Balancing Mobility *and Stability*

Joe Muscolino | DC

Joe Muscolino is a Doctor of Chiropractic. He has been an instructor in the world of massage therapy for over 25 years.

The musculoskeletal system is a marvel of engineering. Myofascial tissues generate and transmit forces that create the proper balance of stability and flexibility to maintain integrity of the body through posture and motion. As manual therapists, our focus is usually on our clients' flexibility. However, it is important to understand and recognize the importance of stability and how the myofascial system blends forces of stability with the forces that create motion.

When we think of muscle function, we usually think of muscles shortening as they concentrically contract as movers to create motion of a body part at a joint. What we often don't realize is that the concentric contraction of mover muscles may be ineffective without the accompanying isometric contraction of stabilizer muscles.

When a muscle contracts, it pulls toward its center, exerting its tension force equally on both attachments; therefore, either one of its attachments or both of it attachments could theoretically move. The muscle cannot choose which of its attachments will move. However, when we contract a muscle, we usually desire that only one specific attachment moves. For this to occur, the other attachment must stay fixed in place, in other words, be stabilized. And for this to occur, a stabilization force is needed.

Sometimes the stabilization force is provided by gravity. In other words, one of the attachments is less likely to move when the muscle contracts because that attachment is heavier than the other. For example, when the brachialis muscle contracts, it can either flex the forearm toward the arm at the elbow joint, or it can flex the arm toward forearm at the elbow joint, or both. Most of the time, the forearm will move instead of the arm because not only is the arm a larger and heavier body part than the forearm, but for the arm to move, the rest of the body must move with it; whereas for the forearm to move, only the forearm and hand need to move. As a rule, proximal body parts are heavier than distal ones, and when proximal body parts move, the core of the body must move with it. For this reason, people often think of muscle contractions as moving the distal attachment. Indeed, this is the reasoning for the terminology of naming muscle attachments as *origin* and *insertion:* the origin is the proximal, heavier attachment; and the insertion is the distal, lighter attachment. Therefore we usually envision the lighter insertion being mobile and moving toward the heavier, stable origin *(Figure 1)*. But this is not always the case.

Often, body weight does not provide sufficient stabilization force, and without additional stabilization force, the proximal attachment of the mover muscle will move. Looking at the same example, if we place a weight in the hand, perhaps the person is attempting to lift up a heavy suitcase, and now ask the brachialis to contract, the arm/body may now be lighter than the forearm/hand along with the weight, resulting in movement of the arm instead of the forearm at the elbow joint *(Figure 2)*. And even without a weight placed in the hand, brachialis contraction would still likely create enough force that there would be slight motion of the arm. The problem is that any motion of the arm would commensurately decrease the force and effectiveness of the forearm's motion. To prevent this, a force in addition to gravity would have to occur to fully stabilize the arm. This force comes from muscle contraction.

It is extremely common for muscular contractions to create stabilization forces that accompany muscular contraction movement forces. The interplay of these muscular stabilization and movement forces

Reverse Actions

When a mover muscle contracts and its distal attachment moves toward its proximal attachment, this can be referred to as its *standard action.* When its proximal attachment moves instead, it can be described as its reverse action. Standard actions usually occur when the extremity is in *open chain position;* reverse actions usually occur when the extremity is in *closed chain position.*

Looking at the upper extremity as an example, the parts of the upper extremity are the shoulder girdle, arm, forearm, and hand. These parts can be viewed as a "chain" of kinematic elements. If the hand is free to move in space, it is an "open chain." If instead the hand is holding onto a stable object/surface, for example a banister when climbing the stairs, it is a "closed chain."

In open chain position, the distal attachment has less resistance to movement so it usually moves, creating a standard action. However, in closed chain position in which the hand is holding onto a stable object or surface, the distal attachment is more resistant to moving; for this reason, the proximal attachment usually moves instead, creating a reverse action.

