410 performance tests should be selected based on sport demand and direction of
411 instability.⁴³ Nearly all the physical performance test have been found to be reliable
412 but the key decision is what tissues are being challenged and what loads have to be
413 controlled during sport performance. Biomechanical studies examining muscle
414 activity, forces, and moments around the shoulder have demonstrated that the
415 Closed Kinetic Chain Upper Extremity Stability test,⁴⁴ Push-ups,⁴¹ Side-Hold
416 Rotations,⁴⁵ Line Hops⁴⁵ activate the serratus anterior and infraspinatus maximally,
417 while primarily placing posterior translation forces on the shoulder for posterior

418 instability assessment. Test that stress the anterior stabilizers includes the ASH
419 test,⁴⁶ upper limb rotation test.⁴² and side-hold rotation test⁴⁵ should be considered
420 for athletes requiring anterior stabilization to return to sport. In those athletes
421 returning to overhead sport that have endurance requirements of the posterior
422 shoulder, clinicians should consider inclusion of the posterior shoulder endurance
423 test,⁴⁷ and the shoulder endurance test.⁴⁸ No one single test is likely to evaluate all
424 the demands of a particular athlete. Therefore, a battery of tests needs to be
425 organized based on patients' physical demands. Each athlete and sport demands
426 are different, therefor the testing battery will likely differ, but we have offered
427 suggested test batteries in figure 6. Ultimately, the decision is the athletes, but the
428 athlete will seek out multiple inputs from their family, coaches, and sports medicine
429 team. Using an approach of shared decision-making to ensure the patient is
430 empowered to make successful short and long-term decisions regarding return to
431 sport is optimal.

432 Conclusions

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

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

444

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631

632 **Table Legends**

- 633 1. Motor Control and strength criteria to progress through rehabilitation stages
- 634 2. Progression of concentric and eccentric internal and external rotation with
- 635 numerical values representing metronome beats per minute (bpm). Patient is to
- 636 perform exercise for 30 seconds on pace with proper form and no substitutions, prior
- 637 to moving to next level speed or level.

638 **Video Legend**

- 639 1. Anterior Rotator Cuff Motor Control Stage 1. Activation of subscapularis with
- 640 minimal pectoralis major or latissimus dorsi
- 641 2. Anterior Rotator Cuff Motor Control Stage 2. Eccentric and concentric
- 642 subscapularis contraction through range with clinician and home exercise
- 643 3. Posterior Rotator Cuff Stage 1 and 2. Humeral external rotation without scapula
- 644 movement

645

646 **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

Online First

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Table 1. Criteria to progress for each phase

Anterior Rotator Cuff Protocol		Posterior Rotator Cuff Protocol	Co-contraction Protocol
Stage 1	<p>-Motor Control: Patients demonstrates good motor control by activating and relaxing the subscapularis isometrically 15 times without difficulty.</p> <p>-Strength-based: Patient sustains 3 x 30-second isometric contraction in the prone lift-off position</p>	<p>-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.</p> <p>-Strength-based: Patient can hold 1kg in 45 degrees of flexion for 30 seconds with 3 repetitions</p>	<p>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</p>
Stage 2	<p>-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.</p> <p>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.</p>	<p>-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.</p> <p>-Strength-based: Patient can hold 1kg at 90 degrees of flexion for 3 sets of 30 seconds</p>	<p>Patient can hold 5 kg for 3 sets of 30 seconds and control clockwise and anticlockwise circles with scapula protracted.</p>
Stage 3	<p>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.</p>	<p>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.</p>	<p>Patient can hold side hold on hand and hips for 3 sets of 30 seconds with body weight supported on hand</p>

