By Greg Roskopf, MA

When Clients Feel Pain

How can you identify muscle imbalances that contribute to discomfort or distress?

As personal fitness trainers, we recognize our role as specialists in exercise maintenance. On a daily basis, we set up exercise programs designed to help our clients reach their fitness goals. With the educational background and the skills we possess, training our clients for optimal workouts is generally a straightforward process. Our job becomes more difficult, however, when we are faced with the dilemma of training clients who are complaining of pain. Consequently, we must be able to understand injuries to work safely with clients and refer them back to their therapists and/or doctors.

We see it all the time: Clients come to us, as fitness specialists, to heal their pain. Some clients have pain while exercising; others complain that it's difficult to function without pain in everyday activities. Clients "want to play golf without back pain" or "want to play tennis without shoulder pain." They come to us to gain relief. This makes our role as trainers more complicated when setting up exercise routines. We must understand human mechanics and the muscular systems involved in chronic and repetitive stress injuries.

Scope of Practice

It must be understood that personal trainers are not qualified to diagnose, treat or prescribe treatment for any injuries clients may suffer. When a client complains about pain, the correct action for a trainer is to advise the person to see his or her doctor and/or physical therapist. Only by working with these medical practitioners can trainers benefit their clients. When therapists and doctors refer their patients to us, we must ask for and precisely follow detailed exercise instructions created especially for each client. When in doubt, trainers must work in conjunction with and under the supervision of doctors and therapists.

At the same time, trainers must recognize that the exercise programs we design for these clients will directly or indirectly affect their pain. Whether that effect is positive or negative is one key challenge. Another is whether the exercises performed help strengthen weak muscles, thus aiding postrehabilitation of the injury, or whether the exercises reinforce muscular imbalances that already exist. The only way a personal trainer can know is by having a thorough understanding of joint mechanics and how muscular systems relate to the injury.

To effectively work with clients suffering pain, trainers must understand the biomechanics of each joint, along with the muscular contributions to joint motion. With the right exercises, a personal trainer can not only improve function but can also provide an environment for normal healing to occur. This action, in turn, can decrease pain levels.

Note: These evaluative and treatment techniques are complex and require background skills in sports medicine. It is recommended that trainers either hold a degree in a sports medicine-related field or a certification in exercise postrehabilitation from a national certifying agency.

Knowledge of Biomechanics

With a thorough knowledge base of joint biomechanics, personal trainers will be better equipped to determine when abnormal motion is occurring in clients. By

understanding the motions considered correct, trainers can determine when movements are wrong.

For the purposes of this article, let's look at the shoulder joint as an example. For normal shoulder function to occur, a balance must exist in the muscles (Inman, Saunders & Abott 1944). If muscular imbalances exist, the shoulder becomes less efficient and the potential for overuse injuries increases. This potential increases to a greater degree if the resistance exercises reinforce the imbalance. Therefore, identifying abnormal shoulder mechanics will assist trainers in developing effective exercise programs for the injured client.

In this article, we will look at normal biomechanics during shoulder joint abduction and identify how isolated muscle weaknesses can negatively affect normal glenohumeral joint motion.

Biomechanics of Humeral Abduction

For efficient motion in humeral abduction, many mechanical factors must occur. During normal glenohumeral joint motion, many force couple mechanisms occur at one time, creating a fluid, efficient glenohumeral joint motion. These combined muscle actions involve a balance of muscle pull through combined actions of spinal, scapula, clavicle and humerus muscles. Each involved muscle depends on the associated muscles to perform its isolated function. If this association does not occur, normal glenohumeral joint motion is compromised.

For normal humeral joint abduction, the deltoids initiate an upward pull on the humerus (Andrews & Wilk 1994). This upward pull is counteracted by the pull of the supraspinatus, the infraspinatus, the teres minor and the subscapularis. The supraspinatus helps initiate abduction while holding the humeral head in the glenoid. The subscapularis and infraspinatus resist the upward pull as they create a downward force on the humerus, stabilizing the head of the humerus in the glenoid. The serratus anterior abducts the scapula while also stabilizing the scapula against the thorax as the scapula rotates upward.

The upper and lower trapezius muscles also assist in upward rotation of the scapula as the humerus moves into abduction. It is this upward rotation of the scapula that moves the acromion superior and posterior, which in turn provides more space for the humeral head to move freely in the glenoid, thus preventing impingement.

