GOLF: Conditioning the Hip/Trunk & Compensatory Swing Mechanics

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Note to Participants:
There will be interactive questions throughout this lecture. If you choose to ‘pause’ the lecture, and return at a later time, a natural ‘break’ time would be after answering the interactive questions. (You are able to pause at any time and the presentation will ‘remember’ where you were. It’s just a more natural time to pause after the interactive questions.) For your convenience, this outline reflects where within the lecture the interactive questions occur.

This lecture has 88 slides. It is 93 minutes in duration.

GOLF: Conditioning the Hip/Trunk

I. Dynamic rotational movements and forces – necessary and destructive
   A. CORE muscles initiate and attenuate forces generated by the movements of athletic performance
   B. CORE muscles of the
      1. Glenohumeral
      2. Scapula
      3. Thoracic spine
      4. Lumbar spine
      5. Pelvis
      6. Lower leg

II. Spinal stabilization
   A. Panjabi 1992
      1. Passive subsystem – articulate surface – ligaments – joint and soft tissue mobilization
      2. Active subsystem muscles force-generating capacity – strength & endurance training
      3. Neural control – coordinate muscle activity in response to afferent feedback from unpredicted changes – perturbation training
      4. Must activate muscles at the right time, by the right amount, in the correct sequence and turn off muscle appropriately – all of the above

III. Joint stabilization
   A. Intricate inter-relationship and precise control between several muscles acting on the joint to protect it during functional movements
B. Muscles that do not contribute to movement are designed to stabilize

C. Muscle stiffness is a function of muscle most closely related to joint protection and support

D. A muscle stiffness strength-protein-neuromuscular
   1. Intrinsic stiffness – viscoelastic properties in the muscle
   2. Protein stiffness from titin an enormous cytoskeletal protein spans half the sarcomere from Z disc to M-line
      a) Serially linked springs that develop tension when stretched provides the forces needed to maintain proper sarcomere integrity during contractions
      b) Muscle length increases with sarcomere in series = peak torque at longer muscles lengthens
   3. Neuromuscular primary spindle afferents set by the degree of stretch of the muscle and the activity of the fusimotor neurons
      a) Muscles set on higher readiness to react to sudden unexpected changes in direction = perturbation

IV. Categorization
      1. Local muscles
         a) Intertransversarii
         b) Interspinalis
         c) Lumbar Longissimus
         d) Iliocostalis Lumborum
         e) Multifidus
         f) Quadratus Lumborum
         g) Tranverse Abdominis
      2. Global muscles
         a) Longissimus & Iliocostalis pars Thoracis pars Lumborum
         b) Rectus Abdominis
         c) Obliquus Externus and Internus
         d) Hip abductors/extensors/rotators

V. Local and global muscles
   A. Local muscles are capable of controlling movement and intervertebral relationship of the spine segments and the posture of the lumbar spine
   B. Global muscles are involved in moving the spine and transferring load directly between the thoracic cage and pelvis
   C. Balance external loads applied to the trunk so that the residual forces can be handled by the local muscles
VI. Local CORE muscles in golf
A. Intertransversarii/interspinalis proprioception
   1. Signals the end of the range as in the back swing in golf mobilization to improve arthrokinematics
B. Stabilization of LS control shearing & torsion forces in the golf swing
   1. Tranverse Abdominis – lumbar-dorsal Fascia
   2. Multifidus – stiffness the spine
   3. Quadratus Lumborum – lateral stability
      a) Lumbar Longissimus
C. Transverse Abdominis – local CORE muscle
   1. Strong stabilizers of the spine
   2. Attaches to the thoracolumbar fascia
   3. Drawn in the lower abdominal wall away from the elastics of the pants-contraction
D. Abdominal muscles
   1. Transverse Abdominis & Rectus local and global
      a) Top relaxed abdominal muscles
      b) Bottom Tranverse Abdominis
   2. Top protruding abdominal area
   3. Bottom Rectus Abdominis local CORE
E. Perturbation – neuromuscular
   1. Activation is linked to the control of reactive moments produced by the limb movements
      a) e.g. The Transverse Abdominis was active 30ms before the prime mover of the shoulder and 110ms with leg movement
   2. Active in the control of the spine stability
   3. Perturbation to the trunk results in preparatory spinal motions to dampen forces. Transverse Abdominis acts to maintain a stable intersegmental orientation allowing movement

