Chiropractic Treatment of Golf Injuries

- Approximately 30 million Americans play the game of golf.
- Inherent in the golf swing is the potential for injury to the neck, mid and low back, upper extremities, hip and knees.
- During the course of playing 18 holes, depending upon one's skill level, a golfer will take approximately 70-150 swings.
- While practicing at a golf range, a golfer may take 50-100 swings per half hour. This routine may last for several hours in one practice season.
- The golf swing requires the spine to flex, laterally bend, rotate and extend very quickly. Most golf swings take less than 1 second and the average club head speed is approximately 80-100 MPH. Tremendous kinetic energy must be generated to achieve sufficient club head speed and resultant ball flight distance.
- A study of PGA players indicated that approximately 77% of all professional golfers reported having acute or chronic low back pain from golfing.
- Most professional golfers train year round specifically to meet the demands of their sport. These elite athletes possess good to excellent golf swing mechanics. Yet a high percentage sustain low back injuries.
- The amateur golfer typically possesses less than excellent golf swing mechanics and rarely trains year round in order to golf. Therefore, it is reasonable to assume that the amateur golfer's incidence of low back injury is as high as or higher than that for the professional golfer.
- The majority of golf injuries are caused by poor swing mechanics resulting from mechanical dysfunction and physical limitations, poor posture and decreased flexibility.
- Golf injury prevention requires building a fundamentally sound golf swing, reducing golf swing faults, and performing golf specific exercise and flexibility training.
- Chiropractic care, such as spinal and extremity manipulation, passive physiotherapy and active exercise, are efficacious treatment methodologies for golf related injuries.
- The act of driving a golf ball requires tremendous muscular intensity at a given point in time. The energy required is equivalent to the power needed to lift a load that can only be lifted 2-4 repetitions before the onset of muscular fatigue or swinging at and striking a baseball causing the ball to travel 300 feet. Often times, the amateur golfer does not possess the required strength and or technique to meet the demands of playing highly competitive golf.

Spinal Posture and Golf Swing Biomechanics

- The golf swing is a compilation of static and dynamic postures.
- At address the golfer assumes a static posture at approximately 45° forward flexion with the lumbar spine in lordosis and the cervical spine in slight lordosis.
- Excessive forward flexion at address can result in repetitive spinal strain injuries.
- During the golf swing the golfers posture is dynamic. The golfer's strength, flexibility and fitness level determines their ability to maintain proper dynamic posture.
- Poor golf posture (hypo or hyper lordosis of the cervical and lumbar spines), will restrict spinal rotation and decrease club head speed. Poor spinal rotation often causes golfers to swing too fast, have an accentuated backswing and over swing resulting in repetitive strain and even disc injuries.
- Having the cervical and lumbar spines in lordosis during the golf swing allows for increased spinal rotation and increased strength and ease of movement of the spinal column.
Golf Swing Fundamentals

Grip

- Grip the club properly. The thumb and forefinger of each hand should form a V. The V's formed by the thumb and forefinger of each hand should be parallel. Typically, the forefinger of the lead hand is interlocked with the pinky finger of the trail hand. While a baseball grip may feel more comfortable to some, the baseball grip may limit your ability to hit straight shots.
- A proper grip is one in which the club is held firmly by five fingers;
  - The middle, ring, and little finger of the left hand.
  - The middle and ring fingers of the right hand. The other fingers maintain light contact with the grip for support.

Posture

Develop an appropriate static posture at address which is characterized by assuming and maintaining cervical and lumbar lordotic curves.

Setup / Address

- Let your arms hang at address.
- Your arms should hang under your shoulders and feel relaxed when you address the ball. Your hands should be closer to your body for leverage. You should be looking in at your hands, not out at them. Don't feel as if you are reaching for the ball.²

- A bad setup leads to a bad backswing which leads to trying to correct the problems on the downswing. At address, your lead shoulder should be higher than the other and your head should be behind the ball.³
Backswing

- A controlled backswing, where the hands, arms, shoulders, hips, knees and feet move in rhythm, is necessary to create the kinetic energy and smooth movements necessary to initiate the golf swing.

- Unless you possess incredible flexibility in the shoulder and hip joints and unrestricted ability of the spine to laterally flex, rotate and extend, like John Daly, a short backswing will create greater kinetic energy than a big backswing. Power is not stored in the backswing. Power is built in the backswing, and released in the downswing. Therefore a full, big, backswing is not necessary. Shortening the length of the backswing (a 1/2 to 3/4 backswing) will create greater power.\(^4\)

- In baseball, for example, a short, quick, compact swing generates greater power than a long, looping swing.

- Maximal stretching of a muscle reduces muscle cross bridging and creates less force. For example, an athlete performing a broad jump will achieve greater distance if their legs are bent at a 45º angle rather than a full squat position.

- To generate optimum force from your golf swing take a short backswing (this insures that a maximal number of cross bridges remain intact); and when going from the backswing to the downswing change directions as quickly as possible (the greater the velocity of stretch the greater the amount of elastic energy).

- Elastic Energy - In order to generate power in any movement, the muscles must be stretched. This muscle stretching creates elastic energy.

- A muscle can do more positive work if it is stretched while being activated. An example of this would be an eccentric contraction as seen in a tricep press exercise maneuver.

- An eccentric - concentric sequence of muscle activation produces a greater quantity of elastic energy than if a muscle merely experiences a concentric contraction alone. This concept is known as the stretch shorten cycle.

- As the result of an eccentric - concentric sequence of muscle activation increased concentric contraction force occurs without any increased energy expenditure.

- Elastic energy is created by the change of direction (backswing followed by the downswing) during the golf swing.

The Backswing Biomechanics

With a right handed golfer:

- During the initial movement of the backswing, the left shoulder moves across the torso until it reaches its elastic barrier. At that point, the glenohumeral joint and its muscles and ligaments become activated thereby
allowing continued left arm movement. This movement continues until the glenohumeral joint reaches its elastic barrier. This movement is followed by thoracic spine rotation.

- Individuals with poor shoulder and upper torso flexibility will attempt to compensate during their backswing by bending their left elbow thereby collapsing the arc of the backswing, or lifting their head or torso.

### Techniques to Improve Scapula Restriction

1. Shoulder retraction exercises (3 sets of 10 repetitions).
2. Elbow curls. (3 sets of 10 repetitions).

### Techniques to Improve Restrictions of the Glenohumeral joint

1. Shoulder range of motion exercises in all planes of movement with progressive resistance weight (3 sets, 10 repetitions).
2. Shoulder stretches (hold the stretch for 30 - 60 seconds).

### Techniques to Improve Thoracic Rotation

1. Thoracic spine stretching technique. Lie supine with your knees bent; arms straight out with palms together. With your right hand pull your left arm across your body. Allow your knees to move to the left as your arms move to the right.

### Hip Rotation

- When visualizing a backswing think of the body as having three parts stacked one on top of another. The top portion, the shoulder, turns 90°; the middle portion, the hips, turn 45° and the lower portion, the legs remain stable.  
- During the downswing, the body uncoils from the legs to the hips to the shoulders.
- Perform a hip rotation assessment of the golfer. With the individual prone, have them lift their right leg. Check internal and external hip rotation. Normal internal hip rotation is 40 degrees; normal external rotation is 50 degrees.
The Hip

A. Inward rotation: measured by rotating leg outward. Outward rotation: measured by rotating leg inward.

B. Inward rotation (internal): measured by rotating the leg away from the midline of the trunk with the thigh as the axis of rotation, thus producing inward rotation of the hip. Outward rotation (external): measured by rotating the leg toward the midline of the trunk with the thigh as the axis of rotation thus producing outward rotation of the hip.

- Lumbar muscles contribute only approximately 5% of the total torque (force production) involved in trunk rotation. Lumbar muscles are primarily involved in flexion and extension movements.
- The oblique abdominal muscles are the primary rotators of the trunk.
- Each vertebra has approximately 1° of rotation or 5° total for the entire lumbar spine.

To Aid Hip Rotation

1. Train the abdominal oblique muscles utilizing crunch and twisting maneuvers.
2. Utilize plyometric techniques for explosive power. Perform medicine ball tosses to a wall. Line up parallel to a wall and toss the ball at the wall. Perform the exercise bilaterally with 10-50 repetitions depending upon your fitness level. This drill will enhance the golfers ability to perform quick changes of direction which is necessary in the transition from the backswing to the downswing.
3. Groin stretch - hold for 60 seconds, 5 repetitions.
4. Hip stretch - hold for 60 seconds, 5 repetitions.
Maintain a Strong Pivot Foot

- The right handed golfer must position his right pivot foot 90º perpendicular to the plane line of the golf swing. The maintenance of a strong, stabilized pivot foot allows for the creation of kinetic energy needed for a forceful golf swing.
- Maintain a lumbar lordosis as this allows for increased mechanical leverage needed to rotate the hips.
- If your right pivot foot is not perpendicular to the target line of the golf swing then kinetic energy is lost and the golf shot will have a tendency of going offline to the right.

Target ___________________________ target line

Rt foot perpendicular

- Weakness of the gluteus maximus (which helps to stabilize the hip and knee joints) and the quadriceps muscles (which is the primary weight supporting muscle during the backswing), will destabilize the right pivot foot causing offline golf shots.

