The javelin throw: a kinesiological analysis with recommendations for strength and conditioning programming

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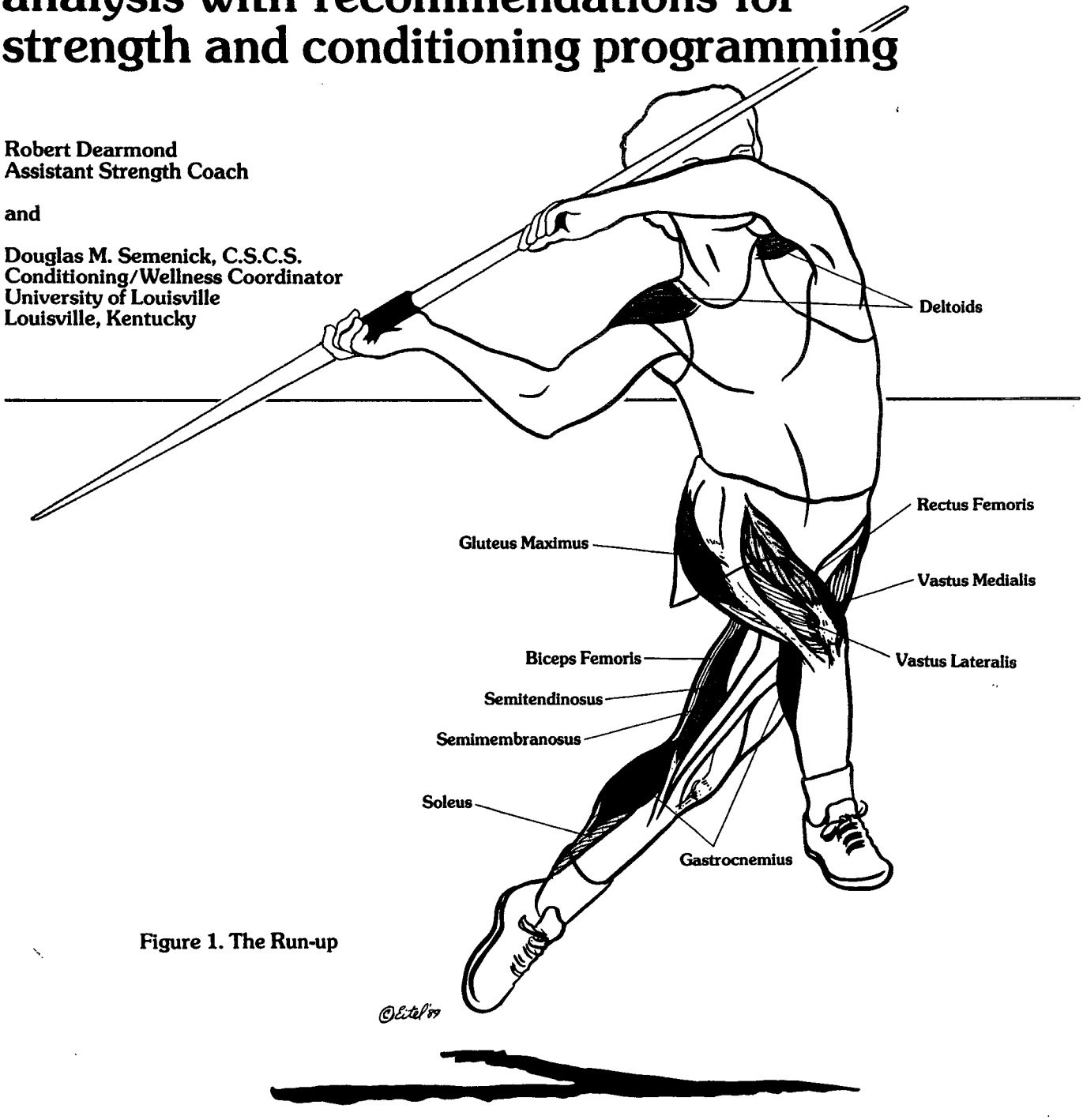

Figure 1. The Run-up

In the javelin throw, the human body is called upon to acquire momentum, produce torque, and ultimately to transfer momentum of effort to attain maximal displacement of the projectile. The distance of the throw is determined by the height and angle of the release point in adjunct to angular velocity of the javelin at the instant of release. A high release point in relation to the runway (with an angle of release not to exceed 45 degrees to the horizontal), and near-maximal force imparted to the projectile will afford the javelin more time in flight before it must succumb to the forces of gravity. Clearly, the taller, more powerful thrower will have a physical advantage over a shorter, less powerful opponent.

For analytical purposes, the javelin throw is generally discussed in terms which illustrate four discernible phases: the run-up, the withdrawal, the crossover, and the throw and follow-through. The point of reference is the thrower, who is assumed to be right-handed.