VII. Muscle function
A. Multifidus local CORE muscle
   1. Panjabi et al – concluded that the intersegmental Multifidus gave significant advantage to the neuromuscular system for controlling the stability of the lumbar segments
   2. Muscle forces were found to stiffen the motion segment – Multifidus responsible for reducing ROM in all directions except rotation
4. Mooney 1998 – 8 week 16 session exercise program
   Multifidus strength increased an average 65% with resolution of low back pain
   i. balance

Interactive Questions – slide 25 @ 26 minutes

VIII. Testing muscle endurance
   A. Local – Quadratus
   B. Global-back extensors and abdominals
      1. Biering-Sorensen 1984 demonstrated that a decreased torso extensor endurance predicts greater risk of back problems
      2. Balance of three muscle groups are involved in spine stability during any task and critical for the athlete
         a) Test one – abdominal bracing – sit up posture with back rest at 60° angle – back rest removed & hold
         b) Test two – lateral muscles – full side bridge position legs extended and top foot in front – non wt. arm to opposite shoulder – hold
         c) Test three – back extensors – upper body over table feet are fix hands resting on opposite shoulders – hold
      3. Mean endurance times(sec) and ratios normalized to extensors
      4. Assessment of Quadratus Lumborum
      5. Local CORE muscle
         a) 95% of muscles activation is an isometric contraction
   C. Side bridge – McGill optimal exercise
      1. In addition high EMG activity of:
         a) Glut Med (74%), Ext Oblique (69%), Lumbar Multifidus (44%), Longissimus (40%)
         b) Rectus Abdominis and Ext Oblique (43% & 47%)
   D. Modified leg loading test
      1. Weakness of the CORE stabilizers results in
         a) Left hip drops into flexed position and rotates laterally
      2. High EMG activity
         a) Glut (40%), Med (47%), Hamstring (40%), Longissimus (40%), Multifidus (44%)

IX. Pelvic myofascial system
   A. Three myofascial systems and muscles
      1. Thoracolumbar – Lats, Internal Abdominal Obliques, Transverse Abdominis, Glut Max, Erector Spinae, Multifidus
      2. Abdominal fascia – Ext Oblique, Transverse Abdominis, Pect Major, Serratus, Rectus Abdominis
      3. Fascia Lata – Gluteus Max, Tensor Fascia, Quads, Hamstrings, and hip adductors
X. Testing global hip/pelvis muscles
   A. Abductors (leg drop test)
   B. Extensors (knee flexed hip extended)
   C. Adductors (eccentric loading)
   D. Rotation of the femur (isokinetic testing or manual muscle testing for int/ext rotn)
      1. Special tests – single leg partial squat knee control
      2. Jump test knee position
      3. Leg drop test – posterior fiber of Glut Med
         a) Positive leg drop test – unable to hold
   E. Pelvic stability femoral rotators – global
   F. External rotators
      1. Piriformis, Super/Inf Gemellus
      2. Obturator Internus and Externus
      3. Quadratus Femoris
      4. Glut Max 2/3 attached to TFL
      5. Iliopsoas, Sartorius, Biceps Femoris
   G. Internal rotators
      1. Medial hamstrings
      2. Ant. portion of Glut Med
      3. TFL/ITB, Glut Min, Pectineus, Gacilis
         i. balance

Interactive Questions – slide 50 @ 53 minutes

XI. Dynamic EMG of trunk muscles
   A. During golf swing
      2. Importance of trunk muscles in stabilizing and controlling the loading response for max power and accuracy in golfer's swing muscle: abdominal Oblique, Rectus, Glut Max, and Erector Spinae
   B. Muscle activity forward swing
      1. Trail Leg – Glut Max is the most active hip muscle during FS initiating pelvic rotation
         a) Internal rotators – Biceps Femoris, Semimembranosus, Adductors & anterior fibers Glut Med
      2. Lead Leg – Vastus Lateralis max activity during FS – without the VL forceful pelvic rotation would not be possible
         a) Stabilizes the lead knee as the leg pushes the ground to provide a fulcrum around which the pelvis rotates
         b) Acceleration phase sequence of muscle activity similar to baseball swing – both drive their power early in the swing from hips and knee
3. Glut Max lead leg peak activity assisting in pelvic rotation and hip ext
4. Bicep Femoris and Semimembranosus maintain knee in flexion allowing transfer of power from pelvic rotation to be transmitted to the trunk and arms
   a) Glut Max & Hamstrings in trail leg reaching peak early in the forward swing