Methods To Improve Gluteus Maximus and Quadricep Muscle Fitness

1. Plyometric bounding and hopping.
2. Standing gluteal contractions

Arm Position At the Top Of The Backswing

- At the top of the backswing, you want a straight left arm and a right arm which is bent at 90° at the elbow.
The Left Hand Controls The Clubface

- The position of the left hand directly influences the position of the clubface.
- At the moment of ball impact the left hand should be flat and facing the target.
- Any movement of the left hand out of proper impact position will cause the clubface to not be square which will cause an offline shot.

The Angle of Hip Rotation Sets Up a Square Hit

- The spine is flexed forward approximately 45º at address.
- The shoulder rotates under the spine during the swing (the left shoulder rotates under during the backswing and the right shoulder rotates under during the downswing).
- At the top of the backswing the upper and lower bodies coil creating elastic energy.
- At impact the right shoulder moves under the chin and the hips rotate on a level plane.

Golf Swing Synopsis

- At address maintain a proper cervical and lumbar lordosis (this will increase mechanical leverage and allow for increased elastic energy and rotation).
- At address make sure the right pivot foot is stabilized by the strong gluteal and quadriceps muscles and positioned perpendicular to the plane line of the ball and the target.
- During the backswing the left arm should be straight and the right elbow should be bent at 90º.
- Bring the club back low and slow. A big backswing is not necessary for a forceful swing.
- Initiate a quick change of direction between the backswing and the downswing. This quick direction change generates force.
- During the downswing the left arm should be parallel to the plane line of the ball and the target.
- Uncoil the body from the knees to the hips to the shoulder.
- The backswing creates kinetic energy and the downswing releases kinetic energy.
- A balanced follow through and finish is the hallmark of a good golf swing. At the finish you should be facing the target.

Golf Swing Faults

1. Poor static posture at address characterized by a cervical and lumbar spine kyphosis and forward lumbar flexion greater than 45º.
2. Poor dynamic posture during the swing. Instead of rotating the hips and trunk fully (due to range of motion / flexibility limitations), the golfer will extend during the backswing, flex forward during the downswing and extend at the finish.
3. Lateral shifting (backward movement) during the backswing due to a mechanical inability to rotate the hips and trunk.
4. Lateral shifting (forward movements) during the downswing.
5. Bending of the lead arm during the backswing.
6. Inside takeaway AKA Flat takeaway - bringing your hands back and inside of the target line. Often seen in the backswing of those golfers who are attempting to compensate for a slice.
7. Over the top swing pattern which is due to an extension movement in the downswing. This pattern has a tendency of causing a hook shot because of a closed clubface. The pattern resembles a wood chopping movement.

8. Improper arm position at impact. At impact your arms should be straight forming a V shape.

9. Early wrist release in the downswing AKA Casting. Unlocking the wrists too early will cause a loss of power. Often seen in golfers with exaggerated, long, backswings resulting in wild, off target shots.

10. Early follow through on the downswing. The golfers left arm, left hip and left knee are in front of the ball at impact and the hands and club lag behind.

11. Hips parallel to the ball at impact caused by restricted hip rotation. At impact the hips should be opening up slightly toward the target and the shoulders should be parallel to the target line.

12. Pivot foot faults such as: A) an open pivot foot; B) having your pivot foot positioned with the heel off of the ground (up on the toes). This position prevents proper weight transfer. Being on the toes with the pivot foot causes the golfer to hit shots fat or thin.

13. Improper clubface position at impact. When the club is open at impact (meaning the heel of the club head is closer to the target than the toe of the club head) the spin produced by the impact causes the golf ball to slice. A slice shot is a ball that flies severely to the right of the target for right handed golfers.

14. Cupping of the left wrist at the top of the backswing will cause a slice. Your left wrist should be flat at the top of the backswing. This will put your club face in a square position. A square club face will help to remedy a slice.

15. Fanning the clubface open on the backswing which leads to a slice.

16. Improper set up with your right shoulder higher than your left and your head in front of your hands.

**Golf Injuries**

**Management And Effects On Performance**

- Back Injury
- Muscle Pulls
- Knee/Thigh Injury
- Hip and Pelvis Injury
- Shoulder Injury
- Elbow Injury
- Wrist and Hand Injury
- Heat Stress

Golf poses a unique situation for the clinician. We are aware that this sport is not subject to high levels of compression or weight bearing on the spine, as seen in contact sports like football or weight lifting. Rather, golf can contribute to torque or rotational insult. This is related to an accumulation of various shearing forces in the horizontal plane. The golfer is also subject to applying excessive movements of the spine in a ballistic manner increasing tensile stress on those structures. The principle forces of the golf swing will be translated through most structures from the base of the cervical spine through to the ankle and foot. But the area most often impacted is the lumbar spine. We will be exploring various injuries of the extremities and trunk, but initial attention will be paid to that area that affects the golfer the most, the low back.
Back Injury

Biomechanics

Golfers are required to generate violent lumbar rotation. Unlike the baseball swing, where the batter can step to translate force through the pelvis and hips, the golfer’s feet are fixed and the only pivoting action occurs in the lower extremities. Of course, as we will see, this will contribute to lower extremity injuries; it will also increase the potential for back insult and pain development. In a review done by Calloway and Jobe in the 1985-1986 PGA Season, 77% of golfers were injured, with 43.8% of those injuries attributable to the spine and 42.4% to the lumbosacral spine, specifically. If we were to speculate that the PGA represents the best athletes in the sport, then we would expect that they have a higher level of technique, consistency, fundamentals and fitness than the average amateur golfer. We can further speculate that the recreational golfer’s potential for injury can be even higher if they participate frequently in the sport.

The pain arising from the swing motion can often be localized to poor fundamentals. Ideally, the golfer wants to spread out the rotational stresses over several structures, including the shoulder, hips, pelvis and the entire spine, as opposed to just the lumbosacral spine. Potentially, this would minimize over-stress in a single area during the power phase of the swing.

Like the baseball swing, the golf swing is dependant upon maintaining a parallel plane between the shoulders and the pelvis, not just at impact, but through most of the swing. For control of the trunk, the abdominal musculature must remain tense. This is aided by slight knee flexion, so knee flexion and trunk control will aid in keeping the shoulders and hips and pelvis in a parallel relationship. It has been said that a powerful swing relies on the ability of the golfer to retain tight muscle control as he or she goes from the maximum backswing to the power portion of the swing. Additionally, one can opine that this would also decrease the potential for repetitive injury in one focal area of the spine. This control over parallel position should limit the tendency of the golfer to laterally bend to the front leg side (left side for a right handed golfer) creating an off-balance asymmetrical loading of the spine.

Anatomy

Because the vertebral column is a chain of intervertebral joints, the neuromotion segment is comprised of the intervertebral disc, its facet joints, concomitant ligaments, vessels and nerves. The basic unit of spinal anatomy and function is the neuromotion segment. The ligaments provide resistance to injurious forces, further supported by the trunk musculature and the lumbodorsal fascia. It is muscle control of the fascial structures that decreases bending and loading stress along with the cushioning effect of the disc. Loads are managed through two basic components; an anterior compartment, consisting of the disc, the body of the vertebra and the longitudinal ligaments. The posterior compartment is comprised of the facet joints, lamina, spinous process, ligamentum flavum and pars interarticularis. For our purposes, it should be pointed out that the intervertebral disc, i.e., the annulus, nucleus, and the accompanying end-plates resist compressive forces well, but torsional forces less efficiently.

Overview

Mechanical Back Pain- which is made worse by activity and relieved by rest is our main focus, but the clinician must rule-out other clinical syndromes. Remember non-mechanical syndromes may appear
inflammatory, show constant pain, are minimally affected by activity and are usually worse at night or early morning. There are also other conditions such as sciatica and neurogenic claudication which must be ruled-out. Sciatica reveals predominately radicular pain with positive stretch signs and represents a specific dermatome level. Neurogenic claudication results in radiating leg pain or calf pain made worse with ambulation or spinal extension while showing negative stretch signs and relief with flexion.

**Muscle Pull on Strain** - this is a quick reference as it pertains to the lumbar spine. We will discuss muscle pulls at greater length in the upcoming text. This, of course, is the most common injury in golf resulting from repetitive twisting, straining, flexion-extension or even the lifting motion. It will result in spasm and can even occur with good body mechanics. When serious pathology has been ruled-out, reasonable rest, passive therapy modalities and manipulation on a time limited basis, is effective management. The medical approach includes NSAIDs or even muscle relaxants. A rule of thumb suggests that passive care should be followed by stretching and strengthening exercises to prevent re-injury. A modification in activities will also have to be applied.  

**Facet Arthropathy/Facet Syndrome** - afferent pathways of pain perception originate in the dura, posterior longitudinal ligament, annulus fibrosis and paraspinal muscles, as well as, in the intra-articular joint.

Kleynhans classifies three types of facet syndrome:

- **Traumatic** – where there is an acute onset of inflammation of synovial linings of the joint with effusion, synovitis and decrease range of motion.
- **Pathologic** – where there is an apparent narrowing of the intervertebral disc space which permits an approximation of the joint surfaces. Kirkaldy-Willis identified stages of pathologic facet syndrome as dysfunction, instability and re-stabilization.
- **Postural** – the presence of a protruding abdomen due to weak musculature with increased lumbar lordosis is common. All classifications can develop into osteophytes and stenosis either in the lateral recess or the vertebral canal. Classic facet syndrome includes local tenderness, pain on hyperextension, hip, buttock or back pain on Straight Leg Raise and an absence of neurological signs.