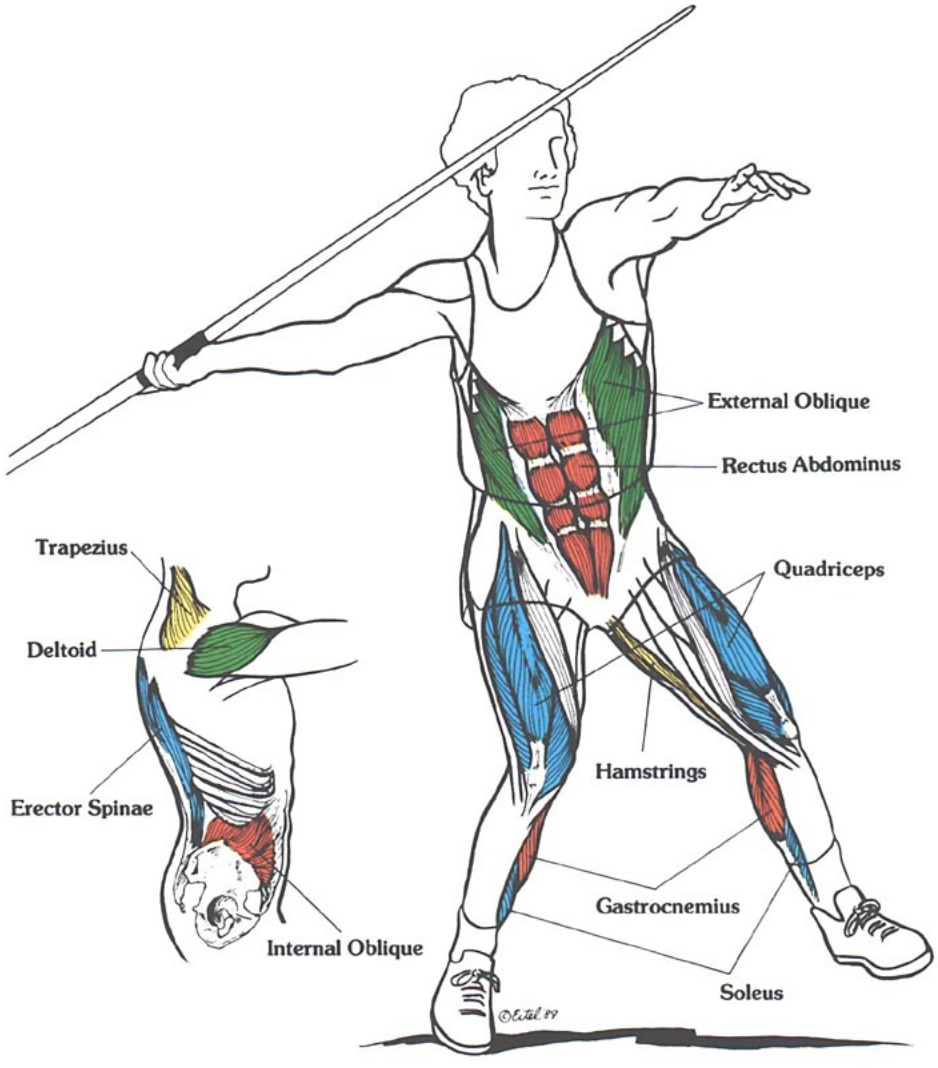

Figure 2. The Withdrawal

The Run-up Phase

The run-up (**Figure 1**) is comprised of the initial 10 to 12 steps of the approach, which allows the athlete to acquire momentum. The javelin is carried next to the head, horizontal to the runway. The stride should be somewhat relaxed and balanced, gradually accelerating into a horizontal speed governed by the thrower's ability to maximize transfer of momentum to the projectile.

The Withdrawal

To place the body in a more favorable position to make the throw, the athlete laterally flexes and rotates the trunk and drops the javelin back to a "cocked" position (**Figure 2**). Concentric contractions of the left external oblique, right internal oblique, erector spinae (right side), and quadratus lumborum (right side) initiate lateral flexion and rotation to the right. Simultaneous with trunk movement, horizontal hyperextension of the humerus and full extension of the forearm are controlled by the posterior deltoid, posterior fibers of the middle deltoid, the rhomboids, the infraspinatus, and the teres minor muscles as prime movers; assuming this position increases the range and time which the thrower can exert his forces upon the javelin. Furthermore, the

