

An anatomical and biomechanical analysis of the full golf swing

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The full golf swing is the primary foundation upon which all other golf swings are based. It is the swing most often used when teeing off or hitting long shots from the fairway. The primary objective of a golfer executing the full swing is to produce maximum distance, accuracy, control, and consistency in each golf shot. All movements of the body must be made in a sequence, and at a pace which allows the golf club to be swung in a rhythmic motion in the simplest possible arc, and on a path that produces on-center hits and maximum club head speed without great effort.

Mechanical Analysis of the Full Swing

The full swing consists of three major phases. These are: 1) the preparation phase which consists of the grip, posture, stance, and ball position, 2) the execution phase (ie: backswing and downswing) and 3) the recovery or follow-through phase. The following analysis is for a right-handed golfer who is executing a drive for maximum distance and accuracy.

Preparation Phase

The Grip

The grip is the foundation of a good golf swing. Its primary purpose is to insure that the hands and wrist work together in order to transfer the force generated by the body and leg actions during the swing to the ball.

There are three grips commonly

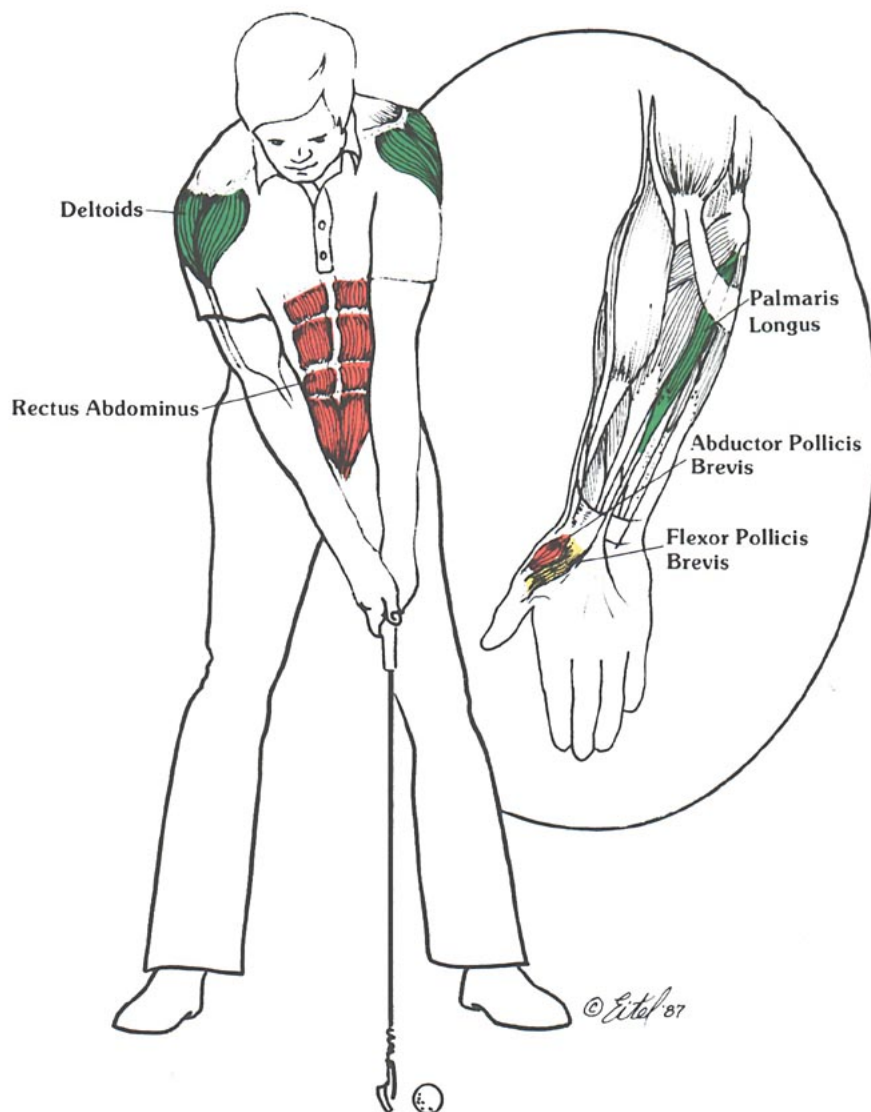


Figure 1. Major Muscles Used When Gripping a Golf Club

used by golfers: the Vardon (overlapping), the ten finger and the interlocking. The difference between these three grips involves the placement of the little finger of the right hand and the index finger of the left hand.