**Herniated Disc** – this spinal insult is commonly identified by a history of a specific trauma, leg pain greater than back pain, neurologic deficit or pain measurable by a decrease in nerve tension/stretch signs; pain increases with sitting and leaning forward; increased intrathecal pressure; or nerve-root impingement visualized by advanced diagnostic imaging.

**Sciatic Neuralgia** – herniated disc, facet-joint arthropathy, spinal stenosis, as well as, annular tears can contribute to the presence of radiating pain in the lower extremity. Golf is often reported as a culprit in the cause of these syndromes. As a quick reference, straight leg raise can identify probable root compression. Valsalva’s test identifies probable intrathecal pressure. Pain on hyper-extension identifies probable facet irritation, while myositis or myogenic irritation requires a quick dynamic exam called the Stress Tests. Myositis of the lumbar paravertebral muscles can be reproduced with active or passive stress tests. Active tests are performed with the patient prone, arms lying next to the body and hands besides the hips. The examiner places his or her hand between the patient’s scapulae and provides downward resistance while the patient uses the paravertebral muscle to extend his or her spine. Reproduction of pain is positive for lumbar paravertebral myositis. The passive procedure has the supine patient grasping both knees to the chest. The examiner then flexes the neck forward. Reproduction of pain suggests lumbar paravertebral myositis.
Gluteal myositis is also evaluated with the active and passive stress tests. For active testing, the prone patient flexes one knee to 90° then attempts to lift the knee off the table against downward pressure. During the passive stress testing, the patient lies supine and the examiner maximally flexes one leg while the other leg is left straight. The examiner then adducts the hip and brings the knee toward the contralateral axilla. Both procedures are repeated on the opposite side. Reproduction of pain in the gluteus maximus muscles is a positive test result for myositis. 14

Muscle Pulls/Strains

These result when more tension than a muscle can bear is applied to it. Typically with pulls, the more intense the pain is, the more severe the injury is. The muscle pull is usually the result of:

- **Insufficient Warm-up** – the amateur golfer is often rushed by rangers trying to pace play. The player needs to make time to warm-up prior to the first series of abrupt swings.

- **Muscle Imbalance** – if one muscle or group of muscles are dominant, it can overpower and even damage the weaker antagonist.

- **Poor Flexibility or Improper Stretching** – a routine of reproducing the sequence in the golf swing, along with the series of static stretches will decrease a quick elongation injury.

- **Mineral Deficiency** – a decrease in sodium, potassium, magnesium and other minerals and electrolytes predispose the tissue to injury.

- **Structural Abnormalities** – an actual leg length variant, spondylolysis or spondylolisthesis, lordosis, etc. can increase stress, further increasing the likelihood of injury.

- **Poor or No Training** – the gradual increase of the workload and the speed of activity can lead to overstretch injury.

- **Poor Endurance** – rhythmic endurance exercises thicken muscles, tendons and ligaments, consequently increased endurance would provide more resistance to injury.

- **Trauma** – the golf course itself can be a hazard. Wet conditions, holes in the ground, missteps and the carting of the bag can all contribute to muscle pulls.

Knee And Thigh Injury

Biomechanics

Most torsional injuries to the knee involve the menisci and result from impact. Golf provides a repetitive shearing force that can impact both cartilage and ligaments. Most knee and thigh injuries in the golfer are muscular in nature.
Anatomy

Though it is the largest joint in the body, the knee is structurally weak. The weakness is attributable to its unstable bone structure. The femur, the longest and largest bone in the body sits upon the small main weight bearing bone, the tibia. The femur only has a small amount of normal rotation on the tibia, further contributing to instability of structure. Though the convexity of the femoral condyles articulates to the concave surface of the tibial plateau, flexion still incrementally decreases the joint integrity. The fibula is primarily non-weight bearing and is laterally articulated only to the tibia and serves as the point of attachment of the lateral collateral ligament and the biceps femoris muscle. The patella is incased in the powerful patellar tendon and will slide in the superior and inferior planes during flexion and extension. The bone instability of the knee is compensated by strong ligament and even stronger muscular support. Of course, the knee is stabilized by the lateral collateral ligaments and the anterior and posterior cruciate ligaments. On the medial side, the medial collateral ligament secures the tibia to the femur and connects to the medial meniscus. Weaker is the lateral collateral ligament. This is not attached to the lateral meniscus. Anterior displacement is limited by the posterior cruciate and vise versa. Extension is managed by the quadriceps (rectus femoris, vastus lateralis, intermedius and medialis). Flexion is managed by the hamstrings (medially by semimembranosus/semitendonosus and laterally by the bicep femoris). The rotary movement of the tibia is controlled by the hamstring. The other supporting muscles include the sartorius, gracilis, popliteus, gastrocnemius, plantaris and tensor fascia latae/iliotibial band.

Common Injuries

The recreational golfer may be subjected to muscular weakness, poor posture, overuse syndromes, poor mechanics or even improperly fitted shoes.

- **Muscle Strain** – is the result of any or all of the above.

- **Patellar Tendonitis** – originates in the quadriceps muscles and the severity of the conditions will determine the amount of swelling. Almost always, the pain increases with play or overuse. Strength and flexibility in the hamstrings is usually the main preventor of this condition and is the primary focus of rehabilitation.

- **Sprains** – first degree sprains result in minor discomfort, point tenderness with little swelling and no abnormal movements. The second degree sprain has all of the above and loss of function for several minutes or more. Favoring the unaffected leg is common. The third degree sprain reflects a complete tear of one or more ligaments. The joint will demonstrate all of the above while joint instability and accompanying fracture is possible.

- **Chondromalacia Patellae** – is a painful degeneration that results in softening of the cartilage on the posterior aspect of the patella. Flexion will elicit pain. Look to muscle imbalance or weakness as the cause.

- **The Female Golfer** – the female golfer has the greatest susceptibility to chondromalacia patellae, patellar dislocation or subluxation. Structural differences in the pelvis increase the problems for women. The wider pelvis creates a sharper Q-angle. The Q-angle is an imaginary line originating from the anterior superior iliac spine (ASIS) to the intersection of an extended line of the patellar tendon. A sharper Q-angle changes the line of pull of the quadriceps and may cause the patella to be pulled in a lateral direction upon contraction. 15
- **Postural Affects of the Thigh** – an indicator of tight hamstrings is the development of hypolordosis in the lumbar spine. This also may reflect tight gluteals or weak erector muscles. Differentiation and correction is fairly easy and the Straight Leg Raise test easily identifies tight hamstrings. Tight hip flexors or tight spinal erectors or weak abdominals can produce hyperlordosis. Tight quadriceps can cause knee joint crepitus. This is easily found during knee to buttock prone orthopedic testing.  

**Hip And Pelvis Injury**

**Biomechanics**

The hip and pelvis play an important role in the stabilization of the golfer through the power phase of the swing. Flexibility at the hip is a key benefit to the golfer and is important in decreasing the chance of injury that will be translated to other contiguous areas, like the lumbar spine and knees.

**Anatomy**

The hip is the strongest joint in the body due to the arrangement of bones, ligaments, muscles and tendons. Of course this is a ball-and-socket joint formed as the spherical head of the femur articulates into the deep socket acetabulum of the ilium. The osseous structures of the ilium, ischium and pubic area, along with the sacrum and coccyx, comprise the pelvis. The supporting ligaments are made up of the ligamentum teres, transverse, acetabular, iliofemoral, pubofemoral and inguinal ligaments. Along with muscular attachments, these structures will transfer weight between the torso and the lower extremities. There is a multitude of muscular recruitment patterns to manage motion of the hip. Flexion is managed by the iliacus, rectus femoris and sartorius all supplied by the femoral nerve emanating from the segmental levels of L2 and L3. The adductor brevis and magnus (which have a greater contribution when the hip is already extended) are supplied by the obturator nerve and emerge from L2 and L3 segmental levels. The psoas muscle is segmentaly supplied from the plexus emanating from L2 through L4 levels. The remainder of flexion is conducted by the femoral nerve (accessory obturator) or the L2-L3 level and the tensor fascia latae fed from the superior gluteal nerve and L4 through S1 levels.

Extension is managed with the firing of the gluteus maximus, supplied by the inferior gluteal nerve and segments L5 through S1. The long head of the biceps femoris (L5 through S2) the semimembranosus and semitendinosus are all conducted through the sciatic nerve with the last two supplied by L5 and S1. The gluteus medius is supplied by the superior gluteal nerve at L4 through S1 and finally, the abductor magnus is fed by the sciatic nerve from the L4 and L5 levels.

Abduction is conducted from the superior gluteal nerve and L4 through S1 for the management of the gluteus minimus and medius and tensor fascia latae and again, the gluteus maximus and the sartorius.

Adduction is managed by the adductor brevis and longus, fed by the obturator nerve and the adductor magnus (fed by the obturator and the sciatic nerve). The pectineus is supplied by the femoral nerve at the levels of L3 and L4. These levels also supply the obturator nerve and the muscle function of the gracilis.
Common Injuries

With golf the likelihood of avulsion fracture, general fracture or complete tears and contusions from normal play is very low, but a myriad of motion or nagging injuries are common.

