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**Evaluation and Treatment of Rotator Cuff Pathology and Impingement**

Background

 The rotator cuff, which consists of four muscles and their myotendinous attachments, the subacromial bursa, and numerous ligaments are responsible for approximately 65% of all shoulder-related injuries. 1 The subscapularis internally rotates the humerus, the infraspinatus and teres minor externally rotate the humerus, and the supraspinatus initiates abduction. When these four muscles are activated in a coordinated effort (and are healthy), they depress and provide dynamic stabilization of the humeral head in the glenoid fossa. 1 The rotator cuff works together with the deltoid to form a force couple mechanism that guides the movement of the humeral head in the glenohumeral joint during shoulder elevation. 2 Rotator cuff injuries can be classified as acute, chronic, or acute-on-chronic in nature. 1 Acute injuries are caused by traumatic events, such as a fall or blow to the shoulder, and are typically found in younger patients. 1 Chronic injuries result from either long-term degeneration of the rotator cuff tendon in older adults, or repetitive use in overhead athletes. 1

 Dr. Charles Neer was the first to define impingement syndrome as a mechanical compression or impingement of the rotator cuff tendon, the subacromial bursa, and/or the long head of the biceps tendon beneath the coracoacromial arch, the anterior third of the acromion, the coracoacromial ligament, and/or the acromioclavicular joint. 3-5 Impingement can be considered primary or secondary; primary impingement involves the direct mechanical compression of the rotator cuff under the coracoacromial arch whereas

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secondary impingement is relative narrowing of this same space as a result of underlying glenohumeral joint or scapular instability. 3

Neer developed a classification system for impingement syndrome that is still currently used in practice. Stage I typically affects patients younger than 25 years old and is manifested by acute inflammation, edema, and hemorrhage of the rotator cuff. 3 Stage II impingement is seen in patients 25-40 years old who have fibrosis and tendinitis of the rotator cuff tendon. 3 Imaging may begin to show osteophyte formation on the inferior aspect of the acromion and, if left untreated, this injury could develop into a more serious tendon rupture. 5 Impingement may be classified as stage III if the patient is over 40 years old and has a chronic history of shoulder issues, there is mechanical disruption of the rotator cuff tendon (including rupture), and osteophytes are present. 3,5 Signs and symptoms associated with each stage are detailed below.

Impingement may lead to a tear in the rotator cuff, and this tear may progressively worsen if the patient continues to aggravate it over time. Once an individual has reached stage III, Ellman further subclassifies the injury into grade 1-3, depending on the severity of the tear. 6 Grade 1 is a partial tear (less than 3mm deep) but there is definite disruption of the tendinous fibers. 6 Grade 2 lesions (3-6mm deep) are more significant, but do not exceed one-half of the thickness of the tendon. 6 Finally, grade 3 lesions are more than 6mm deep and involve more than one-half the substance of the tendon. 6

Impingement syndrome is not an isolated condition that can be easily diagnosed, but rather it involves a combination of intrinsic and extrinsic factors. 7 Seitz et al suggests that some of the intrinsic factors can include alterations in biology (glycosaminoglycan and

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collagen content), mechanical properties (stress and strain of tendon), morphology (thickness), and vascularity (supraspinatus tendon has avascular zone). 8 A patient’s symptoms are therefore a result of overload on the degenerating rotator cuff tendons. 9 Extrinsic factors, or those external to the tendon, include anatomical variants of the acromion, alterations in scapular or humeral kinematics, postural abnormalities, rotator cuff and scapular muscle performance deficits, and decreased extensibility of the pectoralis minor or posterior shoulder. 8 In this case, symptoms of impingement are caused by mechanical compression of the rotator cuff. 9