It is interesting to note that the research suggests that no one grip has a significant advantage over the others with respect to the distance and accuracy of shots of beginning golfers (13).

Whether the golfer chooses the overlapping, interlocking, or ten finger grip, the basic fundamental principles are the same for all three grips.

When gripping the golf club, the back of the left hand and the palm of the right hand must face the target. The club is held in the palm and the fingers of the left hand. The club is held primarily by the last three fingers of the left hand. The thumb is placed slightly right of center of shaft. A "V" is formed by the index finger and thumb. This "V" should point to the right shoulder. The left hand is the support hand and provides the strength.

The right hand applies the hit. The right hand grip is taken more in the fingers than the left hand. The middle two fingers apply the greatest pressure; this ensures greater control and feel. The thumb and index finger close around the shaft so that they gently touch each other. The hands must be kept firmly together, but not rigid, and properly aligned with the club face. The major muscles used in gripping the club are presented in **Figure 1**.

The Stance

The set-up provides the basis of movement. It is the only aspect of

the swing in which the golfer has 100 percent conscious control.

When in the golf stance, key considerations must be given to posture and balance. It is largely believed that in golf the entire sequence of movements a golfer generates rests upon his feet. That is, how the golfer places his feet is closely linked with the way he generates power to swing the golf club (1). For example, if the width of the stance is too wide, turning freely and fully becomes difficult. The golfer is restricted from using his hips to generate maximum power (1). If the stance is too narrow, the golfer lacks stability and balance. This position prevents the full use of the leg drive as a source of power to produce lateral movements of the hips and lower torso (1).

The ideal foot placement in the stance appears to be accomplished by setting the insides of the heels approximately shoulder width apart (10, 11). The golfer's weight should be distributed evenly over both feet during the address. To maintain balance, the golfer must keep his center of gravity within and directly above his support base. Balance can be improved by learning to relax; excessive tension must be avoided during the preparation phase (12).

The golfer's knees must be slightly flexed in the preparation phase. This lowers the golfer's center of gravity which in turn increases his balance by placing the center of gravity closer to his base. Slightly flexing the knees also enables the golfer to: 1) produce greater torso rotation, 2) place the leg extensor muscles on stretch, 3) flatten the swing arc (ie. increase the number of impact areas), and 4) gradually absorb force during the follow through (12). See **Figure 2**.

Stance Alignment

The posture and alignment the golfer assumes when addressing the ball directly affects the plane of swing and the club head pathway. Alignment influences the golfer's ability to rotate properly, transfer weight and maintain good balance during the swing (8).