Abnormal Shoulder Mechanics

Identifying muscle weaknesses will help you plan an exercise program for injuries such as impingement syndrome. Let's take a look at how isolated muscle weaknesses contribute to abnormal biomechanics, which in turn leads to overuse injuries such as impingement syndrome.

- **Weak Serratus Anterior.** When a weakness of the serratus anterior occurs, the inferior angle of the scapula will tend to migrate posteriorly and medially. With this inhibition, the mechanical advantage is placed on the rhomboids as they gain the mechanical advantage to pull the inferior angle of the scapula medially, creating a downward rotation pull on the scapula. This downward rotation force places increased tension on the upper trapezius in its attempt to upwardly rotate the scapula.
- **Weak Upper Trapezius.** If the upper trapezius is weak, the inferior angle of the scapula will be pulled medially, due to the transference of the mechanical advantage to the rhomboids and levator scapula. The role of these muscles is to downwardly rotate the scapula. With the resultant pull from the levator scapula on the superior angle, a downward rotation force is placed on the scapula. If the trapezius is weak, the acromion will drop and the shoulder will move forward on that side. This downwardly rotated position of the scapula creates an anterior and inferior positioning of the acromion, which closes down on the joint space as the humerus is pulled into abduction.
- **Weak Subscapularis or Infraspinatus.** The function of the subscapularis and the infraspinatus is to stabilize the head of the humerus in the glenoid while creating a downward pull on the humerus as the deltoid abducts the humerus. A weakness in the subscapularis or infraspinatus will create a resultant instability of the head of the humerus, relative to the glenoid, along with an unresisted upward pull from the deltoids, thereby pulling the humerus up into the acromion. This action, in turn, leads to impingement.
- **Weak Supraspinatus.** Since the function of the supraspinatus is to pull the head of the humerus into the glenoid as the deltoid abducts the humerus, then a weakness in the supraspinatus will result in instability in the glenohumeral joint.

SHOULDER MUSCULATURE

MUSCLE NAME	FUNCTION
supraspinatus	abduction, external rotation
infraspinatus	external rotation
teres minor	external rotation
subscapularis	internal rotation
serratus anterior	scapular protraction, upward rotation
upper trapezius	scapular upward rotation
middle trapezius	scapular retraction
lower trapezius	scapular upward rotation, depression and retraction
rhomboids	scapular retraction

Evaluation of Muscle Weakness

As trainers, we have the opportunity to address the muscular imbalances that contribute to the injury through exercise—*as long as we know how to identify them.* When faced with designing an exercise program for a client complaining of impingement syndrome, the trainer must consider that one or all of the muscles involved may be weak. Since each of these muscle functions vary during abduction, it is important that the involved muscles have adequate strength to perform their isolated function. The key is having a process in place for determining the strength of each of these muscles.

The evaluation of muscle strength can be accomplished by performing isolated muscle strength tests on each muscle involved in shoulder abduction. This process holds true for any muscle, but for the purposes of this article, we will address the muscles involved in shoulder abduction.

Introduction to Muscle Testing

Isolated muscle strength testing can be performed on any muscle of the body as long as we understand the muscle's function. Testing muscles is a very specific science. **If you do not understand the function of the muscle, do not performs these tests. Instead, work with a doctor and/or physical therapist.**

To test the strength of a specific muscle, the trainer must first position the joint such that the muscle being tested is in its most shortened position. This testing position has been well researched, relative to the components of length-tension relationships and joint mechanics, and is considered the most effective position for testing to be performed (Hislop & Montgomery 1995). It is important to note, however, that due to the contribution of synergistic muscles, in some cases this position may need to be altered into the point in the range where the muscle can be most challenged.

To perform the muscle test, the client holds the shortened position as the trainer applies a force in opposition to the line of pull of the muscle being tested. The client must resist the pull applied by the trainer. (For further information regarding the techniques involved in manual muscle testing, see Hislop & Montgomery in the Reference section at the end of this article.)

Using shoulder abduction as the example, we recognize that many muscles are associated with the performance of this movement. It is beyond the scope of this article to address all of the isolated tests for the muscles involved in abduction. A review of the muscle tests for the infraspinatus and teres minor will be addressed to provide examples about the effects of muscle testing relating to isolated muscle weaknesses.