Evaluation

 When evaluating a patient with shoulder pain, it is important to consider all possible diagnoses. The clinician should use differential diagnosis to rule out other common shoulder dysfunctions such as acromioclavicular joint injury, biceps tendonitis, cervical spine involvement, joint instability, labral injury, or thoracic outlet syndrome. 4 Patients with rotator cuff pathology and impingement will typically present with shoulder pain during shoulder elevation, weakness during abduction and external rotation, and loss of range of motion. Depending on the severity and time frame of the injury, the patient may have significant functional limitations and altered movement patterns. Stage I injuries may result in dull aching after activity, point tenderness at the supraspinatus insertion site, the presence of a painful arc (60-120 degrees of abduction), and poor scapulohumeral rhythm.5 Patients who have a stage II injury will have the above signs and symptoms, as well as night pain and activity limitations secondary to pain. 5 These patients may have a reduction in strength and range of motion, as well as an occasional catching sensation around 100

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degrees of shoulder elevation. 5 By the time the patient has a stage III injury, he may experience significant pain without provocation, but also weakness on strength tests without pain. 5 The patient’s scapulohumeral rhythm is usually significantly altered by this point, and, in some cases, it is reversed. 5

 Special tests are an important adjunct to the physical examination of a patient with shoulder pain and can aid in differential diagnosis. Some of the commonly used special tests for impingement include the Neer Test, Hawkins-Kennedy Test, Yocum Test, and the Internal Rotation Resisted Strength Test. 10 For the rotator cuff, a few of the special tests are: Full Can Test, Drop Arm Test, Hornblower Sign, Lift Off, Belly Press, and External Rotation Lag Sign. 10

Conservative Intervention

 Conservative approaches to treatment should be the first option when determining the course of action for a patient with impingement syndrome or rotator cuff pathology. The patient may directly come to physical therapy via direct access or be referred to physical therapy from his primary care physician.

Physicians may prescribe, or patients may self-prescribe, a non-steroidal anti-inflammatory drug (NSAID) as a preliminary treatment approach. In the literature, both oral and local NSAIDs have been effective in reducing pain due to tendinopathy or acute shoulder bursitis in the short term (7-14 days). 11 However, patients with more severe, chronic injuries had a poor response to oral NSAIDs. 11 NSAIDs help to reduce pain, inflammation, and muscle guarding, which allows the patient to perform necessary activities of daily living, continue working, and be an active participant in physical therapy.

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Patients should be aware of the potential risk of gastrointestinal, cardiovascular, and renal complications while taking these medications. 11

Corticosteroid injections are another intervention that may be utilized in this patient population. The medication is injected into the subacromial space with the purpose of reducing inflammation within the bursa. By creating more room for the tendon and bursa, scapulohumeral mechanics are improved and there is less compression in this area. 1 Ramirez et al found that corticosteroid injections were highly effective at reducing pain and improving range of motion at 12 weeks post-injection. 12 However, the long-term effects of injections are unclear in recent clinical studies. If a patient receives more than one injection, it is recommended that they are given at least three months apart with the total number of injections being no more than three. 1 If this is not followed, the patient is at an increased risk of tendon weakening or rupture.

 The overall goals of physical therapy are to restore the patient’s shoulder motion, strength, and control. Since the patient’s symptoms are typically caused by inflammation and/or altered movement patterns, it is critical to incorporate range of motion exercises, strengthening exercises, pain relieving strategies, functional activities, and modalities into the plan of care. 13 Determining the patient’s unique impairments and functional limitations will help to guide treatment and it is important to identify potential causes of the injury. Education is essential; the physical therapist should encourage the patient to avoid moving within his painful range and stop repetitive, overhead activities. 13 All activities and exercises should be as pain free as possible, since pain may be an indication that the patient is aggravating the inflamed, injured tissue. 13 The patient may have trouble sleeping due to

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his shoulder pain, and the clinician can teach him to sleep with a pillow under his arm to provide support. Ice or another type of cryotherapy will be beneficial in reducing inflammation and pain for the patient, especially if he is in the acute phase of the condition. Other modalities such as electrical stimulation, ultrasound, and Kinesio taping have also been studied in this patient population, with varying success. 13