- **Trochanteric Bursitis** - the cause of this condition is a snapping of the iliotibial band over the greater trochanter. This occurs at the bursae sac at the gluteus medius/iliotibial band intersection at the greater trochanter. Repetitive play, walking the course on uneven surfaces, and pulling a hand cart can all contribute to this irritation. Obviously, the sooner this is detected, the sooner an application of rest, ice, compression and support can be applied. Most likely, this is discovered in the sub-acute or chronic phase, when the use of heat and supervised stretching are most affective.

- **Hip Strain** - this commonly occurs when the joint undergoes a violent twisting motion of the torso accompanied by the feet being fixed in a stationary position. This, of course, is a great description of the swing action in golf. When evaluating a possible hip strain, have the patient perform various movements like flexion, extension, adduction and abduction, as well as, circumduction motions. The more acute the discovery, the easier it is to apply a principle of support and stabilization, but chronic management will clearly become rehabilitative and require modifications of activity and restorative exercises.

- **Iliotibial Band Syndrome** – the iliotibial band originates on the iliac crest and inserts on the lateral tibial condyle. This condition is usually due to an overuse-syndrome, occurring when the fascia latae repetitively snaps over the lateral femoral condyle. This is more common in runners than golfers, but it can have an impact on performance and can become chronic if unattended. The most difficult part of managing this is that it will require a significant modification of activities. Something golfers do not like to do. Conservative care programs will emphasize a decrease in inflammation and encouraging a protocol of stretching with gradual return to activities and retooling body mechanics, or even using orthotics.

- **Groin Pull** – usually this is a strain of the psoas muscle because the individual has not employed proper stretching techniques. It is important to rule-out other problems like hernia, back instability, prostatitis, urethritis, nephrolithiasis or testicular torsion, since some of the symptoms overlap. There will most likely be point tenderness over the groin. There will be little pain on passive movement, but pain will occur during active hip motion. In the acute phase, it is necessary to control the hemorrhage, pain and spasm for approximately 2 to 3 days with ice and rest. Stabilization can be done with a 6 inch wide elastic hip spica (a figure 8 bandage that generally overlaps the previous portion to form a V-like design). In the second phase of management, between 4 to 6 days, pain and spasm control continues and restoration of full ability is encouraged. The therapy modalities will include ice, massage, and muscle stimulation above and below the pain site (approximately 5 to 10 minutes). Proprioceptive neural facilitation at 3 to 4 times per day is suggested with optional jogging in place for 10 minutes or so. The third phase is directed at resorting strength and flexibility, while managing inflammation. This can be accomplished with muscle stimulation using surge current to tolerance with ultrasound. Active therapy is continued including PNF and progressive-resistance exercise. The patient can use ice packs or ice massage after the exercises, if required. The fourth goal is to return the patient to full power, speed, endurance and flexibility. Light jogging may be used in this phase. Finally, the fifth goal is to return the individual gradually to the sport while using protection, like a hip spica bandage for a short while. Measure full function and capacity by comparing the injured side with the uninjured side through strength and range of motion testing.
• **Slipped Capital Femoral Epiphysis** – this is a low possibility, but youth participants in golf are increasing. This would most likely occur with obese males in the age range of 9 to 15 years. There will be pain and gait changes present as the femoral epiphysis slips off the metaphysis. Of course, though rare, this can be severe if it develops into avascular necrosis.

• **Degenerative Joint Disease** – the opposite end of the age spectrum from the previous condition is degenerative changes. The senior golfer is often impacted by restriction developed over time. The treatment is supportive and preventive. Usually, it is centered on modifying the frequency of play and influencing the range of motion, both passively and actively.

**Shoulder Injury**

**Biomechanics**

The shoulder girdle is one of the most mobile anatomical structures in the body. The shoulder girdle moves in multiple directions, allowing the upper arm to assure an unlimited number of positions. The more positions it can assume will increase the number of possibilities for directional injury. It is the most frequently dislocated joint. Both over use and under use can lead to injury. Disuse will lead to adhesive capsulitis, while the rotator cuff injuries are increased with age (usually after 40). Impingement syndrome impacts those individuals who perform heavy duties, while women and adolescents can be more susceptible to instability, due to reduced upper body strength.

**Anatomy**

The sternum, the clavicle, the humerus and the scapula comprise the shoulder girdle. The four joints of each shoulder are the sternoclavicular joint, the acromioclavicular joint, the coracoclavicular joint and the glenohumeral joint.

The shallow glenoid fossa of the scapula accommodates the spherical head of the humerus adding to mobility and also structural weakness. The ligament support is comprised of the costoclavicular, acromioclavicular and coracoclavicular, acromion, sternoclavicular and glenohumeral ligaments.

Muscular control is vast. The biceps provide flexion and supination of the arm. The triceps extends the forearm and upper arm. The coracobrachialis adducts and assists in flexion and pronation of the arm. The rotator cuff provides rotational movements. The supraspinatus assists in abduction, the infraspinatus in external rotation; the teres minor also in external rotation and the subscapularis performs internal rotation and adduction. The rhomboids retract and rotate the scapula. The pectoralis major flexes, adducts, and internally rotates the arm. The pectoralis minor raises the ribs, draws the scapula forward, downward and inward causing shoulder depression. The latissimus dorsi extends adducts posteriorly and rotates internally the arm and rotates the scapula downward. The levator scapula elevates the scapula, extends and allows lateral flexion of the neck and assist the downward rotation of the scapula. Serratus anterior rotates the scapula for abduction and flexion of the arm, while protracting the scapula. The teres major assists in extension, abduction and internal rotation of the arm. Finally, the trapezius retracts, rotates upward and elevates the scapula; it also rotates the scapula downward based on the fibers engaged.
Common Injuries

Violent rotation and pulling injuries are the most common shoulder injuries in golf.

- **Rotator Cuff** – in golf, acute trauma is less common than chronic irritation due to repetition. Symptoms range from minimal pain with no weakness to severe pain and decreased range of motion and weakness. The latter suggests a tear of the rotator cuff. The diagnosis is based on stress testing the isolated muscles as described previously. Conservative care is almost always the first treatment approach. Unlike the greater weight bearing hip, the shoulder should not be drastically restricted by supports unless severe tears are present. Stabilization can lead to greater restriction and longer periods of rehabilitation. When inflammation is controlled, gradual progressive resistance muscle-toning exercises should be implemented. The exercises must be directed at preventing the existing range of motion limitation.

- **Glenohumeral Subluxation or Dislocation** – 95% of these displacements are anterioward. Remember the glenohumeral joint is bound solely by soft tissue in the anterior structure. A coexisting rotator cuff injury should be suspected in any one over the age of 45. We will discuss two techniques for reduction of the subluxation/dislocation of the glenohumeral joint. The Simpson technique requires placing the patient prone on a table with the affected arm hanging free. Then the clinician would apply weight or gentle traction downward, expecting that muscular relaxation will permit the humerus head to slide back into place. The other technique is known as the Milch technique, this technique has the clinician abducting the arm overhead then externally rotating it. The head of the humerus is then pushed posteriorly back into the glenohumeral joint. In either case, a period of 2 to 3 weeks of immobilization is standard. The use of a daytime sling to prevent overstress is common, but will likely extend the rehabilitation period. This condition will also require analysis of neurovascular compromise.  

The return to play may require a glenohumeral joint wrap as the patient returns gradually to competition. Using a 6 inch wide wrap, loop the affected arm with the bandage material, then wrap anteriorly across the chest, then under the arm and around the back, then finally over the affected shoulder and re-anchor it on the upper arm of the affected side.

Elbow Injury

Biomechanics

The elbow permits the movements of flexion, extension, pronation and supination. The golf swing applies specific demands on the elbow. Those demands will vary from lead arm to follow arm. The lead elbow endures most of its stress in the pre-contact phase of the swing, while the follow arm incurs stress while decelerating following the swing.

Anatomy

The elbow joint is an intrinsic collection of bones, muscles, ligaments, and nerves. The humerus has two articulating condyles at the distal end. The proximal end of the ulna forms the olecranon process and is limited in extension by a notch in the humerus. In essence, the ulna works as a stationary axle and the radius turns around it as the forearm and hand rotates. It is the olecranon process that articulates with the proximal radius. Ligaments and tendons use the medial and lateral epicondyles knobs of the humerus as a base of attachment.
The elbow is made up of two joints called the humeroulnar and the humeroradial. The ligament structures which support these joints are the ulnar collateral, radial collateral, annular and the isosceles triangle. The isosceles triangle is comprised of the anterior oblique, posterior oblique, and the transverse oblique ligaments. Flexion and extension of the elbow is controlled by the articulation of the medial condyle with the ulna of the lower arm. The lateral condyle of the humerus articulates with the radius. This articulation is the structure which permits pronation and supination of the lower arm and hand. The medial collateral ligament is attached to the humerus and the ulna. The lateral collateral ligament is attached to the humerus and the radius. The annular ligament binds the radius and the ulna from separating. The movement of the elbow is controlled in the muscles that originate above that structure on the humerus and the scapula. Specifically, the bicep, triceps, and brachioradialis muscles flex and extend the joint. There are numerous muscles that control movements of the forearm, wrist and fingers, these originate at the two epicondyles of the humerus. The bicep muscle conducts flexion and supination of the arm. The triceps muscle extends the forearm and upper arm. The coracobrachialis abducts and assists in flexion and pronation of the arm. The brachialis aids in flexion at the elbow. The anconeus extends the elbow. The brachioradialis flexes the elbow, while supination is controlled by the supinator and pronation by the pronator teres and pronator quadratus.

