



Standard of Care: Shoulder Impingement

ICD 9 Codes:

726.10 - Rotator cuff syndrome of shoulder and allied disorders
840 - Sprains and strains of shoulder and upper arm

Case Type / Diagnosis: Shoulder impingement.

Indications for Treatment:

Subacromial impingement with rotator cuff tendinopathy is a very common condition seen by both orthopedic surgeons and physical therapists.^{23, 4, 18} Impingement syndrome as defined by Neer refers to a pathological condition in which the suprahumeral structures are compressed against the anteroinferior aspect of the acromion and/or the coracoacromial ligament.^{23, 4, 17, 34} Impingement can also occur internally between the humerus, glenoid rim, and labrum.⁹ The structures most often involved are the rotator cuff tendons, the long head of the biceps and the subacromial bursa.⁴ Rotator cuff syndrome is a term that is often used to describe the process when both rotator cuff tendinitis and impingement are thought to be occurring simultaneously.²³ There are four major causes of rotator cuff tendinopathy: external impingement, internal anatomical impingement, functional overload and intrinsic tendinopathy.²³ Rotator cuff tears can occur either traumatically or by the result of the degenerative process of tendinosis.

Rotator cuff tears (RCT) are frequent and increase with age, yet the varying functional implications of a tear can have a unique and dramatic impact on a patient's daily life. The presence of a RCT can cause a vast array of impairments and associated dysfunctions. This can be the result of many variables including: age of the individual, activity level of an individual, size of the tear, location of tear, number of tendons involved, and overall rotator cuff tissue quality, as well as the presence or absence of other pathology within the shoulder complex.

There are several other issues that can cause shoulder impingement and can progress to rotator cuff tendinitis, tendinosis, or tear. Primary impingement is impingement caused by compression of the rotator cuff within the subacromial space from either the anterior third of the acromion, coracoacromial ligament, coracoid, or acromioclavicular ligament.⁶ Anything that decreases the amount of space within the subacromial outlet, such as scar tissue or a fracture, will increase the risk of primary impingement. Other risk factors for primary impingement include bone spurs and hooking of the acromion (a type 3 acromion).¹¹ Secondary impingement is caused by anterior shoulder instability which ultimately allows the humerus to translate anteriorly with activity. This translation leads to impingement of the rotator cuff and long head of the biceps tendon within the subacromial space.⁶ The final subcategory is internal impingement which can occur posteriorly or anteriorly. Posteriorly impingement can occur between the posterosuperior aspect of the glenoid rim and the humeral head.⁶ This phenomenon occurs when the shoulder is abducted to 90 degrees and placed in 90 degrees of external rotation.

Standard of Care: Shoulder impingement 1

⁶ In this position the supraspinatus and infraspinatus tendons shift posteriorly allowing for impingement to occur. ⁶ Internal impingement can also occur anteriorly between the anterosuperior labrum and the rotator cuff. ⁶ Both types of internal impingement can lead to articular side tears as opposed to primary or secondary impingement which usually cause bursal side tears. ⁶ It is useful to consider the anatomy of the shoulder when discussing rotator cuff syndrome. It is a ball and socket joint consisting of the large humeral head and smaller glenoid fossa of the scapula. Given this discrepancy in size, the shoulder has very little bony and capsular stability. As a result of this, the shoulder joint has a very high degree of motion in many planes. At rest, the joint capsule plays some part in stabilizing the humerus. With the arm hanging at the side, the superior portion of the joint capsule, along with the coracohumeral ligament, are in a taut position. Little to no muscle contraction by the deltoid or the rotator cuff is needed to prevent inferior subluxation of the humeral head. This is true even if there is a slight amount of weight in the hand. ¹¹ Given the lack of bony and capsular stability, the shoulder musculature plays an important role. The rotator cuff consists of four muscles: the supraspinatus, the infraspinatus, the teres minor and the subscapularis. Each of these muscles not only stabilizes the shoulder joint but also allows for normal biomechanical motion to occur at the glenohumeral joint. ^{23, 13} The tendons of the rotator cuff merge with the joint capsule and form a continuous cuff that surrounds the anterior, posterior and superior portions of the humeral head. This continuity of fibers allows the cuff to provide dynamic stabilization of the joint.

