Evaluation of the Full Swing and Injuries in Golf

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Presentation Outline

• The Game
• The Swing
• Common Injuries in Golf
• Common Swing Faults and Injuries
• Golf Screen Overview
History of Golf

- Modern Golf began in 12th century Scotland (www.abc-of-golf.com)
- United States Golf Association (USGA) Founded in 1894 to govern U.S. Amateur. (www.usga.org)
Sport of Golf

• By definition, golf is a low-impact sport.
• Satisfies the Surgeon General’s recommendation for regular, leisure-time activity
• American College of Sports Medicine recognizes golf as an effective exercise means to reduce risk factors for stroke and heart disease.
• No fewer than 16 professional tours around the world for men, women and seniors (PGA, LPGA, European Tour, etc.).
• Handicap systems allows for competition between different skill levels.

Brandon and Pearce (2009)
Golfing Population

- 29.5 million golfers in the U.S. ages 6 and up in 2007
- Estimated to eclipse 55 million by 2020
- Males have greater representation at 75% of the population.
- 33% of golfers are over the age of 55.

Brandon and Pearce (2009)
A Simple Game

• **Hit a** ball
  – The golf ball must be spherically symmetrical and may be no smaller than 42.67 mm in diameter and weigh no more than 45.93 g.

• **Into a** hole
  – The hole is 108 mm (4 ¼ inches) in diameter and shall be cut no less than 101.6 mm (4 inches) deep.
• While avoiding penalties and *hazards*
  – Large trees, sand, water and long grass

• In as few *strokes* as possible
  – A stroke is defined as the forward movement of the club made
    with the intention of striking at and moving the ball

• In order to achieve the lowest *score* possible for 18 consecutive holes.
  – Par of championship courses range from 70-73
A Simple Game?

Deterministic Model of Ball Flight in Golf

Hume, Keogh and Reid (2005)
Individual Differences in Generating Ball Displacement

- High vs. Low Handicap
- Male vs. Female
- Anthropometrics
- Physical Attributes
Zheng, et al. (2007)

- Low handicaps demonstrated larger shoulder range of motion on backswing
- Greater angular velocities on down swing
- Improper mechanics in high handicap players may lead to high incidence of golf injury
Male vs. Female Golfers

*Egret, et al. (2006)*
- Study involving experienced amateur golfers
- ♂ showed increased shoulder and hip joint rotation angles
- ♀ showed more weight transfer
- both demonstrated equal club head speed

*Zheng, et al. (2008)*
- Study involving professional (LPGA vs. PGA) golfers
- ♂ showed significant difference in pelvic rotation at impact
- ♀ demonstrated increased angular velocities
  - club shaft, left wrist, right wrist and right elbow extension

- Japanese golfers \((n=52)\) are mesomorphic compared to non-golfers \((n=45)\)

Hellström (2009)

- Comparison of 40 golfers (hdcp <3) Anthropometrics vs. Swing Speed
  - Height \((r=0.51)\) and arm length \((r=0.45)\) showed weak but significant correlations to swing speed \((p<0.05)\)
  - Body mass \((r=0.22)\) and shoulder width \((r=0.20)\) were not correlated to swing speed
Sell, et al. (2007)

- Elite players (hdcp < 0) showed significantly greater hip, torso and shoulder strength and flexibility than less skilled golfers (hdcp 10-12)

Hellström (2009)

- Trunk power ($r=0.80$), leg and hip power ($r=0.60$), combined arm and trunk power ($r=0.58$) and grip strength ($r=0.54$) showed the strongest correlation to swing speed
Evaluation of Golf Swing

• The Golf Grip
• 2 Dimensional Video Analysis
  – Determine Style
    • How does the player like to swing the club
• 3 Dimensional Digital Analysis
  – Determine Efficiency
    • Sequencing of body segments for optimal efficiency
The Golf Grip

Grip Positions
- Strong
- Neutral
- Weak

Grip Styles
- 10 Finger/Baseball
- Interlocking
- Overlap

UW Health
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• 5 fixed cameras (ideal)
  – down the line (sagittal plane), face on (frontal plane),
    overhead (transverse plane), rear view (frontal plane),
    oblique view (45° face on).