C. Specific exercises for global hip muscles Glut Max
1. Exercise for active joint stabilization
   a) Co-contraction – closed chain exercises
   b) Use slow controlled CKC exercises
   c) Focus on joint position rather than control of force
   d) Do not over train co-contraction of large torque-producing muscles

D. Extension exercises
1. Advanced exercises for spinal stability
   a) Perturbation training unexpected movements of the upper and lower extremity activates the Transverse Abdominis to stabilize the spine by responding to afferent stimuli
   b) Overhead throws using a medicine ball
   c) Balance activities
      i. e.g. dynamic edgem tilt boards, shuttle balance system
2. Muscle imbalance etiology of patella femoral pain, Hamstring dysfunction, Quad strain, lateral hip pain
   a) Glut Med – ER movements – decelerates femoral adduction/internal rotn
   b) Weakness of Glut Med increase frontal and transverse plane stress to PFJ and Tib/Fem joint increase pelvic tilt
   c) Weakness of the hip ER increasing internal rotation – valgus at the knee and foot pronation

E. Muscle Imbalances

1. Results:
   a) A rehabilitation program consisting of progressive agility and trunk stabilization exercises is more effective that a program emphasizing isolated hamstring stretching and strengthening in promoting return to sports and preventing injury recurrence in athletes suffering an acute Hamstring strain.
      i. Before and after – tight Hamstrings
ii. Exercise to posterior hip CORE muscles
iii. Extensors – posterior fibers Glut Med
iv. External Rotators
v. Before and after – hip flexor tightness
vi. Hip CORE exercises
vii. Eccentric loading of Hamstrings reduces pelvic tilt
viii. Increased muscle length
ix. Strengthen hip extensors shuts off hip flexors

1. 41 athletes (139 tested) 29% sustained 48 back or LE injuries, 35% females, 22% males
2. Injuries correlated with hip abductor, external rotator weakness, and lower abdominal performance
3. Isometric hip strength (ER) more accurate predictors of back and LE injury than trunk endurance

H. Case study: low back pain in golfers
1. Hip instability during the take-away
   a) Lack of control of the hip in the take away will increase the spinal rotation secondary to instability of the hip – poor eccentric control by the posterior fibers of Glut Med, ER, Glut Max
   b) Excessive spinal rotation forces are dampened by the trunk muscles
c) Fatigue of the Multifidus quadratum abdominal Obliques, Transverse Abdominis will cause increased strain to the facets and disc

GOLF: Compensatory Swing Mechanics
I. Golf swing is a complex movement
   A. Five musculoskeletal components of the golf swing that promote the most efficient weight transfer and club head speed and prevent injuries
      1. Strength
      2. Stability
      3. Explosive power
      4. Normal joint mobility
      5. Balance
         a) Vision
         b) Vestibular
         c) Proprioception

II. The typical golfer wants to hit a home run
   A. Swing too hard = reverse “C”
   B. Feels the power coil is a position to store power for increased distance
   C. Has physical limitations they maybe unaware of
D. Golf injuries
   1. 75% of all golfers experience LBP
      a) #1 reported injury in golf
      b) Golf swing generates peak compressive load to the LB 8x’s body weight
      c) Excessive backward bending

III. Weight transfer critical for power and prevention of injuries
   A. Violent weight transfer causes swing to be unbalanced, reducing power and club head speed at impact of the ball
   B. Weight transfer is not a powerful, muscular movement
   C. Highly refined movement
      1. Efficient muscular activity and maximal use of momentum created during the backswing by good balance