Figure 1. The brachialis contracts, flexing the forearm toward the arm at the elbow joint. (Figure courtesy of Joseph E. Muscolino)

Figure 2. When attempting to lift a heavy suitcase, brachialis contraction can cause the arm to flex toward the forearm at the elbow joint. (Figure courtesy of Joseph E. Muscolino)

is coordinated by the nervous system. When a mover muscle contracts to move one of its attachments, another muscle called a stabilizer muscle is ordered by the nervous system to contract and stabilize the mover muscle's other attachment. It is the fine interplay and balance of these muscular contractions, in other words *coordination* of muscular contractions, that allows for efficient, healthy, and graceful motion.

Following are examples of the balance of movement and stabilization forces in the body.

Pelvic Girdle Stabilization

The classic example of stabilization occurs at the pelvis and is often known as *core stabilization.* Almost every muscle that crosses the hip joint attaches from the pelvis to the thigh. Because both the thigh and the pelvis are mobile, for these muscles to contract and efficiently move the thigh, their pelvic attachment must be stabilized. Let's use hip flexors as an example. If a person in supine position contracts to elevate the thigh into flexion at the hip joint, hip flexor musculature would also exert a force of anterior tilt on the pelvis at the hip joint. This would have two undesired effects. The first is that any movement of the pelvis would decrease the strength and range of motion of flexion of the thigh. The second is that anterior tilt of the pelvis would result in an increased lordosis of the lumbar spine, causing increased compression on the lumbar facet joints and narrowing of the intervertebral foramina.

To prevent the pelvis from anteriorly tilting, a stabilization force of posterior pelvic tilt is needed. This is usually accomplished by contraction of the anterior abdominal wall musculature. *Figure 3* demonstrates an example of this mover/stabilization coordination pattern in which the tensor fasciae latae (TFL) is the mover of thigh flexion and the rectus abdominis acts to stabilize the pelvis.

Shoulder Girdle Stabilization

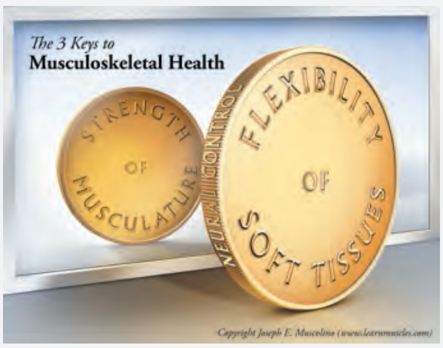
Just as movement of the thigh at the hip joint requires stabilization of the

Pilates and Core Stabilization

Although Pilates is a comprehensive method of body conditioning, it is probably best known for its emphasis upon core stabilization patterning and strength. Whereas classic fitness training is usually focused on the ability of the extremities to work against resistance and move large weights, the Pilates instructor focuses more on the core of the body while the extremity is working. For example, in the mat exercise known as *Leg Circles,* the client lies in a supine position and moves the thigh in circles. Although movement of the thigh is important, the Pilates instructor is more concerned with the client's ability to engage stabilization musculature of the core to isometrically contract and hold the pelvis stable. Indeed, during almost every Pilates exercise, the primary concern of the instructor is the quality of the coordination between the mobility and stability muscles. There is an old saying in the world of Pilates that manifests this emphasis on the quality over quantity of motion when performing exercise: *"It is not how many; it is how."* (Above: Photographs courtesy of Simona Cipriani, The Art of Control Pilates.)

The Three Keys to Neuro-myo-fascio-skeletal Health

Although there are many factors that are important to the health of our myofascial and skeletal tissues, stability and mobility are likely the two most important. Flexibility of all soft tissues is necessary for mobility of the body; and strength of musculature, not only for movement but also for joint stabilization is also of paramount importance. The other factor that is crucial is proper neural control by the nervous system to co-order (i.e., co-ordinate) all of these muscular contractions for healthy posture and movement patterns. The importance of these three concepts can be shown with the depiction of a coin placed in front of a mirror. *Flexibility of Soft Tissues* is seen on one side of the coin; *Strength of Musculature* is seen in the mirror on the other side; and *Neural Control* is seen on the edge. (Figure courtesy of Joseph E. Muscolino)