It is important to note that when testing for isolated muscle strength, the goal is to determine the "position of weakness" in joint motion. It is these positions of weakness that indicate where instability in the shoulder joint exists. As mentioned previously, these positions of muscular instability can potentially lead to overuse and repetitive stress injuries. Therefore, when testing muscles such as the external rotators, it is important to test the muscle in more than one position of isolation to determine the positions of weakness. Thus, the strength tests for the infraspinatus and teres minor should be performed in various positions of shoulder abduction. These testing positions are consistent with the tests described by Beardall (1983).

Beardall described the infraspinatus as a muscle separated into three different divisions, each requiring a separate strength evaluation test. Beardall projects that many of the larger muscles in the body, based upon fiber alignment and innervation, may be separated into two or more divisions. Each muscle division has its own isolated function; therefore, a different strength test needs to be performed for each division. Although each division does not act alone in its function, the altered position of testing places greater isolation on the particular group of fibers being tested. By differentiating between the muscle divisions, strength testing becomes more precise and the trainer is provided with a testing procedure that creates the foundation for identifying muscle imbalances.

Strength Tests for External Rotators

For trainers conducting strength tests, the goal is to determine the positions of isolated weakness to more effectively design exercise programs. When performing isolated strength tests for the external rotators of the humerus, the strength tests must be administered in a sequence designed to determine positions of instability. Conventional testing methods, in which there is one general test for external rotation strength, have proven to be vague and inconclusive.

By dividing the infraspinatus and teres minor into four divisions, the strength of the external rotators will be analyzed in four positions of abduction. The infraspinatus is tested in three positions: the arm abducted 90 degrees (upper fibers), 60 degrees (middle fibers) and 30 degrees (lower fibers), while the teres minor is tested at zero degrees of shoulder abduction. This variation in testing position helps identify not only if these external rotators are weak, but also the isolated position of the muscle weakness. By isolating the position of weakness, trainers can more effectively design corrective exercises.

Muscle Activation

When a muscle, or a division of a muscle, demonstrates a weakness in its muscle test, it means there is altered proprioceptive input to that muscle. Muscles receive the least amount of proprioceptive input in their shortened position. This factor is key for testing muscle strength in the muscles' shortened position.

Demonstration of weakness in muscle testing means that proprioceptive input is altered; to improve joint stability, normal proprioception must be

restored. The implementation of isometric contractions is a technique designed to restimulate the muscle by increasing sensory input to the brain. By performing isometric contractions in the position of weakness, the muscles' ability to contract will improve immediately. Corrective isometrics can act as great precursors to designing corrective exercises.

Through the implementation of corrective isometrics, proprioceptive input will improve, which in turn increases the muscle's ability to contract. By restimulating the muscles, there will be a greater carryover in strength when performing concentric exercises. For proprioceptive reinforcement, trainers should perform corrective isometrics prior to designing corrective exercises for clients.

Performing Isometric Contractions

To improve proprioceptive input through corrective isometrics, the following protocol should be followed:

- Client will perform six contractions holding for six seconds on each contraction, placing muscle in position of weakness (same position as muscle test).
- First contraction: Client initiates contraction to further shortened position at 30 to 50 percent intensity. Trainer matches resistance.
- Second contraction: Client initiates contraction at 70 percent intensity. Trainer matches resistance.
- Third contraction: Client initiates contraction at 100 percent intensity. Trainer matches resistance.
- Fourth contraction: Trainer initiates contraction, matching client's maximum resistance.
- Fifth contraction: Trainer initiates contraction, matching client's maximum resistance.
- Sixth contraction: Trainer initiates contraction, matching client's maximum resistance.

Notes: The trainer should gradually increase the force initiated over the last three contractions. Performing isometric contractions will improve the muscle's ability to contract. Follow-up with corrective exercise is necessary to maintain muscle balance and improve joint stability.

Exercise Caution

When designing exercise programs for the injured client, a few cautionary notes must be addressed:

- If exercise is prescribed by a doctor or physical therapist, consult with this medical practitioner to determine if any structural or ligament damage exists.
- This bears mentioning again: As trainers, we are not trying to diagnose and rehabilitate injuries, but we can identify and strengthen the muscle weaknesses that create joint instability. This action in turn provides for efficient movement and an environment that facilitates normal healing.
- Pain is an indicator that something is wrong. This fact must be at the forefront of any program involving dynamic, multi-joint exercises. If the client experiences pain, that pain represents joint instability in the movement pattern. The goal, therefore, is to identify and then strengthen the positions of weakness.
- When muscle weakness is noted, corrective isometrics must be performed to improve proprioceptive input, followed by isolated exercises designed to reinforce muscle strength.
- It is important to prescribe stretching exercises for the antagonist muscle. Typically, a coinciding tonicity of the antagonist muscle will exist relative to the muscle weakness.
- Full-range, multi-joint strengthening exercises will tend to reinforce the imbalance if the isolated weaknesses are not identified and strengthened.