Interactive Questions – slide 71 @ 67 minutes

IV. Overview
   A. Objectives
      1. Describe phases of a golf swing
         a) Muscle function
         b) Mobility
         c) Balance
         d) Stabilization
      2. Swing faulty mechanics
         a) Physical limitations of the golfer
            i. Posterior capsule flexibility L Shlder = Hrztl add
            ii. 90° of ER in adb position R – GH joint
            iii. Flexibility of the right ant capsule = 90 abd. ER
            iv. Eccentric strength of the L hip ER, posterior fibers glut med, & glut max controls L hip IR and establishes a strong base
            v. Strength of the trunk muscles to reduce rotational forces during the back swing
         b) Possible swing faults secondary to physical limitations
            i. Posterior capsule flexibility poor in L Shlder = limited IR < 45°
         c) Possible swing fault bending of the left elbow
            i. Elbows moves away from side as shlder abd compensates
         d) Over rotation of the trunk
            i. ER < 45° in R add – GH joint
            ii. Poor flexibility of the R ant capsule less = 70 abd. ER
            iii. Scapula adducts and/or trunk rotates

B. Test shoulder motion
   1. Restriction will cause problems in golf swing
   C. Possible physical limitations – trunk and hips
1. Poor eccentric strength of the L hip ER, posterior fibers glut med & glut max
   a) Over rotation of spine, hip sways excessive back swing hyperextension of the L/S
2. Poor strength of the trunk muscle to reduce rotational forces during the back swing
   a) Trauma to the lumbar spine

V. Golf specific exercises for trunk stability lateral muscle and abdominals
   A. Primary function of trunk spinal muscles in golf swing is to stabilize & protect the spine from excessive rotation and spinal forces
   B. Goal is to hold starting position for 70 seconds
      1. Side bridge
      2. Prone bridge

VI. What are back muscles?
   A. Back muscles are important to the golfer. They help to reduce excessive rotational forces during the swing and assist in smooth even weight shift

VII. Hip strengthening exercises
   A. Hip abd strength out to the side and back to isolate the hip muscle
      1. Glut med posterior fibers
   B. This muscle directly associated with improved performance

VIII. Transition
   A. Changing directions
      1. Balance is critical
         a) Quadriceps strength to hold known flexion angle
      2. Initiate downward swing
         a) Requires transfer of weight through knees and feet (hip support)
         b) Wrist strength to control flexion and allow supination (rotation)
         c) Strength of the trunk muscle to reduce rotational forces

IX. Acceleration
   A. Thru the pelvis-abdominal obliques and hip IR
   B. Weakness of the abdominals
      1. Over rotation of thoracic/lumbar spine
   C. No primary IR
      1. Internal Rotators
         a) Medial hamstrings
         b) Ant. portion of glut med
         c) TFL/ITB, glut min, pectineus, gracilis
X. Finish
   A. Good balance weight transfer
      1. Highly refined movement reduced muscle activity and max use of momentum
      2. Muscle control professional golfer 50% less muscle activity than amateur
   B. Poor eccentric control of right hip
   C. Over rotation of trunk
      1. Increased torsional forces to spine
   D. Possible swing faults secondary to physical limitations
      1. Released Impact
         a) Precise timing
            i. Reduced dynamic visual acuity lack of consistency of ball contacting club head squaring club face to ball
      2. Deceleration
         a) Poor eccentric control of R GH joint and hip movement
            i. Over rotation of R hip with excessive coil
         b) Poor strength of the wrist supinators and pronators
            i. Can not square club face to ball
   E. Finish poor balance = inefficient weight transfer chopping down at the ball with shoulders asymmetrical

Interactive Questions – Slide 85 @ 86 minutes

XI. Summary
   A. Poor shoulder mobility
   B. Poor eccentric strength of ER of the shoulders
   C. Poor strength of the scapula rotators and rotator cuff muscles
   D. Poor strength of supinators and pronators of the wrist
   E. Hip out of control L hip during take away
   F. Trunk stabilizers weak
   G. Poor balance and weight shift
   H. Poor dynamic visual acuity
   I. Hypo-function of the vestibular ocular reflex
Conditioning Hip & Trunk Bibliography


Compensatory Mechanics Bibliography