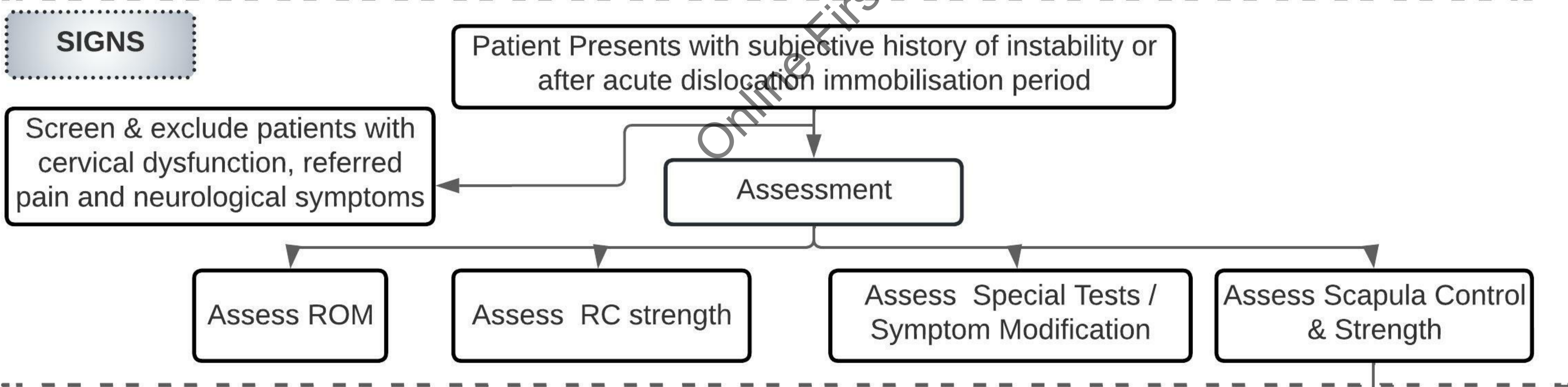
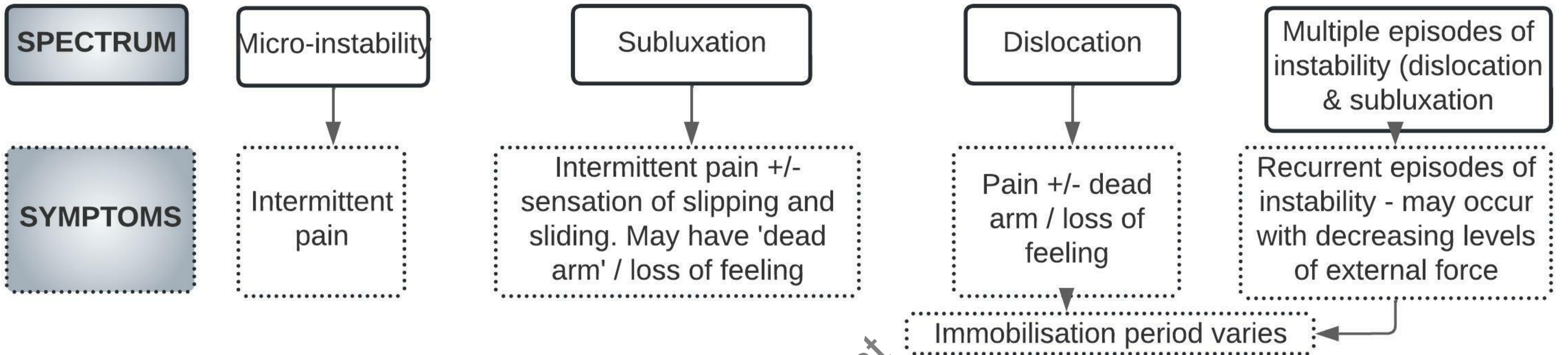
Stage 4	Patients should be able to withstand one minute of perturbations with no pain before they attempt return to sport testing	Patients should be able to withstand one minute of perturbations with no pain before they attempt return to sport testing	
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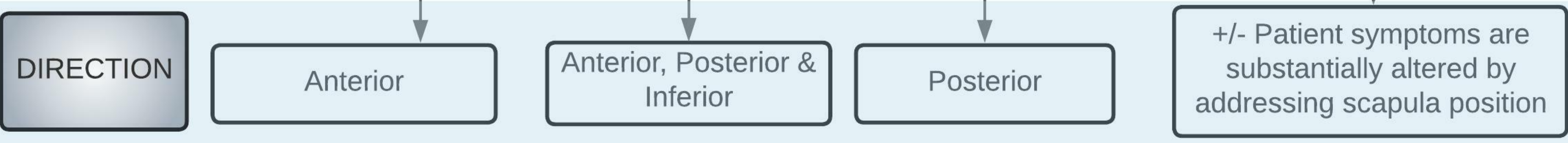
Table 2: Progression of concentric and eccentric internal and external rotation with numerical values representing metronome beats per minute (bpm). Patient is to perform exercise for 30 seconds on pace with proper form and no substitutions, prior to moving to next level speed or level.