• 1 portable camera (current)
  – 2 views (face on and down the line)
  – enough information to draw basic conclusions
Down the Line View

- Align camera at hip height on hands
- This view shows how you like to swing the club
  - Club path
  - Swing consistency
- Sagittal plane movements
  - Posture
  - Knee, hip and trunk flexion

following Images from: http://v2.v1home.com
Face on View

- Frontal Plane Movements
  - Lateral spine
  - Lateral knee positions
  - Lateral pelvic position

- Power Production
  - Weight transfer
  - club position / lag
Swing Make-up

1. Address / Set-up
2. Backswing
3. Downswing
   • Acceleration
   • Impact
4. Follow-through
Address

Hume, Keogh and Reid (2005)

20-25°

45°

16°

60%

40%
Backswing

- Coil the stretch reflex
- **Right Arm**
  - 75-90° Abducted
  - 90° External Rotation
- **Left Arm**
  - Horizontal Adduction
  - Internal Rotation (90°)
  - Scapula: abducted, elevated and outward rotation

0.76-1.10 seconds

78-102°

47-55°
• Pelvis rotates left with right hip extensor and abductors and left adductor magnus
• Left arm externally rotates and moves toward the midline
• Sequential uncoiling of the pelvis, torso, arms, hands and club head
Downswing - Impact

- Left shoulder externally rotates
- Right shoulder internally rotates
- Left hip internally rotates
- Right hip internally rotates
- Weight transferred to the outside of the left foot
- Trunk remains open compared to address

0.005 Seconds – ball on clubface

Most common position of injury at 49.7% of injuries (McCarroll, 2001)
Follow-through

- Left Shoulder – abduction with external rotation
- Right Shoulder – adduction and internal rotation
- Both elbows flex to decelerate the club head
- Left Hip – internal rotation
- Left Ankle - supination
3-D Swing Analysis

- Evaluation of x, y, and z planes
- Efficiency of movement in addition to quality
  - Kinematic Sequencing
  - Evaluation of X-factor
  - Valuable in assessing timing of golf swing
3-D Swing Analysis
## 3-D Swing Analysis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Pelvis</th>
<th>Trunk</th>
<th>Arms</th>
<th>Club</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceleration</td>
<td>kd/s/s</td>
<td>2.4</td>
<td>3.0</td>
<td>4.6</td>
<td>6.9</td>
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<tr>
<td>Deceleration</td>
<td>kd/s/s</td>
<td>-2.3</td>
<td>-3.1</td>
<td>-5.7</td>
<td>-9.5</td>
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<tr>
<td>Max Speed</td>
<td>d/s</td>
<td>487</td>
<td>721</td>
<td>1,077</td>
<td>2,293</td>
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<tr>
<td>Speed Gain</td>
<td>d/s</td>
<td>0</td>
<td>235</td>
<td>356</td>
<td>1,216</td>
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<tr>
<td>Transition Order</td>
<td>ordinal</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>1</td>
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<tr>
<td>Transition Timing</td>
<td>msecs</td>
<td>-13</td>
<td>-8</td>
<td>-21</td>
<td>0</td>
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<tr>
<td>Peak Order</td>
<td>ordinal</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Peak Timing</td>
<td>msecs</td>
<td>125</td>
<td>83</td>
<td>79</td>
<td>4</td>
</tr>
</tbody>
</table>
X-Factor

- First used by instructor Jim McLean to describe how power is generated in the golf swing. (Golf Magazine, 1992)
- Defined as the degree of separation in the transverse plane between the pelvis and the shoulders during the golf swing.
- Most pronounced at the top of the swing.
- Increased at initiation of down swing.
- Thought to elicit the stretch reflex.
X-Factor

Hume et al., 2005

• PGA vs. Amateur (15 hdcp)
  – 11% greater in PGA

• Long Hitters vs. Short Hitters
  – 5 PGA long hitters 38° (avg. PGA Tour Driving Distance Rank 19)
  – 5 PGA short hitters 24° (avg. PGA Tour Driving Distance Rank 161)

• PGA vs. Senior PGA vs. Amateur (17.5 hdcp)
  – 51 male PGA 32°
  – 46 male Senior PGA 29°
  – 34 male amateur 24°
X-Factor Stretch