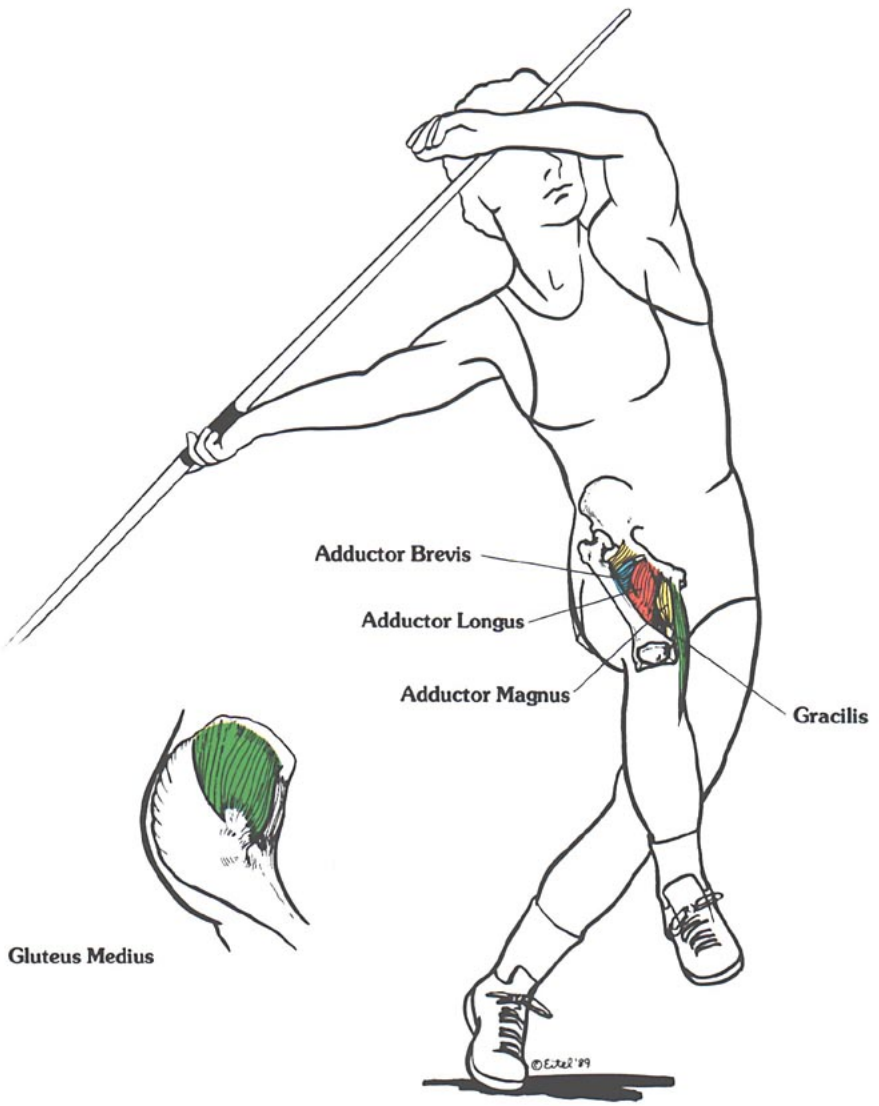

Figure 3. The Crossover

muscles that are prime movers for the throwing action are placed on a partial stretch in preparation to store elastic energy produced when an eccentric contraction immediately proceeds a concentric contraction.

The Crossover

The crossover begins on the third of the final three steps with inward rotation of the left foot to place the lower extremities in a more favorable position to cross-step and, ultimately, to impart force to the projectile. The athlete propels the body horizontally, with the gracilis, adductor magnus, adductor longus, and adductor brevis contracting concentrically to hyperadduct the right leg while airborne (**Figure 3**). The thrower should avoid any vertical propulsion during the crossover to maintain horizontal velocity, thus conserving momentum. Simultaneous with the crossover action of the lower extremities, concentric contraction of the left deltoid abducts the left arm approximately 100 degrees in the frontal plane where the position is fixed, resultant to static activity of the deltoid. The right foot touches down as the athlete's center of gravity shifts to the right leg.

The Throw and Follow-through

Beginning with the touchdown of the right foot, subsequent to the crossover, the right leg drives hard as the soleus, gastrocnemius, tibialis posterior and plantaris concentrically contract to initiate strong plantar flexion of the right foot as the body begins to produce torque and transfer momentum to the projectile. The trunk laterally flexes and rotates to the right an additional five to 10 degrees, the erector spinae contracts to hyperextend the spine, and horizontal hyperextension of the right humerus is increased slightly. The prime movers of the throwing action undergo eccentric contractions to store