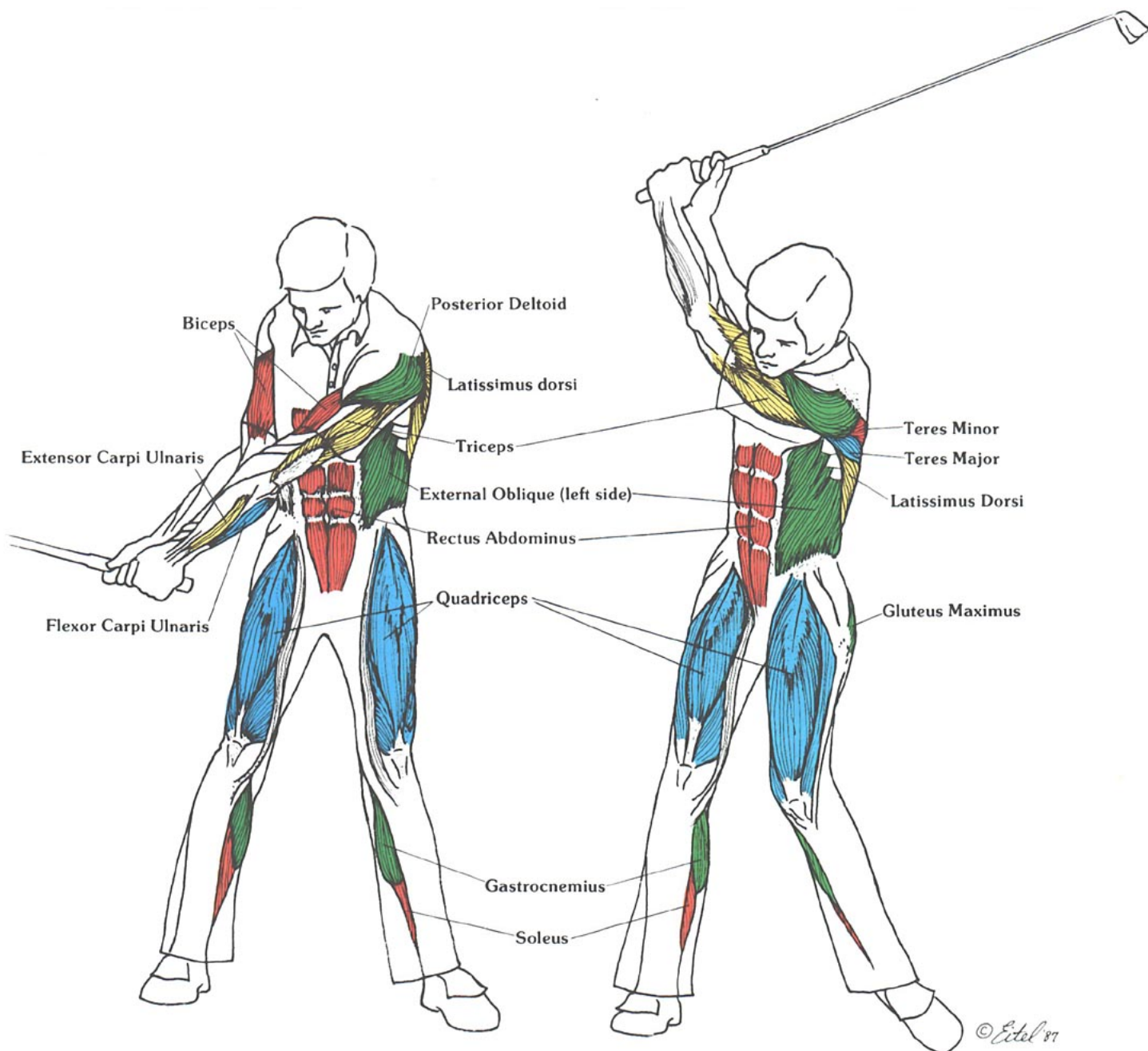
To assume the correct stance, the golfer draws an imaginary straight line through the ball to the target (i.e., target line). The golfer then aligns himself so that his feet, hips, and shoulders are parallel to the target line. While in this position, the feet are shoulder width apart, knees slightly flexed, the back is straight (to enhance trunk rotation) and the hips should be slightly rotated forward. Slightly rotating the hips forward assists in facilitating a more upright swing and allows the arms to swing through more freely.

The golfer's left arm must be straight while the right elbow is slightly flexed and held closely to the side of his body. A straight left arm enables the golfer to increase the speed and range of motion through which the club head may move. Bending the left arm results in varying the length of radius which decreases the possibility of delivering the club head to the point where the path of the descending club head momentarily coincides with the target line (i.e., location of the teed ball) (9). The club head must be soled directly behind the ball and perpendicular to the target line.

The golfer's head should be positioned directly over the ball. The eyes should focus directly either over the ball or slightly behind and on target line.

Ball Position

The basic objective in positioning the golf ball is to place it at the lowest



point of the full swing. This is accomplished by locating the ball on the left side of the target line center, and toward the left inside heel.

Execution Phase

The golf swing occurs in two planes, the plane of the back swing and the plane of the down swing. Also, the swing evolves around three dimensions: 1) vertical, the up and down movement, 2) lateral, the side to side movement, and 3) rotary, the movement around the body (5). The vertical dimension is controlled by the golfer's hands, the lateral movement is influenced by the arms,

and the rotary movement is controlled by the pivot of the body (3).

The Backswing (Figures 2 and 3)

The plane of the backswing is simply described as an angle inclination running from the ball to the shoulders. This angle is pre-determined by two factors: 1) the height of the golfer's shoulders and 2) the distance he stands from the ball at address (5). This distance is determined by how tall the golfer is and the length of the club.