Corrective Exercises

When designing exercises for the injured client, the goal is to improve the function of the joint to reduce the stress being placed on it. From an exercise prescription standpoint, the goal is

STRENGTH TESTS

Infraspinatus Upper Fibers: Client lies supine with elbow bent to 90 degrees and humerus fully externally rotated. Abduct arm 90 degrees. Trainer stabilizes against medial elbow and braces against dorsal aspect of wrist, applying force into internal rotation.

Infraspinatus Middle Fibers: Client lies supine with elbow bent to 90 degrees and humerus fully externally rotated. Abduct arm 60 degrees. Trainer stabilizes against medial elbow and braces against dorsal aspect of the wrist, applying force into internal rotation.

Infraspinatus Lower Fibers: Client lies supine with elbow bent to 90 degrees and humerus fully externally rotated. Abduct arm 30 degrees. Trainer stabilizes against medial elbow and braces against dorsal aspect of wrist, applying force into internal rotation.

Teres Minor: Client lies supine with elbow bent to 90 degrees and humerus fully externally rotated. Arm against side. Trainer stabilizes against medial elbow and braces against dorsal aspect of wrist, applying force into internal rotation.

to avoid reinforcing the strength imbalances that already exist. Isolated muscle strength testing provides the trainer with a tool for identifying the muscle weaknesses that create joint instability. By determining the positions of weakness through muscle strength testing, trainers are provided with the tools needed to effectively design exercises that will improve joint stability.

For example, if a client demonstrates a weakness in the middle division of the infraspinatus (tested at 60 degrees of abduction), then the trainer will know that an exercise needs to be designed to strengthen the muscle in that position. Performance of the conventional "rotator cuff" exercises may be contraindicated, since these exercises may reinforce the muscle imbalance that already exists. It is recommended that clients perform the corrective isometrics prior to trainers designing corrective exercises.

When performing the corrective exercises, it is important to understand that the position of weakness is supported by small groups of fibers that stand alone and are not very strong. Therefore, when designing corrective exercises, the resistance must be light enough to prevent the client from compensating by using other muscles or other divisions of the same muscle. If compensatory recruitment is allowed, the imbalance will be reinforced through the strengthening exercises. Also, performing corrective exercises through the full range of motion of the joint motion is vital. Since the muscle weaknesses are identified in the shortened position of the muscle being tested, the corrective exercises must address this full range of motion so that strengthening occurs through its weakest point.

Note: **The positions of weakness and joint instability will vary from client to client; therefore, it is vital that trainers have a system for evaluating the individual differences. These individual differences can act as pain indicators. When trainers design "cookbook" exercises, the chances of contributing to the problem increases dramatically. Again, consult the client's doctor and/or physical therapist before moving forward.**

With an understanding of the muscular relationship to movement, trainers can determine the muscle tests that need to be performed on any muscle or division throughout the body. In the case of shoulder abduction, if abnormal motion is noted or a patient complains of impingement syndrome, the trainer should know to test the supraspinatus, subscapularis, infraspinatus, serratus anterior, upper and lower trapezius and deltoids. The process remains the same, regardless of the joint motion being evaluated. With an understanding of biomechanics, trainers are well equipped to determine positions of instability and, therefore, correct instability through sound exercise design.

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CORRECTIVE EXERCISES

Notes: These exercises are determined by position of weakness in muscle. Use cables or tension bands for exercises. Alter line of resistance based on the angle of pull of each division of the muscle.

Infraspinatus Upper Fibers: Client stands. Arm is abducted to 90 degrees, with elbow flexed to 90 degrees. Resistance is angled slightly downward. Externally rotate humerus into shortened muscle position.

Infraspinatus Middle Fibers: Client stands. Arm is abducted to 60 degrees, with elbow flexed to 90 degrees. Resistance is angled downward and inward. Externally rotate humerus into shortened muscle position.

Infraspinatus Lower Fibers: Client stands. Arm is abducted to 30 degrees, with elbow flexed to 90 degrees. Resistance is angled downward and inward. Externally rotate humerus into shortened muscle position.

Teres Minor: Client stands. Arm is against side, with elbow flexed to 90 degrees. Resistance is angled across body. Externally rotate humerus into shortened muscle position.