Unskilled

Skilled

Increase in torso to pelvis angle increases from the top
• Significant increase in ball velocity with increase in X-Factor and X-Factor Stretch. (Myer et al., 2008)

• PGA Tour players showed significantly larger X-Factor vs. low, mid and high hdcp golfers. (Zheng et al., 2008)

• In skilled (<0 hcp) vs. unskilled (hcp>15) golfers, the X-Factor Stretch was significantly greater in the skilled group. (Cheetham et al., 2001)

• 10 PGA Tour players who ranked top 50 in driving distance had larger X-Factors than the rest of the tour players. (McTeigue et al., 1994)
Why is more club head speed important?

• Professionals
  – Hellström 2009 (Literature Review)
    • GIR is greatest performance predictor of scoring average.
    • GIR is positively correlated to distance into the green on approach.

• Amateurs
  – Fradkin et al., 2004
    • Clubhead speed is a valid predictor of performance in amateur golfers.
Injuries in Golf

- Although considered low impact, golf has an alarming rate of injury.
- In 2007, 1/558 golfers presented to the emergency room with an injury. (Brandon and Pearce, 2009)
- In a German Study (Gosheger, et al., 2003), 60% of professionals and 40% of amateurs sustain a golf-related injury each year.
Common Injuries in Golf

McHardy et al. 2006

- Professional Golfers
- Amateur Golfers
- Specific Injury Sites and Mechanisms
Injuries in Professional Golfers

• Most Common Injuries
  – ♂ - Low Back, left wrist, left shoulder
  – ♀ - Left Wrist, low back, left hand

• Most Common Mechanism
  – ♀ and ♂ high volume, repetitive practice
  – Abrupt deceleration of the club head at impact
Injuries in Amateur Golfers

• Most common injuries
  – Low back, wrist, elbow (left), shoulder
  – ♀ lead elbow

• Most common mechanism
  – Poor biomechanics with too much play/practice
Specific Injury Sites and Mechanisms

Low Back
Wrist / Hand
Elbow
Shoulder
Knee
Low Back Injury

- Most common site of injury in professionals and amateurs 23.7-34.5%
- 36% in males vs. 12% in females (Brandon and Pearce, 2009)
- Resulting from high ROM and forces
  - peak compressive forces up to 8xBW
  - amateurs: 80% more lateral bending and shearing and 50% more torque than professionals (common cause of disk injury)
- Professional (Vad et al., 2004) and amateur (Murray et al. 2009) golfers with LBP showed decreased lead hip internal rotation.
Wrist / Hand Injury

- 13-20% of all injuries in amateurs and 20-27% in professionals (McHardy and Pollard, 2005)
- LPGA: 38.8% of UE injuries involved left wrist / hand. (McCarroll, 2001)
- Muscle strains (FCU/ECU), ligament sprains, tendinopathy, fractures of the hook of hamate
- Common Mechanism:
  - Abrupt deceleration of the club head (i.e. fat shots, long rough, etc.)
  - General Overuse
Most common in amateur and female golfers

- 85% of all elbow injuries are lateral (McCarroll, 2001)
- Lateral injuries = overuse (tendinopathy)
- Medial injuries = traumatic (UCL strains)
- Common mechanical causes:
  - Increased grip tension, worn grips, steep angle of approach (fat shots), scooping
Shoulder Injury

• Shoulder injuries account for 8-18% of golf injuries

• Lead shoulder (left) most commonly injured
  – Subacromial impingement, rotator cuff syndrome, acromioclavicular joint disease and glenohumeral instability

• Common Mechanisms:
  – Decreased thoracic spine rotation, length of back swing and follow-through, vertical plane backswing, strong left hand grip

Kim, et al. 2004
Knee injuries account for approximately 6% of golf related injury.