Common Injuries

- **Olecranon bursitis** - most injuries to the olecranon are the cause of a direct blow, but overuse will cause inflammation of the olecranon bursae. Inflammation of the olecranon bursae will significantly impede the ability of the golfer to extend the arm, either during the backswing or in attempting to achieve full extension at the completion of the swing. A quick way to evaluate olecranon bursitis is palpation and observation; one will note a thick and warm feeling at the distal and posterior portion of the humerus. Early intervention will include the use of an elastic wrap, bracing and ice with compression. The chronic presence of olecranon bursitis would require manual massage, heat, active and passive stretching followed by resistive exercises.

- **Dislocation/Subluxation** – commonly, an abrupt stop or hyperextension of the elbow could lead to subluxation or dislocation of that joint. The most common cause of dislocation would be the inability of the upper extremity to bear the full weight of the body upon it in a quick and sustained force. This is not an injury that is common to golf, however golf requires walking long distances on wet or uneven surfaces. Falls commonly result in injuries of this nature. The key component for the clinician is the requirement to rule-out a fracture before attempting a reduction of the displacement.

- **Epicondylitis** – is broken down into either medial or lateral epicondylitis. Medial epicondylitis is most commonly known as pitcher’s or little leaguer’s elbow, while lateral epicondylitis is often called tennis elbow. The golfer is subject to both of these irritations. Full extension at impact will lead to medial epicondylitis while the rotation that occurs at the completion of the swing may lead to lateral epicondylitis. Management of this condition will necessitate limiting pronation or supination. Commonly, a wrap or elastic compressive band is placed around the elbow. Compression often decreases the sense of discomfort, but will provide very little in ameliorating the irritation derived from excessive supination or pronation. It will be necessary to alter the patient’s activities and slowly rehabilitate through the use of exercise bands or resistant training using weights. Sending the golfer back to competition before healing is complete will make the individual susceptible to further injury. The best way to determine when healing is complete is by the absence of pain during stressful activities and by the return of full range of motion, strength, and endurance to the affected muscle groups. Conservative treatment options are the first line therapy in response to this injury. Contrary to popular practice, corticosteroid injections are not considered a first line
therapy. This type of treatment can promote collagen necrosis. Phonophoresis and electrophoresis are common therapies proceeding the strengthening and rehabilitative phases. The rehabilitation workout must include antagonistic muscle groups to prevent asymmetry in the strengthening process.  

- **Compartment Syndrome** – look for the five P’s. This would include pain on passive movement with pallor, pulselessness and paraesthesia. The key component to this finding is that the pain is disproportional to clinical findings. The fact that there is an impact on neurovascular structures would necessitate a surgical referral, since emergency surgery may be necessary.

- **Osteochondritis Dissecans** – because this condition occurs secondary to repetitive or compressive trauma, it is important to take this into consideration in the management of the golfer. The amateur golfer not only participates in their sport, but also engages in their work related activities which may lead to cumulative irritation. Osteochondritis dissecans can lead to avascular necrosis of the capitellum. Chronic elbow pain must be taken seriously and compel the clinician to perform appropriate x-rays and direct their assessments towards a differential diagnosis.

- **Ulnar Entrapment Syndrome** – continual impingement upon the ulnar nerve as it passes through the cubital tunnel on the medial aspect of the elbow can lead to this condition. The patient will most likely present with weakness of the grip, pain in the area of the cubital tunnel on palpation and paresthesia of the little finger and the ulnar aspect of the ring finger. Tinel’s sign would be present, further identifying the presence of inflammation of the ulnar nerve. Treatment includes rest, ice, compression, elevation and physiotherapy modalities followed by a resistive exercise protocol.

- There are various tests for ligament stability in the elbow, this includes Valgus or abduction stress to evaluate the medial (ulna) ligament stability. Varus or adduction stress will evaluate the lateral (radial) ligament stability. Tests for lateral epicondylitis would include the resisted wrist extension, resisted long finger extension and palmar flexion/pronation stretch. Testing to evaluate medical epicondylitis consists of resisted wrist extension and wrist extension-supination stretch. To evaluate neurological dysfunction, Tinel’s sign at the elbow would detect inflammation of the ulnar nerve, pronator teres syndrome detects inflammation or entrapment of the median nerve while “pinch grip” detects anterior interosseus nerve dysfunction.

**Wrist and Elbow Injuries**

- Wrist and elbow injuries are fairly common among amateur golfers due primarily to poor golf swing mechanics and faults. These injuries are typically caused by repetitive mechanical straining of wrist and elbow tendons and muscles and ligamentous sprains.

- A common cause of wrist and elbow injuries is an improper grip on the club such as baseball grips and super strong grips where the four knuckles of the left hand can be seen. An improper grip causes the club head and shaft to travel in an improper swing path which in turn places mechanical strain on the elbow and wrist during the downswing. Also, an improper grip will limit or restrict the normal unlocking of the wrists prior to impact.

- A simple way to rectify an improper grip is to utilize a grip trainer which promotes a proper grip on the club.
Wrist And Hand Injury

Biomechanics

The wrist and hand comprise the most dynamic areas of movement in the body. The wrist and the hand are the sights of numerous minor, yet very irritating conditions experienced by golfers. For example, heat and friction will lead to blisters, calluses, while repetition can lead to chronic sprains and strains.

Anatomy

The wrist and the hand contain 27 bones, 8 carpal bones, 5 metacarpal bones and 14 phalanges, comprising 38 joints. The carpal bones are the navicular (scaphoid), lunate, triquetrum, pisiform, trapezium, trapezoid, capitate and hamate. According to Basic Athletic Training, the authors Kenneth E. Wright and William R. Whitehill suggest remembering these bones by using the first letter of this statement “never leave the player, the trainer can help.”

The lunate bone is the most often dislocated of the wrist bones, while the navicular is the most commonly fractured. The joints and the wrist comprise the radiocarpal, midcarpal, carpometacarpal, intercarpal and metacarpophalangeal and interphalangeal, which include the distal interphalangeal and the proximal interphalangeal joints in the fingers. The muscles surrounding the wrist and hand include the abductor pollicis brevis, flexor pollicis brevis, opponens pollicis and adductor pollicis, palmaris brevis, abductor digiti minimi, flexor digiti minimi brevis, opponens digiti minimi, lumbricals, the palmar interossei, and the dorsal interossei.

Common Injuries

Generally, fractures are uncommon as a result of golf play. Falls or similar concussive injuries may lead to fractures in the golfer. The nagging repetitive-type injuries are those which most significantly impact the golfer and require the attention of the health care provider.

- Blisters – this is a thin, rounded swelling of the skin that contains fluid. It is caused by irritation, excessive heat or burns and is also known as a vesicle or bulla. Blisters can be limited by the use of gloves, repeat drying of the hands or use of powder. Once the blister has occurred, it is best to leave the skin unbroken to decrease the chance of infection. If repeated irritation occurs after the formation of the blister, it would be necessary to break the overlying skin. The use of a sanitized needle or pin would help drain the blister, but removal of the skin and wrapping of the tissue must follow. The use of a moleskin pad or a gauze bandage is beneficial. It is wise to wash with soap and water prior to application of the cover. Topical application of triple antibiotics, such as Neosporin, is helpful. Though iodine and camphor-phenol will clearly kill germs, there high concentration may also kill cells and decrease healing. The dressing should be changed regularly and the area should remain covered from additional irritation.

- Fractures – navicular (scaphoid) fractures comprise 75% of carpal injuries, in the most at risk groups, which are men ages 15 to 30 years. The most common mechanism for a fracture is falling on an
outstretched or extended wrist, usually leading to the scaphoid or even a Colles’ fracture. The Colles’ fracture is a break which occurs approximately 1 inch above the wrist on the radius and is easy to recognize by the hand position that it causes. It would be impossible to supinate the hand in the presence of a Colles’ fracture; in essence, there will be a dorsal angulation rather than a volar angulation seen with a Smith’s fracture of the same structure.

- **Dislocation** – the scapholunate dislocation results from a tearing of the scapholunate ligament just below the radial head. Swelling, ecchymosis and deviation will be present. This will lead to a long period of immobility and dissuasion away from playing golf for several weeks. The usual acute protocols would be applied. A wrist spica would be applied and a slow and steady rehabilitative phase would occur. Poor motion over a sustained period of time may necessitate a surgical consultation.

### Heat Stress

Much of the golfing season is in the summer months. The age of golfers varies greatly, but there are large numbers of golfers over the age of 45. Appropriate attention must be given to hydration, clothing, sun protection and use of alcohol.

- **Preparation** – high temperatures and humidity pose a difficult problem for the recreational golfer. Of course, exercise generates heat which the body must dissipate. The body will cool itself mainly through the sweating mechanism in which heat is carried away from the body as perspiration evaporates. High humidity will prevent the sweat from evaporating and disrupt the benefits of the thermo-regulatory system. Overstress from excessive alcohol or other factors can also disrupt the thermo-regulatory system by causing the sweating reflex to cease. The best method of prevention is to hydrate the body prior to and during the activity. A fluid loss of as little as 3% of total body weight can adversely affect endurance and coordination. This limited loss can initiate heat illness. Remember, several small doses of water are preferable to one large amount. A strategy for replacing fluid is to drink cold water and 6 to 8% solution of carbohydrate consisting of 34 ounces 2 hours before activity, 13 to 17 ounces 15 minutes before activity and 13 to 17 ounces every 30 minutes during activity. 23

Light and loose fitting clothing will allow air to move over the body. Clothing that binds can trap heat. Protection of the head from direct sunlight or periodic rest beneath trees or other shady locations can drastically reduce the temperature of the body.