The purpose of the backswing is to establish a perfectly balanced, powerful position at the top of the

swing. This is best developed by staying within your backswing plane. In the backswing the club head, the hands, and the shoulders must start in one motion. The weight of the feet in the stance is shifted laterally from the front foot to the rear foot. This shifting of weight increases the range of hip rotation (2). It also flattens the arc of the swing (12). As the weight is shifted to the back foot, lateral rotation at the left hip turns the pelvis away from the ball's flight (2).

At the top of the backswing, the shoulders are coiled, the hands are swung high, and the arms are extended. If the shoulders, arms,

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and hands follow the appropriate route of the backswing plane, it ensures that the upper body and arms will be properly inter-aligned when the swing reaches that critical point where the backswing ends and the downswing begins. In other words, by staying on his backswing plane, the golfer pre-groups his forces so that each component is correctly geared to work with the other components on the downswing. The energy of the hips, shoulders, arms and hands will be released in the correct order, and a perfect chain reaction will result (9).

In order to develop maximum acceleration in the downswing phase, the golfer can apply or develop the following principles:

1) The stretch reflex principle—when the whole muscle is stretched, the stretch of the muscle spindles causes a reflex contraction of their host muscle(s) (9). Applied to the backswing this principle gives a greater range of motion during the force phase of the movement and increases the muscle stretch. As a result, the contractile force of the muscle increases and facilitates the recoil of elastic tissue. This can also be referred to as Newton's third law (action - reaction). This principle can further be developed by increasing the flexibility of the major muscle groups. This will enable the golfer to create more coil in his upper body. The farther a person can rotate his shoulders away from his target, the farther the club head has to travel to the ball. This translates into greater club head speed and increased distance of the shot (4).

2) The greatest acceleration is at the beginning of the skill (i.e.: the top of the backswing). This is accomplished by shortening the radius (the lever arm). The golfer does this by bending his right elbow during the backswing.

The Downswing (Figures 4, 5 and 6)

The downswing is initiated by the rotation of the hips. At this point the golfer must lengthen the lever arm, which results in an increased acceleration of the club head (12). Almost simultaneously with the hip turn, a transfer of weight occurs. The weight is shifted laterally on to the front foot. This transfer of weight position flattens the swing arc which in turn increases the impact area and improves accuracy in beginners (12).

The downswing is on the same plane as the backswing and is the reaction phase of Newton's action - reaction law. Ideally, the hands and arms move the club, and the swinging of the arms turns the shoulders. When the downswing is inaugurated by the hips and the turning hips unwind the upper part of the body, the shoulders, arms and hands flow easily into the swing. This is referred to as the summation of forces principle (12).

At impact, the wrists straighten and with force produced by the trunk and other body parts, produce a maximum hitting effort. Kreighbaum and Barthels (9) reported that one researcher found the wrists to be an important factor in maintaining maximum club head velocity. This investigation concluded that the uncocking of the wrists too early in the downswing decelerated the arm motion; therefore, it decreases the angular motion of the entire swing. It would appear then that the uncocking of the wrists at the

appropriate moment of the downswing is an important mechanical element of the swing, one which cannot be overemphasized.

The Follow-Through (Figure 7)

During the recovery or follow-through phase of the golf swing maximum effort has subsided. The right arm begins to rotate and the right hand begins to climb over the left (7, 11). The golfer's head, which