With shoulder movement, there is increased reliance on musculature for stability. As soon as the arm is elevated in any plane, the joint capsule and coracohumeral ligament lose tension and no longer provide a stabilizing force to the humeral head. The shoulder joint must rely on the surrounding musculature, primarily the rotator cuff, to stabilize the humeral head. When the shoulder is elevated, the deltoid and the rotator cuff musculature develop a force couple. As the deltoid contracts and begins to elevate the humerus, it also causes the humeral head to glide superiorly. At the same time the rotator cuff musculature contracts to depress the head of the humerus and centralized it in the glenoid fossa. If this depression doesn't occur, the humeral head will rise with the force of the deltoid and abut against the underside of the acromion with elevation over 90 degrees. With humeral head depression, the shoulder can then be elevated to approximately 120 degrees. The remaining 60 degrees of shoulder flexion comes from the synchronous motion of the scapula. ²³

In the normal individual there can be anywhere from six to ten millimeters of space between the undersurface of the acromion and the greater tuberosity. ^{23,17} About half of that space is occupied by the supraspinatus tendon. There is believed to be some light contact between the rotator cuff tendons and the acromion, even in individuals with normal kinematics of the shoulder ^{23,17} If the rotator cuff is functioning in an adequate manner the contact between these two structures is minimized and irritation from impingement will not occur. ²³

Early recognition of rotator cuff disease began in the mid 1930's from the work of Codman where he described the critical zone of the supraspinatus near its insertion, where most tears occur. ²² In the mid 1940's Moseley felt that there was a significant age-related decline in vascularity, which contributed to the tendon becoming vulnerable to compression and attrition especially with excessive use. ²⁴ The most common area for lesions is the supraspinatus portion of the cuff and to a lesser extent, the infraspinatus portion of the cuff, partially due to the poor vascularity of in this region. In the 1970's it was thought that there was a higher level of avascularity in the cuff when the arm was adducted and that it seemed to go away as the arm was abducted. ²⁹ This led to the idea that recurrent injury to the rotator cuff is the result of compression between the acromion and humeral head. Neer has advanced the treatment and

Standard of Care: Shoulder impingement 2

surgical management of rotator cuff tears. He has devised a staging system for rotator cuff disease.²⁶ (Table 1)

Stage	Age	Clinical Course	Treatment
I – Edema and Hemorrhage	<25	Reversible	Conservative
II – Fibrosis and tendinitis	25-40	Recurrent Pain with activity	Consider subacromial decompression
III – Bone spurs and tendon ruptures	>40	Progressive Disability	Subacromial decompression and rotator cuff tear

Table 1. *Neer's classification of rotator cuff disease.*

This staging system is widely recognized and an appropriate guideline for most rotator cuff management. However, it has been thought to be less appropriate for the throwing athlete since the degenerative process is usually accelerated secondary to the repetitive stresses applied to the shoulder.²² In addition, it is very broad and lacks the specificity needed to truly describe the vast array of rotator cuff tears. The type and severity of presentation of rotator cuff tears varies considerably between patients as there are so many factors that influence the rotator cuff.³⁵ It has been suggested that a classification system should take into account the extent of the lesion and its topography based on an anatomic-pathologic system. Some classification systems of rotator cuff tears only report the greatest diameter of the tear after excision of the necrotic edges.¹

Patte devised a more specific classification system of rotator cuff tears during the 1980's from the findings of 256 cuff repairs. The classification is based on the: (1) extent of the tear, (2) topography of the tear in the sagittal plane, (3) topography of the tear in the frontal plane, (4) trophic quality of the muscle of the torn tendon, and (5) state of the long head of the biceps.¹⁹ (Table 2)