- **Heat Cramps** – this painful involuntary muscle contraction is due to a decrease in electrolyte intake or even excessive water during exercise (which dilutes electrolytes). These can be managed by drinking electrolyte solutions, stretching and applying a cooling application and above all ruling out further heat illness problems.

- **Heat Exhaustion** – the symptoms of heat exhaustion are often subtle. The individual may experience progressive weakness or a lack of coordination; there is clamminess and a pale or gray appearance in the face. There can be weakening of the pulse and the pupils may dilate. Nausea often accompanies these other symptoms and the golfer can be subject to fainting. Muscle cramps are commonly present.
• **Heat Stroke** – heat stroke is caused by high temperature, dehydration and electrolyte imbalance. A significant increase in body temperature will occur very rapidly. The most common signs will include dizziness, weakness and confusion, the skin can be dry and will appear flush, but the pulse will remain strong and rapid. The skin temperature will feel hot to the touch with axillary temperatures that can range between 101° to 107°. Often the individual will experience sudden unconsciousness. Heat stroke is an immediate emergency. Cool wet towels must be applied to the individual and he or she must be quickly transported for full medical attention. Clothing should be moved aside and they should be moved to the coolest available place. If the individual remains conscious, provide cool or cold drinks to replace the fluid loss.

**Preventative Treatment of Golf Injuries**

In addition to chiropractic manipulative therapy and passive physiotherapy, exercise strength training, flexibility and cardiovascular training and myofascial trigger point therapy are effective methods to treat golf injuries.

**The Role Of Exercise In Physical Fitness**

The most important physical fitness components related to personal health include muscular strength and endurance, flexibility, cardiovascular--respiratory fitness and body composition.

**Exercise Terminology**

**Strength**--is a maximum force that can be generated by a muscle or group of muscles for a single repetition.

**Power**--is the amount of force that can be generated in a short period of time. Generally, in sports activities, power is the quintessential attribute.

**Endurance**--is the ability of a muscle or group of muscles to perform many repetitions.

**Flexibility**--is the possible range of motion around a joint.

**The Physicians Role In Exercise Program Planning And Design**

The physicians role in their patients exercise program involves the initial assessment of physical fitness capabilities, short--term and long--term goal planning, design and implementation of an appropriate exercise program relative to **exercise mode, intensity, duration and frequency**, and periodic evaluation of exercise progression.

**Exercise mode** (is the type of exercise performed. For example, the performance of resistance training for
strength development and aerobic exercise for cardiovascular--respiratory fitness).

**Exercise intensity** (is the speed or tempo of the exercise or the weight of the load lifted. Monitoring ones heart rate during aerobic exercise can measure exercise intensity).

**Exercise duration** (the amount of time required on a daily basis to achieve ones fitness goals).

**Exercise frequency** (the number of times per week that the individual exercises).

Prior to designing an appropriate exercise program for a patient, the physician must first assess the patients physical fitness capabilities and discuss their exercise goals. The physician must determine whether the patients exercise goals are achievable given their age, sex, current physical status and diagnosis.

### General Principles Of Exercise Training

**Principle of Use**--the human body has the ability to adapt to use and imposed demands thereby increasing the body systems capacity and efficiency.

**Principle of Disuse**--dictates that your level of fitness will decline if you stop exercising.

**Overload Principle**-- in order for your cells to increase in size (hypertrophy) the workload (stressor) must be increased beyond what the cells normally experience. This is referred to as overloading. Your body systems must be stressed beyond normal levels of activity if they are to improve. The overload is a positive stressor and is the basis of stress adaptation.

The components of overloading include exercise intensity or load, exercise duration, exercise frequency, exercise repetitions and rest. Each of these components can be increased to impose an overload. **Exercise intensity** or load is probably the most important component of the overload principle. For strength gains to occur, your load should represent an intensity which is at least 60% to 80% of your muscle's maximum strength. This will usually allow the performance of seven to ten repetitions of a particular exercise before resting. Practically speaking, the amount of resistance you use in an exercise is determined by trial and error. In designing an exercise program, always underestimate an individuals lifting capabilities.

Increasing the length of the exercise period (**Exercise duration**) can impose an overload. It is not uncommon for body builders to perform various exercises, in excess of eight hours per day, prior to a competition.

**Exercise frequency** refers to the number of days per week that an individual exercises. To improve or maintain muscular strength or endurance, the average individual would need to exercise on alternate days or approximately three to four days per week. Generally, each major muscle group should be overloaded every 36 to 48 hours. Conversely, elite athletes preparing for competition may require daily training sessions.

**Exercise repetition** is one complete movement of an exercise. A series of repetitions, performed consecutively, is referred to as an exercise set. Exercise repetitions will determine the type of adaptation. For example, an increased weight load with low exercise repetitions will result in muscle hypertrophy. A decreased weight load with high exercise repetitions is best for achieving muscle endurance.

**Rest** is the amount of time between the performance of an exercise set. The amount of rest required will depend upon the load demand. The greater the load, the greater the fatigue, and therefore, a greater rest period
is necessary for recovery. The amount of rest is also dependent upon the type of adaptation which is desired. For endurance (oxidative) adaptations to occur, you will normally rest less and exercise at a lower intensity than when you are attempting to develop strength. To develop muscle endurance, rest 30 seconds between sets. High intensity strength training, such as squat activities, may necessitate rest periods of up to 5 minutes between sets. The rest period for most exercise programs is approximately one to two minutes between sets.

**Principle of Progression**—often referred to as progressive overload or progressive resistance exercise. As exercise adaptations occur over time, your body experiences a sensation of reduced effort for a given performance. This is due to the physiological adaptations enhancing the body's ability to create energy and remove metabolic waste products. To achieve steady improvement, training intensity should be continually increased. However, it is important to progress slowly, as too rapid a progression may lead to overuse injuries.

**Principle of Specificity**—indicates that you must train a specific energy system (often referred to as metabolic specificity) or specific muscle groups (known as neuromuscular specificity) in order for them to improve.

**The Principle of Warm-Up and Warm-Down**—a properly designed exercise program will include a warm-up (low level activities, such as stretching and slow walking, performed prior to more strenuous exercise), a stimulus period (the performance of strenuous exercise) and a warm-down period, also known as the cool-down (performed immediately after the stimulus period). The warm-up and warm-down help to prevent muscle soreness and injury and prevent excessive strain on the heart. For example, if you stop running abruptly, blood may pool in the legs, thereby decreasing the blood's return to the heart.

**The Principle of Recuperation**—due to the stress placed on the body by exercise, rest and recuperation are essential. Inadequate recuperation can result in over training syndrome and overuse injuries such as epicondylitis. However, extended periods of rest may lead to deterioration in one's fitness level.

**The Principle of Reversibility**—the benefits of training are transient and dependent upon continued exercise. You must continue to exercise to avoid deconditioning (use it or lose it). It is said that for every day of inactivity, it takes two days of exercise to return to one's normal fitness level.

**Types of Muscular Contractions**

An **isometric contraction** involves no shortening of the muscle. It occurs when the muscular force generated is inadequate to overcome the resistance. For example, if your 1 repetition maximum for the bicep curl is 50 pounds and you attempt to lift 80 pounds, no movement would occur. While the muscle attempts to shorten, it can not because the resistance is too great.

An **isotonic, concentric contraction** occurs when your muscle shortens during muscular contraction because the amount of force generated by the muscle is greater than the load. This type of contraction is seen during the performance of the bicep curl exercise.

An **isotonic, eccentric contraction** occurs when the muscle length increases during contraction because the load is greater than the force generated by the muscle.

An **isokinetic muscle contraction** is one in which the muscle can shorten only at a set speed with the help of a machine or device which provides resistance that changes depending upon how much force one exerts. The
Kin--Com and Hydra--Gym machines allow for isokinetic muscle contraction.

**Aerobic Exercise**

Aerobic fitness (cardiovascular-respiratory efficiency) is the ability of the cardiovascular and respiratory systems to accommodate the oxygen needs of the muscular system over a sustained period of time, as in endurance events such as distance running, swimming and bicycling.

**VO₂ Max**

Maximal oxygen uptake is the most important measure of aerobic fitness. Another important measure is the ability to sustain exercise at a high percentage of VO₂ Max. To measure VO₂ Max directly, monitor oxygen consumption with a gas analyzer while the individual exercises to exhaustion on a treadmill or bicycle ergometer. VO₂ Max is partially dependent upon body weight. The larger the individual, the greater the potential VO₂ Max. A 200 lb man has twice the VO₂ Max as a 100 lb man (perhaps 4 liters versus 2 liters).

- VO₂ Max is a measure of milliliters of oxygen per kilogram of body weight that the body metabolizes in one minute of exercise.
- During endurance exercise your muscles use oxygen to burn fat and carbohydrates to produce energy.
- The higher your VO₂ Max, the longer and more effortlessly you can perform.
- To increase your VO₂ Max - train at 85%-95% of your MHR. This will increase the size and strength of the heart, thereby allowing it to pump more blood with less effort on every stroke.