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. hold†	30	50	70	90	120			
ER in frontal plane at 135° of abduction thru 0-90° (bpm)							30 sec. hold†	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												

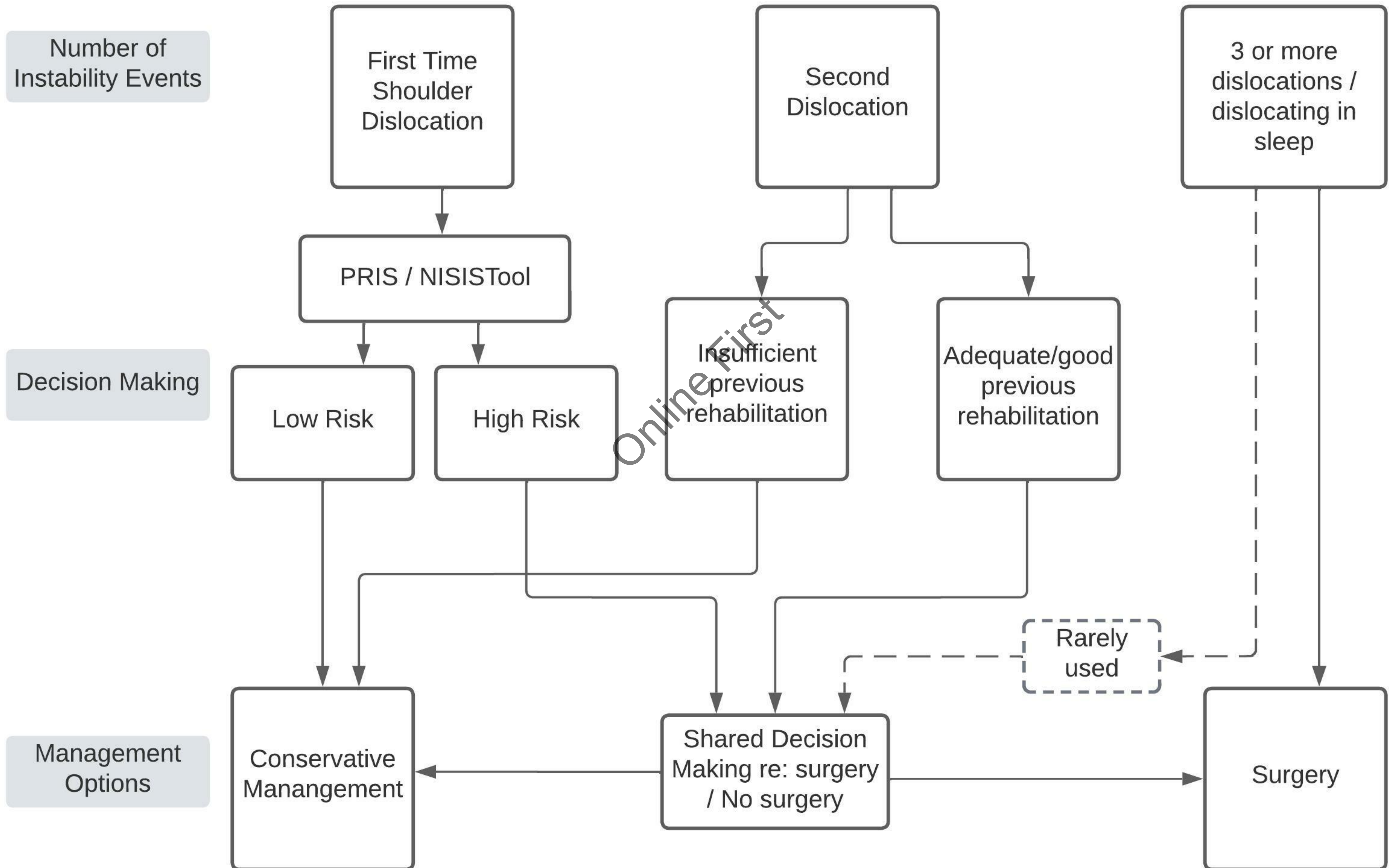
Spectrum, Symptoms & Assessment of Shoulder Instability