Extent of Tear

Group I: Partial tears or full-substance tears measuring less than 1 cm in sagittal diameter at bony attachment (enthesis)

- a. Partial thickness tear bursal surface
- b. Partial thickness tear articular surface
- c. Full thickness tear subcentimeter

Group II: Full thickness tear of entire supraspinatus

Group III: Full thickness tear involving more than one tendon

Group IV: Massive tear with secondary OA

Topography of Tear in Sagittal Plane

Segment 1: Subscapularis Tear

Segment 2: Coracohumeral ligament tear

Segment 3: Isolated supraspinatus tear

Segment 4: Tear of entire supraspinatus and one-half of infraspinatus

Segment 5: Tear of supraspinatus and infraspinatus

Segment 6: Tear of subscapularis, supraspinatus and infraspinatus

Topography of Tear in Frontal (Coronal Oblique) Plane

Stage 1: Proximal stump close to enthesis (bony insertion)

Stage 2: Proximal stump at head of humeral head

Stage 3: Proximal stump at level of glenoid

Quality of Muscle**State of the LHB (long head of biceps)**

Table 2. *Patte Classification System of Rotator Cuff Tears*

Careful consideration of the anatomy, stages of rotator cuff impingement and tears, as well as the many possible underlying causes that contribute to rotator cuff syndrome will assist the physical therapist with efficient and effective evaluation and treatment.

Contraindications / Precautions for Treatment:

No significant contraindications or precautions for treatment other than possible systemic issues.

Evaluation:

Medical History: Review medical history questionnaire (on an ambulatory evaluation), patient's medical record and medical history reported in the Hospital's Computerized Medical Record. Review any diagnostic imaging, tests, work up and operative report listed under LMR (Longitudinal Medical Record).

History of Present Illness: Review the length of time symptoms have been present, specific event of onset, and previous shoulder problems/symptoms prior to this episode. Make note of any new activities or exercise program that may contribute to injury.

Social History: Consider environmental barriers and ergonomics at home and workplace. Focus on repetitive overhead activities and lifting and extended time sitting at a computer or desk.

Medications: NSAIDS, analgesics, and possible injection of corticosteroid and/or lidocaine.

Examination

This section is intended to capture the most commonly used assessment tools for this case type/diagnosis. It is not intended to be either inclusive or exclusive of assessment tools.

Pain: As described using VAS or VRS. Note location, description and activities that increase or decrease symptoms.

Palpation: Palpate entire shoulder girdle, focusing on presence and extent of muscular atrophy and/or swelling. Pay particular attention to anterior structures (supraspinatus and biceps tendons), sub-deltoid bursa, and the cervical and mid-thoracic musculature.

ROM: Take goniometric measurements of active and passive shoulder motions, as well as elbow, wrist and cervical motion.

Scapulo-humeral Rhythm: Scapular kinematics is another key factor in impingement syndrome.^{23,27,10} The glenohumeral joint accounts for approximately two-thirds the range of motion found in the shoulder. The last 60 or so degrees of elevation are due to motions occurring at the scapula. Upward rotation of the scapula elevates the lateral edge of the acromion, which is necessary in preventing impingement under the lateral acromial edge. However, the posterior tipping of the scapula seems to be an even more important factor when it comes to impingement. When the scapula tilts posteriorly, the anterior portion of the acromion elevates away from the rising greater tuberosity during elevation of the shoulder. Both of these motions occur during normal shoulder kinematics decreasing the likelihood of impingement.

Strength: Manual Muscle Test the muscles of the shoulder, elbow and scapula. To aide in the accuracy of strength testing, hand held dynamometry(HHD) is optimal. HHD increases the objectivity of strength testing and allows for more accurate tracking of strength changes.

Upper Quarter Screen: Assess dermatomes, myotomes and reflexes of the upper extremity. If abnormal, further assessment of cervical spine is indicated.

Posture/alignment: Assess shoulder girdle musculature. Primary focus on sitting and standing upper quadrant and upper back posture. Patients tend to be at extremes of rounded shoulders and forward head with increased thoracic kyphosis.