Flexibility Exercises and Major Muscles Stretched		Strengthening Program	
		Frequency: three times per week (every other day) Intensity: 50-70 percent of 1RM Duration: three to five sets, eight to twelve repetitions/set	
Exercise	Major Muscles	Exercises	General Muscle Group
1. Neck Stretch	Sternocleidomastoid Trapezius Semispinalis Capitis	1. Bench Press	Pectoralis Major Anterior Deltoids, Triceps Rotator Cuff
2. *Rotator Cuff Stretch at 90°	Supraspinatus	2. Rotator Cuff - External Rotation - Internal Rotation - Elevation	
3. *Posterior Cuff Stretch	Infraspinatus Teres Minor Subscapularis	3. Lateral Arm Raise	Deltoids & Trapezius
4. Triceps and Shoulder Stretch	Rotator Cuff	4. Tricep Extension	Triceps
5. Chest Stretch:	Triceps	5. Squats (to 90°)	Quadriceps
6. Single Knee to Chest	Pectoralis Major	6. Leg Extension	Quadriceps
7. Double Knee to Chest	Hamstrings	7. Leg Curls	Hamstrings
8. Single Leg Sit & Reach	Gluteus Maximus/Minimus Hamstrings Semitendinosus Semimembranosus	8. Calf Raises	Gastrocnemius Soleus, Peroneus
9. Groin Stretch	Biceps Femoris Hip Adductors, Gracilis, Pectineus Adductor Longus, Brevis, Magnus	9. High Lat Pulldown	Latissimus Dorsi
10. Seated Torso Stretch	External/Internal Obliques Latissimus Dorsi Rectus Abdominus	10. Bicep Curls	Biceps
11. Quadriceps Stretch	Semispinalis Quadriceps Femoris Rectus Femoris Vastus Medialis Vastus Lateralis Vastus Intermedius	11. *Wrist: Extension Flexion Supination Pronation	Forearm Muscles Wrist Flexors Wrist Extensors
12. Calf/Achilles Tendon Stretch	Gastrocnemius Soleus Achilles Tendon	12. Abdominal Muscles (Bent Knees) One quarter sit-ups One quarter sit-up with rotation to opposite knees Seated knee to chest	

*Refer to Jobe, F.W., and Moynes D.R., (1986). *30 Exercises for Better Golf*. Champion Press, Inglewood, California, for a more detailed explanation.

remained stationary throughout the swing, is finally pulled up and rotated forward by the turning trunk and the momentum of the swing (7).

Although maximum effort has subsided, it is still extremely important that the golfer accelerate through impact. The reason for this is three-fold. First, it reduces the danger of decelerating at impact. Second, it decreases the possibility of injury, and finally it increases accuracy (11, 12).

Conditioning Program for Golf

Physical fitness in golf is as

important as in any other sport. However, its importance is often overlooked. A strengthening and conditioning program's objectives must be designed to improve the golfer's muscular strength and endurance, cardiovascular endurance and flexibility. A well-designed specific program of stretching and strengthening exercises will decrease the risk of injury and improve a golfer's potential to play better golf.

Warm Up

An important part of any golf program is the warm-up. Putting on the practice green or hitting a bucket of practice balls does not constitute a proper warm-up.

A proper warm-up is a period of activity which gradually takes the body from a state of rest to an optimal working condition. To be most effective, a warm-up should include: 1) activities which elevate body temperature (walking, slow jog), 2) low level calisthenics (jumping jacks, sit-ups), and 3) stretching exercises (slow static stretches). Finally, the warm-up movements can be specific to golf. Begin by swinging the golf club slowly and gradually increasing the swing speed.

Muscles which are warm and stretched out prior to teeing off are supple and loose, enabling the body to perform to its full capability.