Range of motion increases can be achieved through stretching and glenohumeral joint mobilizations. Kachingwe et al found that including joint mobilizations and mobilizations with movement in the treatment of shoulder impingement led to reduced pain and improved range of motion. 14 It has been suggested that the characteristic pattern seen in patients with subacromial impingement is weakness of the lower and middle trapezius, serratus anterior, infraspinatus, and deltoid, coupled with tightness of the upper trapezius, pectorals, and levator scapula. 15 Focusing on these areas, as well as strengthening the other rotator cuff muscles, will be paramount to restoring the patient’s strength. Proprioceptive neuromuscular facilitation is another specific technique that can be utilized to improve a patient’s strength within functional patterns. 13 As the patient progresses and has a reduction in pain, exercises can become more challenging and the patient can move through a greater range of motion.

Surgical Intervention

 Some patients may be required to resort to surgical interventions if conservative treatments have not been successful; however, it is recommended that patients participate in conservative treatment for about 3-6 months before considering operative interventions. 4 Rehabilitation after a surgical procedure for impingement or rotator cuff

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pathology is necessary for restoring good quality shoulder motion, as well as improving upper extremity strength, functional use, and neuromuscular control.

 Rotator cuff repairs are generally indicated in younger, active patients who have a symptomatic tear and have not responded to conservative treatment. 16 However, many factors should be considered when determining the ideal candidate for this type of surgical procedure, such as tear size and reparability, pain level, functional disability, and previous non-operative treatment. 16 Patient-specific characteristics, including age, motivation, patient goals, and potential patient outcome should also be considered. 16 Rotator cuff repairs can be performed open or arthroscopically and may depend on physician preference. After this procedure, the goals of physical therapy are to restore strength and range of motion, in addition to improving functional use of the shoulder. Physicians typically recommend initiation of active range of motion around 6-8 weeks post-op. 17 Although the joint is not completely immobilized, some negative effects of this prolonged inactivity may occur, with stiffness generally being the most common complication occurring after surgery. 18

Van der Meijden outlines four phases of the rehabilitation process after a rotator cuff repair. 18 The main purpose of phase I is maximal protection of the repaired tissue with gentle passive range of motion exercises. 18 Patients in phase II, which typically occurs 4-8 weeks after surgery, may begin active assisted range of motion, gentle active range of motion, and submaximal isometric exercises, with a focus on restoring normal scapulothoracic kinematics. 18 Phase III (8-12 weeks) is characterized by rotator cuff strengthening and included closed chain stability exercises to improve neuromuscular

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control of the shoulder. 18 Around 12 weeks, the patient may be ready to progress to phase IV, or the advanced strengthening phase. 18 Proprioceptive neuromuscular facilitation, advanced rhythmic stabilization, scapular stabilization exercises, and upper extremity plyometrics may be implemented now. 18

There are various protocols that physicians utilize, and the accelerated protocol (active range of motion starting at week 3) has been shown to result in less pain with activity and improved functional level (on the Disabilities of the Shoulder, Arm, and Hand questionnaire) compared to the slow protocol (active range of motion starting at week 6).17 Nevertheless, the clinician must consider individual patient characteristics when determining progression through the protocol and more research needs to be done to establish the most appropriate timing.

 Subacromial decompression, acromioplasty, and bursectomy are often performed simultaneously to treat impingement within the subacromial space. The surgeon will typically perform this procedure arthroscopically with the goal of removing scar tissue and debris, repairing any rotator cuff tears or fraying, and shaving down osteophytes on the acromion and/or distal clavicle. 19

Ketola et al randomized patients with stage II shoulder impingement into one of two treatment groups: participation in a supervised exercise program or subacromial decompression and acromioplasty followed by participation in a supervised exercise program. 20 Results showed no statistical differences between groups in terms of self-reported pain and shoulder disability at the 24-month follow-up. 20 This demonstrates the success with conservative physical therapy treatment and this study can be used to

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encourage patients not to rush into surgery. However, as mentioned above, surgical interventions are still a viable option if conservative treatment does not improve the patient’s symptoms after 3-6 months.