Joint Play: Assess joint play of the shoulder to determine if hyper mobility or hypo mobility is present. With shoulder impingement it is not uncommon to find anterior laxity and posterior tightness. Assess thoracic spine joint mobility. Cervical mobility can be assessed if involvement is suspected.

Special Tests¹⁹

- Hawkins-Kennedy Impingement
- Neer Impingement
- Drop Arm Sign
- Empty Can Test
- SLAPreheension
- Yergason
- Speeds
- External Rotation Lag Sign
- Hornblower's
- Subscapularis function can be assessed by lift off, belly press, and bear hug

The sensitivity and specificity of the Neer and Hawkins-Kennedy signs have been studied.^{4,18} Both of the tests demonstrated a high sensitivity ranging from 75-92%. The specificity of the tests, however, was not as high with results ranging from 25-60%. This shows that a negative test is a good indicator that a shoulder impingement can be ruled out. However, a positive test does not necessarily predict the exact etiology of the symptoms. Please see the differential diagnosis section below. For a reference on how to perform each special test with sensitivity and specificity scores refer to Orthopedic Physical Examination Tests by Chad Cook and Eric Hegedus.

Functional Outcomes:

The use of a shoulder specific functional capacity questionnaire is recommended to establish initial status and track progress. Possible tools include:

- Simple Shoulder Test (SST)
- American Shoulder and Elbow Surgeon's Shoulder Evaluation Short Form (ASES-SF)
- Shoulder Pain and Disability Index (SPADI)

The SST¹⁵ and the ASES-SF³, and the SPADI³¹ are all standardized self-assessments of shoulder function and have been found to have fairly high responsiveness as well as high test-retest reliability when compared to other shoulder outcome tools.² The SST has a standardized response mean of 0.87, confidence interval 0.52, 1.22; while the ASES-SF had a standardized response mean of 0.93, confidence interval 0.57, 1.29. The intraclass correlation

coefficients for the SST and ASES-SF are 0.99 and 0.96, respectively. They both are very simple and quick for the subject and investigator to fill out. The SST has been shown to be sensitive for various shoulder conditions as well as sensitive in detecting changes in shoulder function over time.^{20,21}

Differential Diagnosis:

- Cervical radiculopathy or stenosis
- Labral tears
- Shoulder instability
- Osteoarthritis
- Rheumatoid arthritis
- Rotator cuff tear

Assessment:

~~(Establish Diagnosis and Need for Skilled Services)~~

Problem List: (individualized for each patient, but may include)

- Pain
- Postural Dysfunction
- Impaired ROM
- Impaired strength
- Impaired shoulder joint play
- Impaired thoracic joint mobility
- Impaired scapulo-humeral rhythm
- Impaired patient knowledge regarding diagnosis and home exercise program
- Decreased function, ADL performance, recreational activities

Prognosis: Good if there is no history of rotator cuff tear or other co-morbidities. Based on the literature, patients with shoulder impingement should do fairly well with therapy, especially if the patient is compliant with exercise program and able to limit aggravating factors at home and work. However, if a rotator cuff tear is present, outcomes may not be as favorable and referral to orthopedist may be warranted for further intervention.

Several studies have shown that treating shoulder impingement and rotator cuff disease with physical therapy and strengthening exercise for the rotator cuff musculature and scapular musculature leads to good outcomes with a reduction in pain and improved function.^{23, 7, 14, 32, 16} Morrison et al, looked retrospectively at 616 patients who had shoulder impingement syndrome and found a majority of them had satisfactory results with strengthening.²³ A recent Cochrane review for interventions in shoulder

Standard of Care: Shoulder impingement 7

impingement was done and it was found that exercise was a very effective treatment in terms of short term recovery in rotator cuff disease.⁷

Goals: (Measurable parameters and specific timelines to be included on eval form)

Goals of intervention are individualized to each patient's medical status and needs, but may include:

- Patient self-manages pain
- Improve posture
- Increase range of motion
- Increase strength
- Improve scapulo-humeral rhythm
- Increase function
- Patient demonstrates awareness of proper posture and ergonomics
- Patient demonstrates independence with progressed home exercise program

Age Specific Considerations: Consider tissue quality, postural changes, degenerative joint disease and other medical issues associated with aging.

