Plyometrics, or "stretch-shortening" exercises, increase power, improve coordination, and accommodate the body to explosive movements and forces. The purpose of this article is to demonstrate application of this technique to the trunk.

The trunk includes the thorax, rib cage, abdomen, spine, and shoulder and pelvic girdles. These anatomical components are "links" in the multijoint chains of kinematic and kinetic events that occur with whole-body movements. The stable but flexible trunk acts as a base for reciprocating, skilled-limb actions such as walking, running, jumping, throwing, and lifting. The stabilizing muscles of the trunk should therefore be addressed before the prime movers of a limb (Jones & Trowbridge, 1998). This concept is called "dynamic stability" (Sullivan et al., 1982) or "core stability."

Muscles can be broadly categorized into two groups, postural and phasic. Postural muscles stabilize the body against gravity. Phasic muscles are the prime movers that explore and manipulate the environment. Postural muscles of the trunk include the hamstrings, erector spinae, iliopsoas, tensor fascia latae, upper trapezius, levator scapulae, suboccipital muscles, sternocleidomastoid, latissimus dorsi, and the pectoralis group. Antagonist to these are the phasic muscles of the trunk: the gluteal group, rectus abdominis, abdominal obliques, quadriceps vasti group, middle and lower trapezius, rhomboids, serratus anterior, and the deep flexors of the cervical spine (longus capitis, longus colli).

With musculoskeletal pathology, postural muscles often become tight or hyper-facilitated while phasic muscles become weak or inhibited (Bronner, 1997). Thus, phasic muscles need to be strengthened or facilitated more than stretched or inhibited. The postural muscles, on the other hand, need to be inhibited to allow proper movement to occur. Plyometrics are a dynamic way to facilitate the weakened phasic muscles, which reciprocally inhibit the tightened antagonistic postural muscles.

**Assessment**

Athletes should undergo a physical screening before beginning plyometrics, since the exercises are vigorous and often work at the end of the available range of motion. Flexibility and range of motion should be assessed since plyometrics are ballistic and might move a muscle too, or beyond, its static limits. Tight postural muscles may require stretching before one can begin plyometric exercises.

The athlete should have enough strength for moderate to high loads with standard weightlifting exercises such as bench press, squats, and deadlifts. Moderate to high load for bilateral upper extremity exercises (e.g., push-ups, chin-ups, dips) is 50 to 80% of body weight. In addition, rapid closed-chain
exercises with moderate loads should be possible before attempting plyometrics. An example would be 5 power squats in 5 seconds with 60% of body weight (Chu, 1992). Basic athletic activities such as running, jumping, and throwing should be pain free.

Any plyometric exercise that is painful should be discontinued until the cause of the pain is determined. Causes of pain during plyometrics include tissue inflammation, poorly conditioned muscle, load or intensity intolerance, poor coordination, improper technique, and fatigue.

Consider whether the athlete is using plyometrics for rehabilitation or to enhance conditioning. The injured athlete may use plyometrics during rehabilitation to simulate sport movements and forces. Healthy athletes can benefit from plyometrics for the trunk as one component of a conditioning program. A weak trunk (unstable under a load), poor coordination, and sport-specific skills training are all indications for plyometric conditioning.

Static and dynamic control of the phasic trunk muscles should also be assessed through a few simple tests which identify weak phasic muscles so the athletic trainer or therapist can apply the appropriate plyometric exercises. During the repeated sit-to-stand test, excessive lumbar spine flexion and extension rather than the use of hips and knees indicates weak gluteals, quadriceps, or abdominals. If hip extension in prone is accompanied by lumbar spine extension or an anterior pelvic tilt, this means the gluteals are weak and the iliopsoas is tight.

Tight iliopsoas and erector spinae and weak gluteals also prevent the normal lumbar lordosis from flattening during standing trunk flexion. Similarly, the lordosis should become more pronounced during standing trunk extension. Weak abdominals and a tight iliopsoas place the lumbar spine near its end-range of extension during resting posture, making further extension impossible.

In the upper body, scapular winging or excessive lateral scapular excursion during bilateral 5-lb dumbbell flexion and abduction indicates overactive upper trapezius and weak serratus anterior and lower trapezius. Scapular winging during push-ups also indicates serratus anterior weakness. Hip or lumbar spine motion during push-ups indicates weak abdominals.

In the supine position, if the athlete cannot touch the chin to the upper sternum without raising his or her head from the surface, this means the suboccipital muscles are tight and the deep neck flexors are weak. Finally, arching of the lumbar spine during bilateral shoulder flexion to 180° in supine indicates tight pectorals or latissimus dorsi, which is linked with weak rhomboids and middle and lower trapezius. Again, once weak muscles are identified, they can be addressed with the appropriate exercises.

**Exercise Principles**

Plyometric equipment ideally includes: adjustable height jump boxes (8–42 in.), weighted medicine balls, large rubber exercise balls (12–30 in.), barriers 6 to 30 inches high (cones, hurdles, etc.), dumbbells, rubber tubing, and an angled trampoline for rebounding weighted balls. A knowledgeable training partner is usually present.

Tissues adapt to the stresses placed on them, so the functional activities and demands of the athlete’s sport should be replicated. Exercises should be selected to address the physical needs and goals of the individual athlete: jump exercises address weight-bearing intolerance; throwing weighted balls reproduce rotary and acceleration-deceleration loads; reaction-coordination exercises promote speed, skill, and agility.

All exercises are performed continuously, but only to the point of fatigue, at which proper movement and muscle recruitment can no longer be maintained. This will differ for each athlete, so simply assigning a specific number of repetitions for a given exercise would not be appropriate. Rather, begin with a single timed set of each exercise. To be effective, the exercises should be progressed periodically with respect to resistance, duration, and difficulty.

When proper technique is maintained for the original duration, then the number of sets, time of performance, or intensity (speed or resistance) is increased. Progress can then be easily monitored. Usually only 3 or 4 plyometric exercises are done in a single workout before fatigue becomes a factor. Exercises may be alternated between days to prevent boredom or to work different muscle groups or skills. Proper technique is more critical than duration—quality before quantity.

The following exercises are representative of plyometrics for phasic muscles of the trunk. Additional