In a prospective randomized trial by Henkus et al, patients with primary subacromial impingement underwent either bursectomy or bursectomy plus acromioplasty. 21 Bursectomy is thought to address intrinsic factors of impingement, whereas acromioplasty is believed to target extrinsic factors. 9 In this study, all patients received physical therapy post-operatively. 21 At 2.5 years after the intervention, there were no significant clinical differences between the two groups. 21 Researchers suggest that the shape of acromion and severity of patient symptoms are better indicators of clinical outcome than the type of procedure. 21

Unless a significant repair of the rotator cuff, biceps tendon, or labrum was also required during surgery, physical therapy after subacromial decompression can be more aggressive compared to the standard rehabilitation following a rotator cuff repair. 22 According to the Brigham and Women’s Hospital protocol, therapy can be broken down into three phases. Phase 1 (1-2 weeks post-op) includes passive range of motion, active assisted range of motion, active range of motion, gentle stretching, and isometric and isotonic exercises. 22 Cryotherapy and electrical stimulation can be utilized to decrease edema and pain. 22 The criteria for progression to phase 2 are full active and passive range of motion and minimal shoulder pain and tenderness. 22 Phase 2 is comprised of more strengthening exercises, proprioceptive neuromuscular facilitation, and joint mobilization.22 The goals of this phase are to regain and improve muscular strength,

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normalize arthrokinematics, and improve neuromuscular control of the shoulder complex.22 Phase 2 should take place about 2-6 weeks post-op. 22 Finally, phase 3 begins to incorporate dynamic strengthening and control exercises. 22 Exercises for the rotator cuff, deltoid, scapular stabilizers, and biceps are progressed, and endurance exercises are added at this point. 22 The clinician can determine appropriate discharge for the patient from skilled therapy once the patient has maintained non-painful active range of motion, has functional use of his upper extremity, has maximized strength, power, and endurance, and has returned to advanced functional activities. 22

Platelet-rich plasma (PRP) is another intervention that is sometimes used with these patients. PRP has a high concentration of growth factors, which speeds up the healing process when injected into an injured tendon. 23 Utilizing a similar mechanism, dry needling is thought to work by creating a localized, acute lesion that releases growth factors and stimulates the healing response. 23 One study by Rha et al 23 compared these two techniques in patients with tendinosis or a partial tear of their supraspinatus tendon. Patients received two treatments of either the PRP or dry needling, the second procedure occurring four weeks after the first. At the six-month follow-up, both groups demonstrated improvements in pain, disability score, and passive shoulder range of motion. 23 However, the group receiving PRP had significantly greater scores on the Shoulder Pain and Disability Index compared to the group receiving dry needling. 23 This shows that PRP can be beneficial for patients with less severe rotator cuff pathology.

 What about more significant rotator cuff injuries? Jo et al conducted a randomized controlled trial examining the effect of PRP with arthroscopic repair of large to massive

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rotator cuff tears. 24 Patients who received PRP had significantly reduced retear rates and greater supraspinatus cross-sectional area at one year post-op compared to patients who received the conventional treatment (no PRP). 24 Overall shoulder function was improved in the PRP group, but there were no other significant differences between groups in terms of clinical outcomes. 24 Researchers suggest that improved clinical outcomes may be seen if there was a longer follow-up period. 24

Conclusion

 Rotator cuff pathology and impingement are complex conditions that require adequate recognition, evaluation, and treatment. Physical therapists are in a good position to help the patient utilize strategies to reduce pain and restore range of motion, strength, control, and function. Patients should take advantage of conservative interventions first, with surgical intervention necessary only if non-operative treatments have been unsuccessful or the initial injury was significant.

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