

Muscle Contraction  
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Off The Road Column

Muscle contraction is one of those things you never think about, you just do it. But if you were to pay close attention you are contracting muscles all the time. The simple fact that you can read this page is due to the contraction of the small muscles that control the movement of your eyes that allow you to scan the page while at the same time focus your eyes.

Posture, circulation, ambulation, digestion, even relaxation are all the result of some form of muscle contraction. In sport muscle contraction is the thing that makes for a competitive effort. The ability to run fast, jump high or throw far are all the result of muscle contractions.

All this is pretty basic and probably common knowledge but what most people don't know or don't appreciate is that there are actually several types of muscle contractions that should be addressed in a comprehensive training program. This more well rounded the development will allow one to practice and compete more safely.

There are at least four types of commonly recognized muscle contractions that a muscle is capable of performing: concentric, eccentric, isometric and isokinetic. Individually we'll take a look at each type of contraction, discuss its application and ways which the contraction can be trained

Were you to ask someone to describe a muscle contraction a very common description would be the example of the dumbbell curl. As the weight is lifted from the legs to the chest the biceps muscle makes a concentric or shortening contraction. (figure 1)

Concentric contractions are how we generate power, accelerate our bodies or objects and oddly, the weakest contraction. Weakest? While you wouldn't ordinarily think that comparisons with the other types of contractions with regards to the number of muscle fibers involved revealed that concentric contractions ran last to all the rest.

The next type of muscle contraction, which actually initiates no action, is an isometric contraction. Isometric training has fallen out of favor over the last 30 years. As our society made a transition towards developing "aerobic qualities" strength work and in particular isometric training fell from favor. Why did this happen? Isometric training does not significantly develop the cardio-vascular system. Since that was the major emphasis championed by people like Kenneth Cooper and his numerous best-sellers isometric training came to be seen as having little value, or even dangerous.

But isometric work is critical from the standpoint of the strength and functional integrity of the tendons, ligaments and joint capsules. Collectively these soft tissues are referred to as the "holding elements" of a joint. Tendons and ligaments become stronger with stress and the stress that makes them stronger is an isometric contraction.

The difficulty many people have with isometric contractions is there is no *apparent* movement. How is there a contraction if there is no movement? Note the word *apparent*. When we initiate a biceps curl there are receptors that register how much force is necessary for us to move the weight. These receptors register this information in a split second by performing an isometric contraction. Once the body “understands” how much force is necessary to curl the weight a concentric contraction begins and the weight is lifted.

The isometric contraction serves two purposes. First it stabilizes the joint so that secondly, the concentric contraction is more efficient. Without this isometric contraction any lifting action would jerk start the muscle movement potentially creating microtears (or even tendon rupture) to the holding elements. An unchecked “springing” action of the weight to the chest, in a biceps curl, would also create maximum joint flexion at the elbow, potentially damaging that joint.

Bottom line isometric contractions are strong and necessary and can be used very efficiently to rehabilitate injured joint capsules. Athletes who commonly suffer from tendon-type injuries could probably benefit from some additional isometric work.

Once the barbell has been curled up it must be lowered to the start position. The lowering of the barbell is an eccentric contraction or lengthening contraction. At first look a lengthening contraction seems to be a contradiction of terms. Generally something that contracts shortens but eccentric contractions maintain muscle tension while the weight is returned to the start position. (figure 2)

Eccentric contractions are decelerating contractions and are the strongest of all contractions and use the most energy. Body builders and power lifters commonly emphasize this type of lifting and call it “negatives” or negative work. The thought is with eccentric work that strength in this movement will contribute or allow for greater strength or force application with the other contractions that make-up the movements of a joint.

Interestingly most muscle injuries occur during the eccentric phase of muscle contraction. In a full out sprint the legs, particularly the hamstring muscles, have to move the high from 0mph to 50+mph to 0mph four to five times per second. If there is the slightest imbalance or in-coordination between the quad and hamstring symmetrical technique can quickly unravel leading to a hamstring strain or pull during the eccentric phase.

Isokinetic training is easily the least used because it needs a special machine for each muscle to be strengthened. That can get expensive, even for an exclusive gym. The machine needs to register and control speed and force. The faster the movement is performed, the greater the force produced and the greater the resistance of the machine.

Isokinetic training can be an effective late rehabilitation modality to signal a readiness to return to play. Used too soon it can damage the ligaments, muscles and tendons and necessitate a return to square one or in some instances prematurely end a career.

The sequence of muscle contraction is that of isometric-concentric-eccentric as a muscle cycles through the actions necessary to produce movement or force. A training goal, that few seem to pay much attention to, is that there should be a seamless transition from one phase to the next.

In truth one's ability to seamlessly flow from one contraction to the next is coordination in its purest sense. While the incidence of injury is very low with our biceps curl example the contraction series of the quads and hamstrings at top end speed of 4-5 strides per second for 10 seconds or more is problematic. Loss of this coordination is akin to the childhood days of running down a small hill with reckless abandon. While the coordination lasts there is a thrill of movement and speed. When the coordination was lost, soon followed by the inevitable fall the thrill was gone.

While muscle contraction will remain one of those invisible mysteries for many the understanding of what is happening and the appreciation for the role of each contraction helps make for the design of preventive exercise programs. Implementation of different exercise programs can provide a fundamental preventive foundation from which performance based efforts can blossom.



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