Treatment Planning / Interventions

Established Pathway ___ Yes, see attached. _X_ No

Established Protocol ___ Yes, see attached. _X_ No

Interventions most commonly used for this case type/diagnosis.

This section is intended to capture the most commonly used interventions for this case type/diagnosis. It is not intended to be either inclusive or exclusive of appropriate interventions.

- Patient Education
- Passive range of motion (PROM)/Active assisted range of motion (AAROM)/Active range of motion (AROM)
- Posture, positioning, ergonomics education / training
- Strengthening of rotator cuff, shoulder and scapular musculature
- Joint mobilization of all joints of the shoulder girdle, cervical spine, and thoracic spine as indicated
- Modalities: ice, ultrasound, electrical stimulation, iontophoresis if indicated (see each specific SOC for procedural guidelines)
- Home exercise program

Of note, it has been concluded that a proper course of therapy for shoulder impingement not only includes strengthening of the rotator cuff muscles but also that of the

Standard of Care: Shoulder impingement 8

surrounding scapular musculature.^{23,17,10} An increasing amount of literature also demonstrates optimal results with respect to pain, ROM, and function when a course of physical therapy includes not only strengthening, but shoulder joint mobilization.^{33, 14} It is also important to note that if inflammation is present, reducing the inflammatory process will be necessary prior to beginning an aggressive strengthening program.

A recent pilot study by Jonsson et al. on painful eccentric training of the shoulder with impingement syndrome yielded promising results on the reduction of pain.¹² Given that the study was a pilot study, the sample size was limited to eight subjects with long term shoulder dysfunction suggesting more of a tendinosis process within the rotator cuff. The small sample size limits the interpretation of the results; however, five of seven (one subject was misdiagnosed) subjects withdrew from a list for surgical intervention following completion of the study.¹² Jonsson’s eccentric protocol also only addressed the supraspinatus with exercises always being performed within an acceptable level of pain. Weight was increased throughout if exercises became pain free.¹²

When designing a treatment program for a patient with shoulder impingement it is important to consider what type of impingement your patient has. Each subtype of impingement is treated differently. See table 3 below as a quick reference of treatment considerations for the various subtypes of shoulder impingement.

	Primary	Secondary	Internal: Posterior
Overall Goal	Restore rotator cuff muscle balance	Stability of rotator cuff	Restore rotator cuff muscle balance
Joint Mobility	Long/short axis distraction mobilizations	Posterior joint mobilizations	Posterior joint mobilization if 180 degrees of combined IR/ER are not present
Stretching Focus	As indicated based on overall tightness	Posterior capsule	Posterior capsule
Strengthening Focus	Periscapular as indicated	Stabilization exercises in closed chain and periscapular	Periscapular
Education	Posture, Shoulder mechanics, Activity modification as necessary, General strengthening	Posture, Shoulder mechanics, Activity Modification as necessary, Posterior cuff strengthening	Posture, Shoulder Mechanics, Activity modification as necessary, Posterior cuff strengthening

Table 3. *Treatment Considerations for the Subtypes of Impingement*

Frequency & Duration: Approximately 1-2x/week for 6-8 weeks

Patient / family education

- PT findings, role and plan of care
- Postural awareness, ergonomics
- Home Exercise Program
- Self management of pain using positioning and/or modalities
- Etiology of symptoms and how to prevent further flare-ups

Recommendations and referrals to other providers: If no improvement, return to referring MD where patient may be referred to an orthopedist.

Re-evaluation

Standard Time Frame- 30 days or less if appropriate

Other Possible Triggers- Failure to improve, additional co-morbidities, significant change in function or pain level

Discharge Planning

Commonly expected outcomes at discharge: Patient returns to previous level of function with a good knowledge of injury prevention.