Compressive peak forces on the knee during the golf swing (McHardy et al., 2006):
- Right Knee (backswing) = 540N
- Left Knee (downswing) = 756N
- Peak compressive forces during a squat range from 550 – 7928N (Escamilla, 2001)

Common Injuries:
- Meniscus injury, tibiofemoral degenerative joint disease, patellar fractures

Common Mechanisms:
- ↑ Rotational forces due to ↓ hip mobility,
Common Swing Faults

• Postural Faults
  – Early Extension
  – Loss of Posture
  – S-Posture
  – C-Posture
  – Reverse Spine Angle
  – Flat Shoulder Plane

• Technique Faults
  – Chicken Winging
  – Slide
  – Sway
  – Early Release
  – Over the Top
S-Posture

Common Injuries:
Low back pain

Common Causes:
• Tight hip flexors,
• weak abdominals,
• tight spinal erectors,
• weak gluteals, resulting in taught hamstrings
• poor hip hinge mechanics

25.3% of amateurs
C-Posture

Common Injuries:
Shoulder pain

Common Causes:
• Tight pectoralis major and minor,
• weak serratus anterior,
• tight upper trapezius and levator,
• weak deep neck flexors,
• tight latissimus and sternocleidomastoid

33.1% of amateurs
Common Injuries:
• Low back pain
• Elbow and Wrist pain

Common Causes:
• Weak abdominals
• Weak gluteals
• Poor shoulder rotation
• Poor balance

64.3% of amateurs
Common Injuries:
- Elbow pain
- Low back pain

Common Causes:
- Poor separation of torso from pelvis at start of downswing.
- Abdominal weakness in stability
- Poor lead leg balance
Early Extension

Common Injuries:
- Low back pain

Common Causes:
- Poor squat mechanics
- Decreased lead hip internal rotation
- Poor thoracic rotation
- Inability to separate torso from hips
- Weak gluteals and abdominals

64.3% of amateurs
Common Injuries:
• Hip pain
• Medial knee pain
• Lateral ankle pain
• Low back pain

Common Causes:
• Decreased lead hip internal rotation
• Difficulty separating upper body from lower body
• Poor lead side lateral strength

31.4% of amateurs
Reverse Spine Angle

Common Injuries:
- Low back pain
- Lead (left) shoulder pain

Common Causes:
- Decreased lat flexibility,
- Poor separation of pelvis and shoulders,
- Poor thoracic rotation
- Right hip internal rotation deficit.

38.5% of amateurs
Common Injuries:
- Hip pain
- Medial knee pain
- Lateral ankle pain
- Low back pain

Common Causes:
- Decreased trail hip internal rotation
- Difficulty separating upper body from lower body
- Poor trail side lateral strength
Common Injuries:
- Elbow pain
- Low back pain

Common Causes:
- Poor separation of torso from pelvis at start of downswing.
- Abdominal weakness in stability
- Decrease lead hip mobility
- Poor lead leg balance

55.9% of amateurs
Chicken Winging

Common Injuries:
- Wrist
- Elbow

Common Causes:
- Poor hip mobility
- Poor ankle mobility
- Poor core/pelvic/lumbar spine stability

35.6% of amateurs
Visit #1 – Initial Evaluation (60 minutes)
• Injury evaluation or comprehensive screen
• Swing video

Visit #2 – Follow-up (30 minutes)
• Review corrective exercise plan

Additional follow-ups can be scheduled as needed.
Injury Evaluation

- Injury history review
- Comprehensive orthopedic injury evaluation performed by a licensed athletic trainer
  - Balance, strength, flexibility, mobility, core stability, power
- Video evaluation of golf swing
<table>
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<th>Comprehensive Golf Screen</th>
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<tbody>
<tr>
<td><strong>Golf Specific 12 Point Evaluation</strong></td>
</tr>
<tr>
<td>- Balance</td>
</tr>
<tr>
<td>- Ankle Mobility</td>
</tr>
<tr>
<td>- Knee Stability</td>
</tr>
<tr>
<td>- Hip Mobility</td>
</tr>
<tr>
<td>- Hip Stability</td>
</tr>
<tr>
<td>- Pelvic Mobility</td>
</tr>
</tbody>
</table>

*UW Health*

*University of Wisconsin Sports Medicine*
Exercise Correction

- Review swing fault – physical connection
- Address specific injury evaluation
- Individualized exercise plan based on specific physical limitations and swing faults
- Follow-up with updated exercise every 3-6 weeks as needed
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