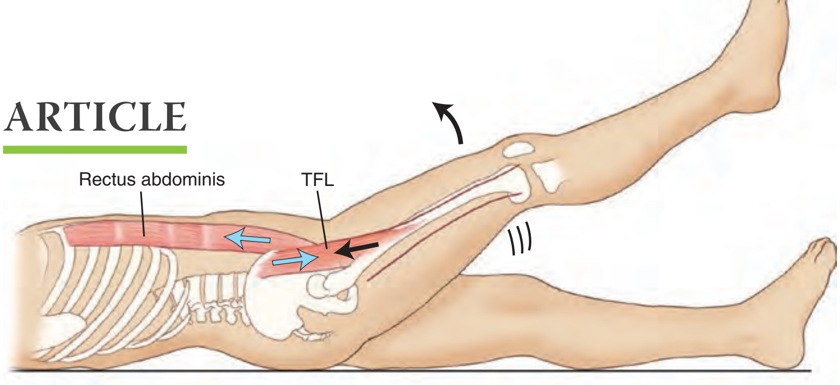


Figure 3. Pelvic stabilization. A, When the tensor fasciae latae (TFL) contracts as a mover to flex the thigh at the hip joint, it also pulls the pelvis into anterior tilt. B, The rectus abdominis contracts as a stabilizer to create a force of posterior tilt upon the pelvis to prevent the TFL from anteriorly tilting the pelvis. (Muscolino, JE. Kinesiology: The Skeletal System and Muscle Function, 2ed. Elsevier.)

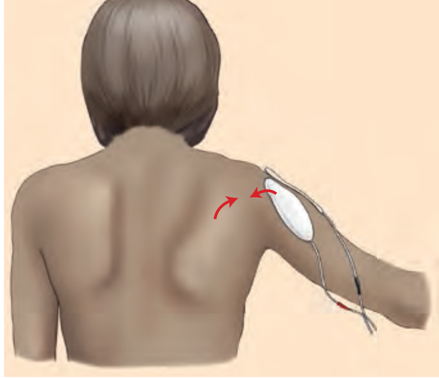


Figure 4. Electrical muscle stimulation (EMS) pads are placed on the deltoid. When the EMS pads are turned on, the contraction of the deltoid can be seen to both abduct the arm and downwardly rotate the scapula. (Muscolino, JE. Kinesiology: The Skeletal System and Muscle Function, 2ed. Elsevier. Inspired by Neumann, DE. Kinesiology of the Musculoskeletal System: Foundations for Rehabilitation. Elsevier.)

The scenario in *Figure 3* can be easily felt on yourself. Lie down on the floor, place your palpating hand on your rectus abdominis, and then flex the thigh at the hip joint. The rectus abdominis will be felt to engage to stabilize the pelvis. (Figure courtesy of Joseph E. Muscolino)

pelvic girdle, movement of the arm at the glenohumeral (GH) joint requires stabilization of the shoulder girdle. Most muscles that attach onto and move the humerus have their proximal attachment on the scapula or clavicle. Therefore, for the distal arm attachment to move efficiently, the proximal shoulder girdle attachment must be stabilized. For example, if the middle deltoid contracts to abduct the humerus at the GH joint, the deltoid would also exert its pull onto the scapula, pulling it into downward rotation. *Figure 4* demonstrates an isolated contraction of the deltoid musculature using electrical muscle stimulation (EMS) pads. The posture of the scapula can be visualized by noting the orientation of the medial border of the scapula. In *Figure 4,* when the EMS is turned on contracting the deltoid, as expected, the arm is seen to abduct; but the scapula is also seen to downwardly rotate as evidenced by the change in angulation of its medial border.

Allowing the scapula to downwardly rotate will decrease the strength and efficiency of the arm motion; it will also cause a pinching of the supraspinatus tendon and subacromial/subdeltoid bursa as the acromion process of the scapula and head of the humerus approximate each other. To prevent this downward rotation of the scapula from occurring, the nervous system would have to co-order an upward rotator, such as the upper trapezius. *Figure 5* demonstrates an example of this mover/stabilization coordination pattern in which the deltoid is the mover of arm abduction and the upper trapezius acts to stabilize the scapula and clavicle.