Transfer of Care: Consult with referring MD if no improvement at re-evaluation. The MD may choose to refer patient to shoulder specialist.

Patient's discharge instructions: Continue home exercise program indefinitely to maintain adequate rotator cuff strength, self-management of pain with modalities, and encourage awareness of positioning, posture and ergonomics to decrease possibility of impingement.

Authors:

**Joel Fallano, PT
Amy Jennings, PT
August, 2004**

Updated:

**Philip Kidd, PT
March, 2011**

Reviewed by:

**Joel Fallano, PT
Reg B. Wilcox III, PT**

Standard of Care: Shoulder impingement 10

REFERENCES

- 1 Bayne O, Bateman JE. Longterm results of surgical repair of full thickness rotator cuff tears. *Surgery of the Shoulder*. St Louis, CV Mosby, 1984:167.
- 2 Beaton D, Richards RR. Assessing the reliability and responsiveness of 5 shoulder questionnaires. *J Shoulder Elbow Surg*. 1998;7(6):565-572.
- 3 Beaton DE, Richards RR. Measuring function of the shoulder. A cross-sectional comparison of five questionnaires. *J Bone Joint Surg Am*. 1996;78(6):882-890.
- 4 Calis M, Akgun K, Birtane M, Karacan I, Calis H, Tuzun F. Diagnostic values of clinical diagnostic tests in subacromial impingement syndrome. *Annals of the Rheumatic Diseases*. 2000;59(1):44-7.
- 5 Codman EA. The pathology of the subacromial bursa and of the supraspinatus tendon. The shoulder: Rupture of the supraspinatus tendon and other lesions in or about the subacromial bursa. (Supp. Ed.); 65-107.
- 6 Ellenbecker, T. Chapter 1 – Rehabilitation of shoulder impingement: primary, secondary, and internal. *Shoulder Rehabilitation: Non-operative Treatment*. New York, NY: Thieme Medical Publishers; 2006
- 7 Green S, Buchbinder R, Hetrick S. Physiotherapy interventions for shoulder pain. *Cochrane database of systemic reviews*. 2003
- 8 Hammond G. Complete acromionectomy in the treatment of chronic tendonitis of the shoulder. *Journal of Bone and Joint Surgery*. 1962;44(A):494-504.
- 9 Hanchard N, Handoll H. Physical tests for shoulder impingements and local lesions of bursa, tendon, or labrum that may accompany impingement. *Cochrane Database of Systematic Reviews* 2008, Issue 4. Art. No.: CD007427.DOI: 10.1002/14651858.CD007427.
- 10 Hebert LJ, Moffet H, McFadyen BJ, Dionne CE. Scapular behavior in shoulder impingement syndrome. *Archives of Physical Medicine & Rehabilitation*. 2002;83(1):60-9.
- 11 Hertling D, Kessler RM. Chapter 10 – The shoulder and shoulder girdle. *Management of common musculoskeletal disorders: Physical therapy principles and methods*. Philadelphia, Pennsylvania: JP Lippincott; 1990.
- 12 Jonsson P, Wahlstrom P. Eccentric training in chronic painful impingement syndrome of the shoulder: results of a pilot study. *Knee Surg Sports Traumatol Arthrosc* 2006;14:76-81