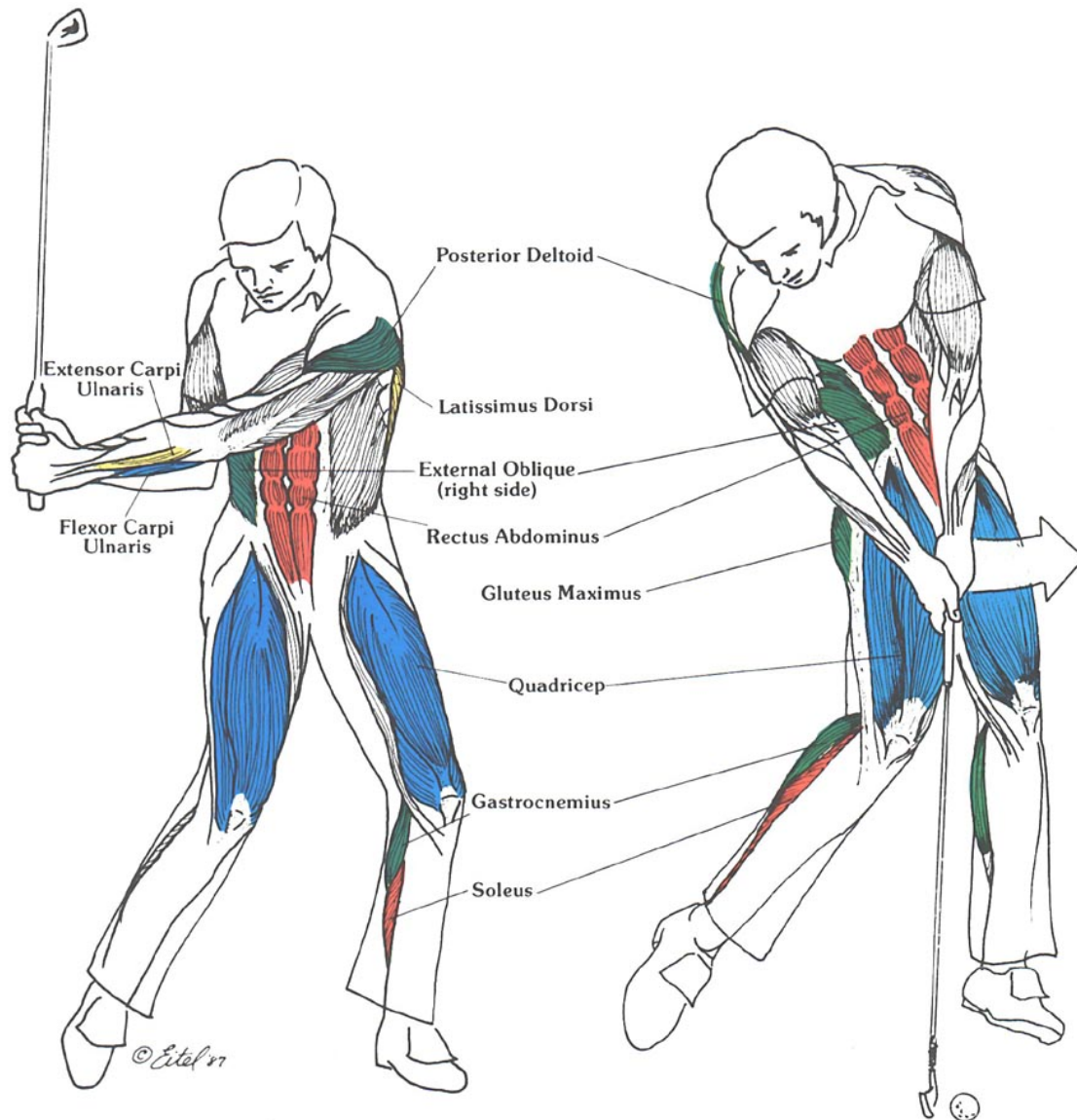


Figure 4, 5 and 6. Rely on the larger muscles of the body to generate power (summation of forces).

Flexibility Training

Within the last several years athletic coaches have started to realize the values of stretching and have increased the emphasis on stretching in their conditioning programs. Once the body has been warmed up the golfer should perform the suggested flexibility exercises following the guidelines provided.

Frequency: three to four times per week

Intensity: Point of discomfort (not pain)

Duration: Hold for 15 to 30 seconds

Use static stretching movements. Do each movement slowly and deliberately through your range of movement, don't rush or reach too far at first. ●

References

1. Cochran, A. & Stobbs, J. 1968. **The Search for the Perfect Swing**. New York: J.B. Lippincott Co.
2. Cooper, J.M. & Glassow, R.B. 1976. **Kinesiology**. St. Louis: C.V. Mosby Co., pp. 128-133.
3. Flick, J. May 1984. "How you can build a swing to fit your body," **Golf Digest**, pp. 60-65.
4. Graham, D. August 1984. "How to stretch your muscles - and your tee shots," **Golf Digest**, pp. 44-46.
5. Hogan, B. & Wind, W.H. 1957. **The Modern Fundamentals of Golf**. New York: Author.
6. Jobe, F.W., and Moynes, D.R. 1985. **30 Exercises for Better Golf**. Inglewood, CA: Champion Press.
7. Jones, Bobby, R.T. 1969. **The Basic Golf Swing**. Garden City, NY: Doubleday & Co., Inc.
8. Kirby R., and Roberts, J.A. 1985. **Introductory Biomechanics**. Ithaca, NY: Movement Publications, Inc.
9. Kreighbaum, E. & Barthels, K.M. 1985. **Biomechanics: A Qualitative Approach for Studying Human Movement**. (2nd ed.), Minneapolis, MN: Burgess Publishing Co.
10. Nance, V.L. & Davis, E.G. 1985. **Golf**. (5th ed.), Dubuque, IA: Wm. C. Brown Publishers.
11. Nicklaus, J. and Bowden, K. 1980. **Play Better Golf: The Swing from A - Z**. NY: Pocket Books.
12. Torbert, M. 1985. **Secrets to Success in Sport and Play**. Inglewood Cliffs, NJ: Prentice-Hall, Inc.
13. Wadlington, R. 1974. **A comparative study of the effectiveness for teaching beginning golf**. Unpublished master's thesis, Southeast Missouri State University, Cape Girardeau, MO.