Wrist Stabilization

When the flexor digitorum superficialis and/or profundus muscles contract to flex the fingers to grip an object or make a fist, they also cross the wrist joint anteriorly and create a force of flexion of the hand at the wrist joint. Therefore, they should flex the wrist joint as they flex the fingers. However, we rarely want wrist joint flexion to accompany finger flexion because of the resultant weakness of the grip (try fully flexing the wrist joint and then flexing the fingers to make a fist; the weakness of the fist will be immediately apparent).

To stabilize the wrist joint, the extensor carpi radialis brevis (ECRB) is usually engaged. Its force of wrist extension will prevent the finger flexor musculature from flexing the wrist. As a result, the wrist remains in anatomic position and the grip/fist strength is preserved *(Figure 6)*. An understanding of this mover/stabilization coordination pattern helps us understand why tennis elbow, in other words, lateral epicondylitis/epicondylosis (the proximal attachment of the ECRB is onto the lateral epicondyle of the humerus) often occurs as a result of chronic gripping and holding of objects.

Pisiform Stabilization

Even a bone as small as the pisiform requires stabilization. The abductor digiti minimi manus (ADMM) muscle attaches proximally to the pisiform and distally to the proximal phalanx of the little finger. When we contract the ADMM with the intention of abducting the little finger, we need to stabilize the pisiform, to prevent it from being pulled distally, so that all of the force of the ADMM can be exerted on the little finger (and so that the pisiform is not dislocated/subluxated). The stabilizer muscle that works with the ADMM is the flexor carpi ulnaris (FCU). Its contraction can be palpated and seen; and in fact, is a good way to locate and palpate the FCU *(Figure 7)*. Abduct the little finger and look for the contraction of the FCU; its contraction can usually be seen at its distal tendon, more proximally at its belly, and at its proximal tendon near the medial epicondyle of the humerus. Once seen, now palpate for its contraction while the little finger is abducting.

Humeral Head Stabilization

Every stabilization example thus far has involved stabilization of the proximal attachment of a mover muscle so that movement of its distal attachment is facilitated. But stabilization can also be important to fix one end of a bone while the other end of the same bone moves. An excellent example is rotator cuff stabilization of the proximal end of the humerus while the distal end of the humerus moves. Whenever the distal end of the humerus needs to be elevated, which from anatomic position occurs with flexion, extension, abduction, and adduction, the head of the humerus needs to be held down into the glenoid fossa of the scapula. This prevents the head of the humerus from being lifted up and banging into the acromion process above, and also increases the efficiency of the movement of the distal humerus. For example, when the deltoid contracts to abduct the humerus, its line of pull would pull the head of the humerus straight up into the acromion *(Figure 8A)*.

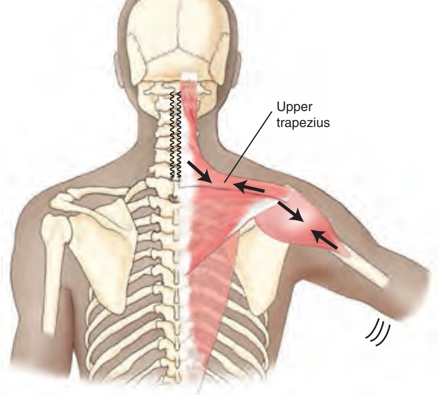


Figure 5. The upper trapezius contracts as a stabilizer to create a force of upward rotation upon the scapula to prevent the middle deltoid from downwardly rotating the scapula. (Muscolino, JE. Kinesiology: The Skeletal System and Muscle Function, 2ed. Elsevier.)

Figure 6. When flexing the fingers to make a fist, the extensor carpi radialis brevis is engaged as a stabilizer to prevent the wrist joint from flexing. (Muscolino, JE. The Muscle and Bone Palpation Manual: With Trigger Points, Referral Patterns, and Stretching. Elsevier.)

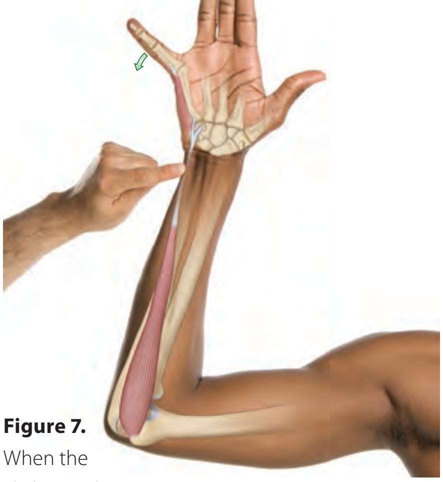


Figure 7. When the abductor digiti minimi manus muscle contracts to abduct the little finger, the flexor carpi ulnaris muscle contracts to stabilize the pisiform. (Muscolino, JE. The Muscle and Bone Palpation Manual: With Trigger Points, Referral Patterns, and Stretching. Elsevier.)