Elite distance runners have been known to have resting heart rates of 30 (BPM) and a VO₂ Max of 60-80 milliliters per kilogram of body weight per minute of exercise.

**Flexibility**

Flexibility is the range of possible movement in a joint and its surrounding muscles.

1. Perform general warm-up before stretching.
2. Use slow deliberate movements.
4. Never bounce while performing static stretches.

Benefits of stretching:
1. Warms the muscles before strenuous training.
2. Lubricates the joints.
3. Decreases chances of injury.

**Frequency and Duration of Stretching**

Each stretching session should have a 5-6 minute warm-up and 8-12 minutes of stretching.

**Active Stretch** - Person stretching supplies the force on the stretch.

**Passive Stretch** - Partner or device provides the force of the stretch - P.N.F.

**Static Stretch** - Is a constant stretch in which the end position is held for 10 - 30 seconds.
Ballistic Stretch - Bouncing movement in which the end movement is *not* held, involves muscular effort. May produce injury to the muscle or connective tissue.

Dynamic Stretch - Flexibility during sport specific movements. Ex. - high knees for sprinters.

**Static Stretching vs. Dynamic Flexibility**

- Atlanta Falcons speed and conditioning consultant Loren Seagrave opines "Stretching makes muscles loose but does nothing to prepare for explosive movements".

In one study, athletes who stretched statically before a vertical-jump test couldn't jump as high as athletes who did no warm-up at all. In another, runners who performed static stretches were substantially slower than peers who went out of the blocks cold. Dynamic flexibility exercises raise your body temperature, increase your ranges of motion, and increase sports performance.

**Dynamic Flexibility Exercises**

Complete the following dynamic mobility exercises every Monday, Wednesday, and Friday before doing strength and power exercises.

1. **Windmill** - Stand with your feet shoulder-width apart, arms out to the sides and parallel to the ground. Turn your arms in small forward circles, gradually making wider circles until your arms are nearly perpendicular to the ground. Do one set of 20; repeat in the opposite direction.

2. **Prone Push-Up** - Lie facedown with your hands planted by your shoulders. Slowly press your upper body up and look toward the ceiling, keeping your hips and lower body flat on the ground. Return to the starting position. Do one set of ten.

3. **High Knee** - March forward, starting with your left foot. Lift your knee as high as it will go (all the way to your chest, if possible) on each step, keeping your foot parallel with the ground and your back straight. Do one set of 20.

4. **Forward Walking Lunge** - Step forward with your left foot so that your left thigh is parallel with the ground, then try to touch the ground just inside your left instep with your left elbow, using your right hand for balance if necessary. Return to the standing position and repeat with your right leg. Do one set of eight on each side.

5. **Walking Side Lunge** - Start with your feet shoulder-width apart. With your left foot, step sideways as far as you can, dropping your hips and bending your knee until your left thigh is parallel with the ground. Your right leg should stay straight. Return to the standing position by continuing to move sideways in the same direction. Do ten with the left side and ten with the right.
P.N.F. - Proprioceptive Neuromuscular Facilitation

Combines alternating contractions and relaxation of both agonist and antagonist; it is based upon inhibition of the anterior horn cell resulting in reduction of sensory activity which in turn, reduces muscle contractive tension, thus removing resistance to elongate P.N.F.

3 Types of P.N.F

- Hold-relax
- Contraction - relax
- Slow reversal - hold - relax

Hold - Relax
1. Passive stretch. (Ex. partner performs straight leg raise to stretch the hamstring)
2. 10 second isometric contraction. (against partners resistance)
3. 10 second passive static stretch. (partner stretches the hamstring)
4. Repeat 2-4 times.

Contraction - Relax
1. Passive stretch 4-6 sec.
2. Concentric contraction while partner pushes 4-6 sec.
4. Repeat 2-4 times

Slow reversal - Hold - Relax
1. Passive stretch to slight discomfort.
2. Isometric contraction 10 sec. of agonist (push against partner).
3. Partner uses enough force to counter resistive force to subject.
4. Subject submaximally contracts antagonist.
5. Partner passively stretches while subject contracts antagonist, then tells subject to relax.
6. Partner ends with 10 second passive static stretch.
7. Repeat steps 2-6 two or three times before bringing back to normal resting position

The Golf Exercise Regimen

- Train three days per week such as on a Monday, Wednesday and Friday. This schedule will facilitate progression and allow for proper rest and recuperation. Choose exercises that will enhance the golf swing.
- Each training session should last approximately 60-90 minutes and entail:
  A) 10 minutes of warm-up utilizing calisthenics and abdominal exercises (crunches and twists) and golf specific stretches.
  B) 15-30 minutes of resistance weight training. Perform at least one exercise for each major muscle group (back, legs, abdomen and arms). Constantly vary the exercises, utilize a light load and perform a high number of repetitions for muscle tone. This will create lean, pliable muscles and flexible joints.
  C) 15-30 minutes of cardiovascular training utilizing a bicycle or treadmill
  D) 5 minute cool down.
Golf Specific Exercises

1. Medicine Ball Rotations.
2. Medicine Ball Wall Tosses.
3. Exercise ball push ups - for core strength, balance and coordination.
4. Cable pulling maneuvers.
5. Seated rows.
6. Tricep dips.
7. Shoulder press.
8. Pec deck chest exercises.
10. Leg press.
11. Leg extension / leg flexion.
12. Abdominal crunches.
13. Abdominal twists.
14. Shoulder range of motion with resistance.
15. Wrist curls.

Golf Swing Exercise

Perform three sets of 15-20 repetitions.
1. Impact bag drill with attention to proper postural alignment and preservation of cervical and lumbar lordotic curves.
2. Abdominal contractions - assume the address position with arms crossed on the chest. Contract the abdominal muscles to initiate hip rotation.
3. Medicine ball abdominal oblique training. Lie prone with legs over a medicine ball. Initiate abdominal oblique contractions which will cause hip rotation and movement of the legs and the medicine ball from side to side. Performance studies such as the one performed by Vera-Garcia indicate that the use of the medicine ball increased oblique abdominal activity fourfold vs. standard floor training.26
4. Downswing exercises with resistance from a cable pulley, flex band or tubing. Assume the address position with hands gripping the resistance. Perform a downswing which will contract the abdominal muscles.
5. Backswing exercise with resistance from a cable pulley, flex band or tubing. Assume the address position and with your left hand gripping the resistance initiate a backswing. This exercise is intended to train hip rotation.
6. Medicine ball reach back drills with a partner. This maneuver will enhance hip rotation.
7. Medicine ball rotational exercise.
8. Hip abduction exercises.
9. Forward lunges with hip and trunk flexion. Can be performed with arms overhead or lateral lunges with an arm reach maneuver.

Golf Specific Stretching

1. Cervical range of motion stretches - hold for a count of five and repeat five times in each plane.
2. Scapular retraction - Clasp hands behind the head, elbows up. Bring the elbows back as far as possible. Hold for a count of 5 and repeat five times.
3. Shoulder retraction - Retract arms and attempt to approximate the elbows. Hold for a 5 count and repeat five times.
4. Elbow curl stretch (5 count, 5 repetition).
5. Shoulder stretches using the opposite arm (5 count, 5 repetitions).
6. Thoracic rotation stretch - (Hold for a 5 count, repeat 5 times.)
7. Cat stretch - Position on hands and knees. Let the back sink down and then arch up and stretch (5 count, 5 repetitions).
8. Single knee to chest.
9. Double knee to chest.
11. Piriformis stretch.
13. Full extension stretch.
15. Cross leg stretch - Sit cross legged and accentuate the lumbar lordosis. This will stretch the hip and piriformis.
16. 90/90 hip stretch.
17. Squat stretch - Squat with feet twice the shoulder width.

**Balance Exercises**

1. Wobble Board / Balance Board Exercises - When unstable surfaces, such as a balance board are used in conjunction with lunge or squat exercises, lower extremity strength can increase significantly.

2. One leg stand with eyes open and then closed. In general, the time that someone can stand on one leg without losing their balance will decrease as their age increases. The average adult should be able to stand on one leg with their eyes open for approximately 60 seconds without losing their balance. With their eyes closed they will lose their balance in a shorter period of time.

**Myofascial Trigger Point Therapy**

- The golf swing may cause repetitive muscle strain and prolonged muscle hypertonicity which can manifest itself in the form of trigger points.

- Trigger Points can cause the development of a reflex arc within the spinal cord. Nociceptive afferent bombardment of the spinal cord from Trigger Points can cause interference with the nervous system.

- The spinal cord will then send efferent impulses back to the hypertonic muscle sustaining the muscle in that condition. This reflex arc results in increased neural activity disrupting the nervous system.

- Trigger points can also be caused by gross trauma, visceral disease, arthritic joints or emotional stress.
Characteristics of Trigger Points

"An active trigger point is always tender, prevents full lengthening of the muscle, weakens the muscle, usually refers pain on direct compression, mediates a local twitch response of muscle fibers when adequately stimulated and often produces specific referred autonomic phenomena, generally in its pain reference zone."27

Trigger Point Histology

"The trigger point nodule itself is thought to be a region of localized muscular contracture, in which a subset of muscle fibers are locked by failure of the actin/myosin heads to release."28

Common Methods to Treat Trigger Points

1. Ischemic compression - sustained pressure to a trigger point for approximately five seconds to a minute utilizing the thumb for smaller muscles, the elbow for larger muscles or a T-bar instrument. Ischemic compression pressure is increased as the sensitivity of the trigger point decreases. Pressure is applied until the trigger point is no longer tender.
2. Accupuncture.
3. Moist heat packs.
4. Ultrasound.
5. Spray and stretch.
6. Injection of lidocaine or prednisone.