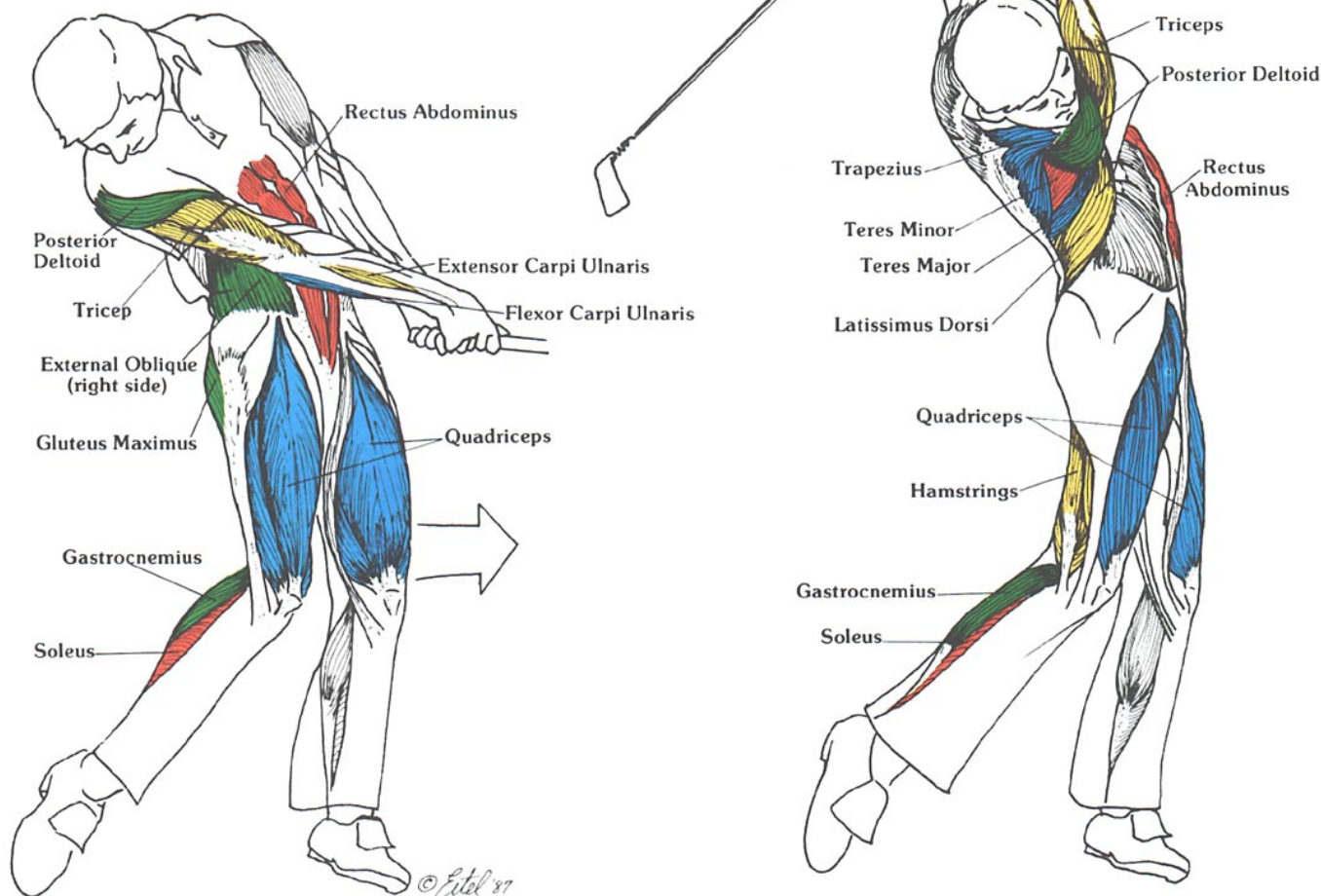


Figure 7. The Follow Through.