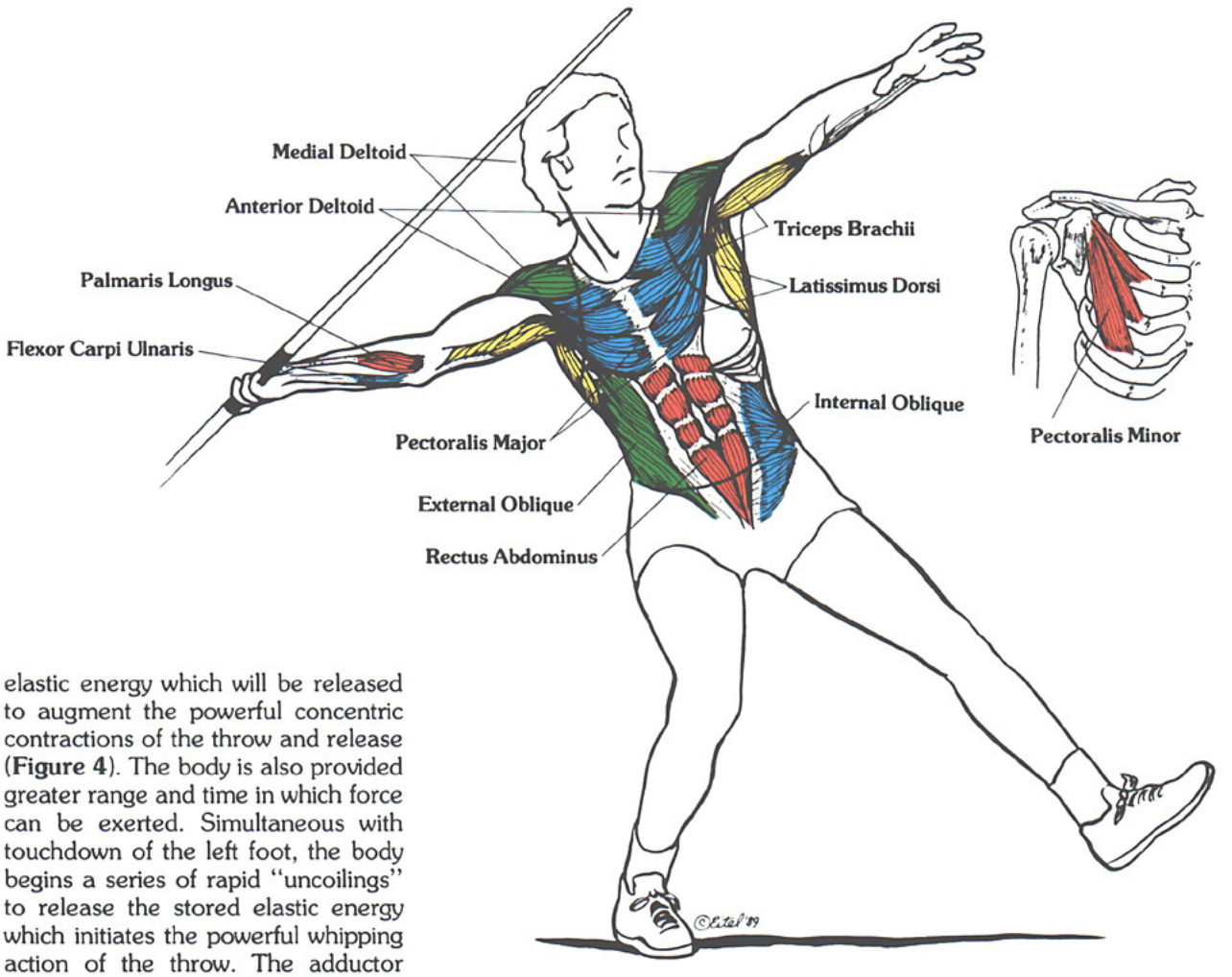

Figure 4. The Throw and Release

elastic energy which will be released to augment the powerful concentric contractions of the throw and release (**Figure 4**). The body is also provided greater range and time in which force can be exerted. Simultaneous with touchdown of the left foot, the body begins a series of rapid "uncoilings" to release the stored elastic energy which initiates the powerful whipping action of the throw. The adductor group of the right femur undergoes concentric contractions to evoke medial rotation of the right leg, consequentially providing additional speed to the explosive rotation and flexion of the hips as derived from concentric contractions of the obliques, erector spinae, rectus abdominus, rectus femoris and quadratus lumborum. Strong concentric contractions of the latissimus dorsi rapidly adduct the left arm to assist in the forward shift of the body's center of gravity. Powerful concentric contractions of the pectoralis major, anterior deltoid, latissimus dorsi, teres major and subscapularis muscles, with some assistance from the short head of the biceps brachii, inwardly rotate and diagonally flex the throwing arm, thus augmenting angular velocity of the forward moving javelin. The semitendinosus, semimembranosus, biceps femoris (long head), gluteals and the rectus femoris, vastus lateralis, vastus intermedius and vastus medialis extend the hip and knee, respectively, to add torque, increase height of release point, and ultimately to assist in dissipation of momentum. The palmaris longus and flexor carpi ulnaris contract concentrically to flex the wrist, thereby completing transfer of momentum to the projectile.

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