Common Trigger Point Areas

1) Upper Trapezius Muscle

- The upper fibers originate above the superior nuchal line, the ligamentum nuchae, and spinous process of C1 through C5. Inserting on the spine of the scapula, the acromion and the lateral 1/3 of the clavicle. The upper trapezius is innervated by the spinal accessory nerve (CN XI, motor) and the 3rd and 4th cervical nerves (sensory). The upper trapezius muscle fibers raise the shoulder. Upper trapezius muscle Trigger Points (TP's) are commonly activated by whiplash and/or repetitive overload.

2) Rhomboids

a) Rhomboid Minor - origin is at the ligamentum nuchae and the spinous processes of the C7 and T1 vertebrae. Insertion is the medical border of the scapula.

b) Rhomboid Major - origin is at the spinous processes of T2 to T5 vertebrae and it inserts at the medial border of the scapula between its spine and its inferior angle.

- These muscles are innervated by the Dorsal Scapula nerve (C5 nerve root). They adduct and elevate the scapula and hold the lower angle of the scapula close to the ribs preventing winging.
• Prolonged Rhomboid Trigger Points can cause rounded shoulders and refer pain to the scapula and the Supraspinatus muscle. These TP's are activated by prolonged forward bending in the round shoulder position and by upper thoracic scoliosis.

• Rhomboid 'TP's are usually found along the medial border of the scapula. Compress them for approximately 1 minute.

3) Supraspinatous Muscle

• The Supraspinatous muscle originates at the medial Supraspinatus fossa and attaches laterally to the upper part of the greater tubercle of the humerus. It is innervated by the suprascapula nerve from the C5 spinal root.

• The supraspinatus muscle strengthens the shoulder joint by drawing the humerus toward the glenoid fossa and it assists in abduction of the arm.

• Supraspinatus T.P.'s can refer pain into the lateral epicondyle of the elbow.

4) Infraspinatous

• The Infraspinatous muscle originates in the Infraspinatus fossa, extends laterally and inserts into the greater tuberosity of the humerus. It is innervated by the Suprascapula nerve arising from the 5th and 6th cervical nerves. This muscle helps to stabilize the shoulder joint by holding the head of the humerus in the glenoid fossa and is involved in external rotation of the arm at the shoulder.

• Infraspinatus trigger points may cause an inability to internally rotate and adduct the arm at the same time. Visualize an individual not being able to reach into their back pocket.

• Referred pain from these TP’s is found in the front of the shoulder joint and down the arm.

• The trigger points are activated by frequent overload stress where the patient must reach out and back repetitively.

5) Teres Minor

• The Teres Minor muscle originates at the dorsal surface of the scapula near its axillary border and inserts at the greater tubercle of the humerus. It is innervated by the axillary nerve which contains fibers from the 5th cervical root.

• The Teres Minor muscle will stabilize the shoulder joint by holding the head of the humerus in the glenoid fossa and also helps to externally rotate the arm at the shoulder joint.
The teres minor will refer pain to the deltoid muscle.

Teres Minor TP's will be found in the area of the arm crease.

6) Teres Major

The Teres Major muscle originates at the inferior angle of the scapula and inserts at the lesser tubercle of the humerus. It is innervated by the lower subscapular nerve containing fibers from the 5th and 6th cervical nerves.

The teres major muscle adducts the arm, assists in extending the arm when it is in a flexed position and assists in internal rotation.

Teres Major T.P.'s refer pain to the posterior deltoid and the triceps brachii muscles.

7) Subscapularis

The Subscapularis muscle originates at the innermost (anterior) surface of the scapula (subscapular fossa). Its fibers pass in front of the shoulder joint and insert into the lesser tubercle of the humerus.

It is innervated by the upper and lower subscapular nerves from spinal nerves C5, C6.

This muscle helps to stabilize the shoulder by keeping the head of the humerus in the glenoid fossa and allows for internal rotation and adduction of the arm.

Subscapularis T.P.’s will prevent being able to move the arm into abduction and external rotation. This inability is often diagnosed as frozen shoulder. The referred pain from these trigger points are found in the posterior shoulder and arm to the elbow.

Codman's exercise is performed to stretch the subscapularis. Have the patient lean over a chair with the involved arm hanging down. The patient then passively swings the arm by moving the body, not by actively using the shoulder muscles.

8) Sacrospinalis / Erector Spinae

The superficial (erector spinae) group, the Longissimus Thoracics, Iliocostalis Thoracics, and Iliocostalis Lumborum are paraspinal muscle fibers.

A) Longissimus Thoracics - has the longest paraspinal muscle fibers. Its origin is the transverse processes of all the thoracic vertebrae adjacent to the 1st to 10th ribs. It inserts at the lumbar transverse processes.
B) Iliocostalis Thoracics - this muscle originates at the transverse process of C7 and to the first 6 ribs. It inserts into the lower 6 ribs.
C) Iliocostalis Lumborum - this muscle attaches from the sacrum to the lowest 6 ribs.
These muscles are innervated by the dorsal primary divisions of the spinal nerves. When acting bilaterally they extend the spine. When acting unilaterally they cause lateral flexion to the same side.

Prolonged sitting is a common cause of erector spinae trigger point activation. The Longissimus Thoracics muscle will refer pain to the lower buttoc. The Iliocostalis Thoracics refers pain upward into the shoulder. The Iliocostalis Lumborum refers pain downward to the buttock.

9) Quadratus Lumborum Muscle

The Quadratus Lumborum Muscle originates from the iliac crest and the iliolumbar ligament and inserts above into the medial 1/2 of the inferior border of the last rib, as well as the apices of the transverse processes of L1 to L4. It is innervated by the 12th thoracic and the upper 4 lumbar nerves.

The quadratus lumborum muscle is a lateral flexor of the spine to the same side when the pelvis is fixed. The muscle extends the lumbar spine when it acts bilaterally.

Quadratus lumborum T.P.'s refer pain along the crest of the ilium to the adjacent lower quadrant of the abdomen, the upper groin, greater trochanter, the upper thigh, across the upper sacral region and into the lower buttock.

Quadratus Lumborum TP's can be activated by improper lifting of a heavy load and twisting of the torso.

10) Gluteus Maximus Muscle

The Gluteus Maximus muscle originates at the posterior iliac crest, lateral sacrum, the coccyx and the Sacrotuberous ligament and inserts into the iliobial band and the femur. It is innervated by L5, S1, and S2 spinal roots via the inferior gluteal nerve.

This muscle helps maintain an upright posture as well as assisting in powerful extension of the thigh at the hip.

The referred pain from Gluteus Maximus TP's is usually concentrated in the buttock region.

11) Gluteus Medius Muscle

The Gluteus Medius muscle originates along the anterior 2/3 of the iliac crest and inserts distally into the greater trochanter. It is innervated by the superior gluteal nerve from spinal roots L4, L5 and S1.

The Gluteus Medius abducts the thigh and is responsible for stabilizing the pelvis during single limb weight bearing.

Individuals with Gluteus Medius TP's have pain when walking. The referred pain pattern is along the posterior crest of the ilium, the sacrum, the posterior lateral aspects of the buttocks and in the upper thigh.
12) **Gluteus Minimus Muscle**

- The Gluteus Minimus muscle its originate at the outer surface of the ilium between the anterior and inferior gluteal lines. It inserts at the greater trochanter. It is innervated by the superior gluteal nerve carrying fibers from L4, L5, and S1.

- The Gluteus Minimus assists the Gluteus Medius in stabilizing the pelvis during single limb weight bearing and assists in abduction of the thigh.

- Referred pain extends down the lateral and posterior aspects of the lower limb into the ankle. Vasoconstriction of this muscle is a common cause of sciatica.

13) **Piriformis Muscle**

- The Piriformis Muscle originates at the anterior surface of the sacrum and it passes through the greater sciatic foramen. It inserts into the greater trochanter. The piriformis is innervated by the first and second sacral nerves.

- It externally rotates the thigh when the hip is extended, abducts the thigh when the hip is flexed and restrains medial rotation of the thigh.

14) **Iliopsoas Muscle**

- The psoas portion originates from the twelfth thoracic and all the lumbar vertebral bodies as well as the corresponding discs and lumbar transverse processes. It runs inferiorly to join with the iliacus to become the iliopsoas. It exits the pelvis through the Lacuna Musculorum (along with the femoral nerve, and the lateral femoral cutaneous nerve) to insert at the lesser trochanter of the femur.

- The iliacus portion arises from the upper 2/3 of the inner surface of iliac fossa, which lines the lateral wall of the greater pelvis. It then joins the psoas at the lesser trochanter of the femur.

- The iliacus is innervated by spinal nerves L2, and L3. The psoas is innervated by L2, L3 and L4 spinal nerves.

- Iliopsoas T.P.’s refer pain to the lumbar spine, sacrum, groin and thigh. To stretch this muscle and alleviate T.P.’s have the patient perform a hip extension stretch (step forward with one foot, lean back and extend the opposite thigh at the hip. Hold this stretch for a count of 10 and then do the other side.)
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