- 13 Kendall FP, Kendall-McCreary E, Provance PG. Chapter 8 – Upper extremity and shoulder girdle strength tests. Muscle testing and function. Baltimore, Maryland: Williams and Williams; 1993.
- 14 Kuhn JE. Exercise in the treatment of rotator cuff impingement: a systematic review and a synthesized evidence-based rehabilitation protocol. *J Shoulder Elbow Surg* 2009;18:138-160
- 15 Lippitt SB, Harryman DT, Matsen FA. A practical tool for evaluating function. The simple shoulder test. In: Matsen FA, Fu FH, Hawkins RJ, editors. *The shoulder: a balance of mobility and stability*. American Academy of Orthopedic Surgeons. 1993;501-518.
- 16 Lombardi I, Magri AG, et al. Progressive resistance training in patients with shoulder impingement syndrome: a randomized controlled trial. *Arthritis and Rheumatism* 2008;59(5):615-622
- 17 Ludewig PM, Cook TM. Alterations in shoulder kinematics and associated muscle activity in people with symptoms of shoulder impingement. *Physical Therapy*. 2000;80(3):276-91.
- 18 MacDonald PB, Clark P, Sutherland K. An analysis of the diagnostic accuracy of the Hawkins and Neer subacromial impingement signs. *Journal of Shoulder & Elbow Surgery*. 2000;9(4):299-301.
- 19 Magee DJ. The Shoulder. In: *Biblis MM, ed. Orthopedic Physical Assessment*. 2nd ed. Philadelphia: W.B. Saunders Company; 1992:90-142.
- 20 Matsen FA, 3rd, Antoniou J, Rozenzwaig R, Campbell B, Smith KL. Correlates with comfort and function after total shoulder arthroplasty for degenerative joint disease. *J Shoulder Elbow Surg*. 2000;9(6):465-469.
- 21 Matsen FA, 3rd, Ziegler DW, DeBartolo SE. Patient self-assessment of health status and function in glenohumeral degenerative joint disease. *J Shoulder Elbow Surg*. 1995;4(5):345-351.
- 22 Meister K, Andrews JR. Classification and treatment of rotator cuff injuries in the overhead athlete. *JOSPT*. 1993;18(2): 413-421.
- 23 Morrison DS, Greenbaum BS, Einhorn A. Shoulder impingement. *Orthopedic Clinics of North America*. 2000;31(2):285-93.
- 24 Moseley HF. Ruptures of the rotator cuff. Springfield Ill. Charles C Thomas Publisher, 1952.
- 25 Neer CS. Anterior acromioplasty for the chronic impingement syndrome in the shoulder. *Journal of Bone and Joint Surgery*. 1972;54(A):41-50.
- 26 Neer CS. Impingement lesions. *Clinical Orthopedics*. 1973;173:70-77.

Standard of Care: Shoulder impingement 12

- 27 Palastanga N, Field D, Soames R. Chapter 4 – The upper limb. *Anatomy and human movement: Structure and function*. Oxford, England: Heinemann Medical Books; 1990.
- 28 Patte D. Classification of rotator cuff lesions. *Clinical Orthopedics*. 1990;254:81-86.
- 29 Rathburn JB, MacNab L. The microvascular pattern of the rotator cuff. *Journal of Bone and Joint Surgery*. 1970;52(B):540-553.
- 30 Reinhold M, Wilk K, et al. Electromyographic analysis of rotator cuff and deltoid musculature during common shoulder external rotation exercises. *JOSPT*. July 2004 34(7):385-394.
- 31 Roach KE, Budiman-Mak E, Songsiridej N, Lertratanakul Y. Development of a shoulder pain and disability index. *Arthritis Care Res*. 1991;4(4):143-149.
- 32 Roy JS, Moffet H, et al. Effect of motor control and strengthening exercises on shoulder function in persons with impingement syndrome: a single subject study design. *Manual Therapy* 2009;14:180-188
- 33 Senbursa G, Baltaci G, Atay A. Comparison of conservative treatment with and without manual physical therapy for patients with shoulder impingement syndrome: a prospective, randomized clinical trial. *Knee Surg Sports Traumatol Arthrosc* 2007;15:915-921
- 34 Valadie AL 3rd, Jobe CM, Pink MM, Ekman EF, Jobe FW. Anatomy of provocative tests for impingement syndrome of the shoulder. *Journal of Shoulder & Elbow Surgery*. 2000;9(1):36-46.
- 35 Wolfgang GL. Surgical repair of tears of the rotator cuff of the shoulder. Factors influencing the result. *JBJS*. 1974;56(A):14-26.