To prevent this, the rotator cuff group contracts to hold the head down, allowing the deltoid to rotate the distal end of the humerus up into abduction around the fixed head *(Figure 8B)*. Indeed, without rotator cuff stabilization, deltoid contraction would create an impingement syndrome, pinching and injuring the supraspinatus tendon and subacromial/subdeltoid bursa between the head of the humerus and the acromion process of the scapula.

Body Wide Stabilization

All stabilization examples discussed thus far are fairly local in scope, playing out at an attachment of the mover muscle that is contracting. However, the concept of stabilization can be widened out to encompass stabilization contraction at locations far distant in the body and even contralaterally on the other side of the body from where the contracting mover musculature is located. In an electromyography (EMG) study, patterns of stabilization contraction were examined in a person who flexed an arm at the GH joint. As the arm lifts up into flexion, the center of weight of the body shifts anteriorly and laterally, destabilizing it toward falling forward and to the side where the arm is lifted. In response to this destabilization of the body's center of weight, it was found that the first musculature in the body to contract when the arm is lifted into flexion is the contralateral hamstring group, engaging to prevent the body from falling into flexion and contralateral (opposite-side) lateral flexion *(Figure 9)*.

From these examples, it is clear that engagement of musculature for stabilization is an essential aspect of musculoskeletal coordination. Countless examples can be found of the mover/stabilization relationship. When we first learn muscles by studying their mover actions, it can create a false impression that a muscle or muscle group contracts in isolation to create movement of the body; this is rarely true. Movement at one joint is usually part of a much larger pattern of muscular engagement that can spread far and wide throughout the body. This can have important consequences for our health. Becoming aware of the role of stabilizer muscles facilitates our recognition of larger body-wide patterns of muscular contraction that occur throughout the body and can improve our assessment and consequent treatment success.

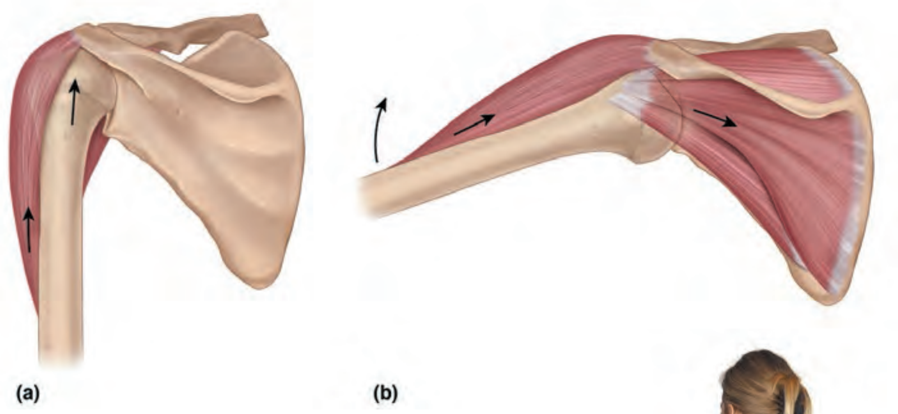


Figure 8. Stabilization of the humeral head by the rotator cuff musculature. A, The effect of an isolated contraction of the deltoid upon the humerus would be to pull the head of the humerus into the acromion above. B, Accompanied by rotator cuff contraction, the head of the humerus is stabilized down into the glenoid fossa while the deltoid lifts the distal end of the humerus into abduction. (Figure courtesy of Joseph E. Muscolino)

Figure 9. When the arm is lifted into flexion, the first musculature in the body to contract is the contralateral side hamstring group, engaging to stabilize the body from losing balance and possibly falling. (Figure courtesy of Joseph E. Muscolino)