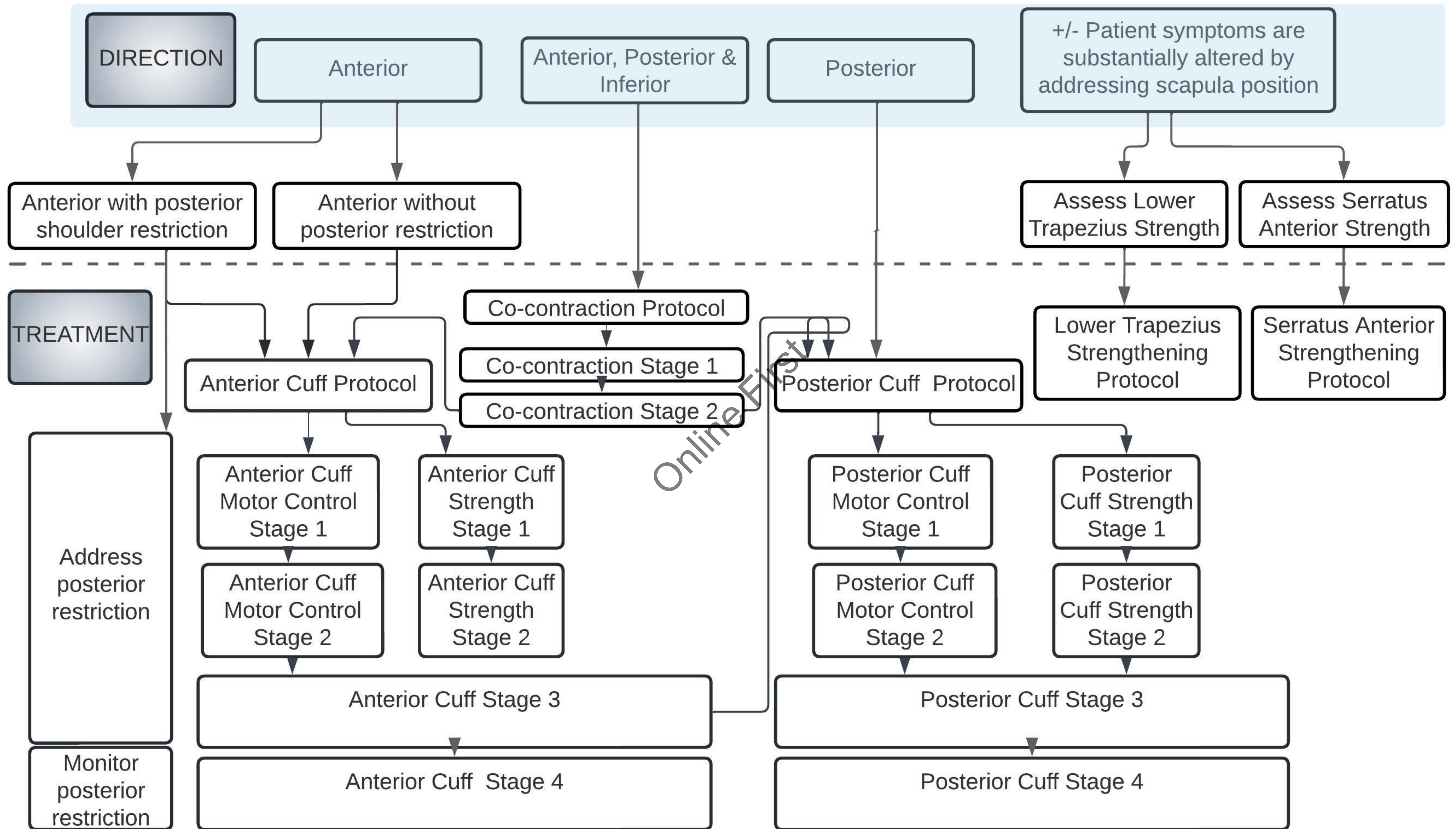


Patient diagnosed with shoulder instability in one or more directions through combination of clinical history and instability tests



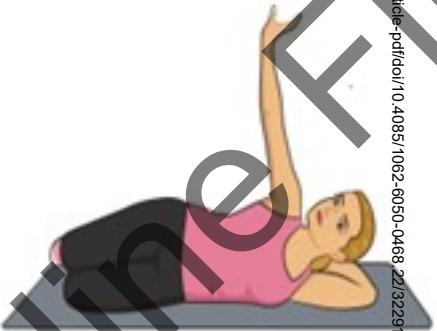
Management of Shoulder Instability





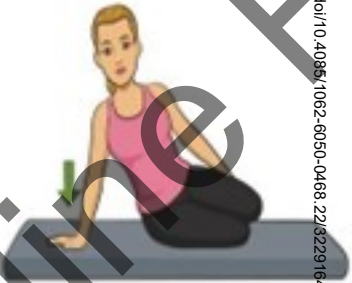








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Summary of Return to Sport Tests by sport type and pathology

