

2017年度定例研究会報告

Bridging the Gap

Young-Hoo Kwon




Young-Hoo Kwon, Ph.D.
 ykwon@twu.edu
 Biomechanics Laboratory
 Texas Woman's University, Denton, TX, USA

Bridging the Gap: Application of Biomechanics in Golf

Chulkyo University, July 19, 2017

Application Cycle-Skill Development

Goals


- Short-term goals
- Long-term goals

Scientific knowledge base

- Key performance factors
- Biomechanically robust golf swing

Through swing analysis service...

- Provide diagnosis/prescription
- Accumulate data for further analysis



```

graph TD
    Measurement[Measurement] --> Diagnosis[Diagnosis]
    Measurement --> Evaluation[Evaluation]
    Diagnosis --> Prescription[Prescription]
    Evaluation --> Prescription
    Prescription --> Training[Training]
    Training --> Measurement
            
```

Golf Performance Factors

Accuracy & consistency in

- Distance
- Direction

Shot outcomes

- Square, fade, slice, draw, hook, ...
- High, low, pitch, ...
- Carry & total distance

Impact conditions

- Clubhead velocity (magnitude & direction)
- Clubface orientation
- Location of impact on clubface

Movement pattern

- Backswing & downswing
- Transition
- Swing plane



TWU's Golf Swing Analysis

Optical mocap-based


- Indoors
- VICON
- 10 infrared cameras
- 250 Hz, 1-mega pixel image resolution
- Foam balls

Ground reaction force (GRF) analysis

- 2 AMTI force plates
- GRFs on individual feet

Standard club conditions

- Men: driver, 5-iron, & pitching wedge
- Ladies: driver, 6-iron, & pitching wedge




Quest for Key Performance Factors

Popular conceptual models

- Multi-pendulum model
- Kinematic sequence
- X-factor (stretch)
- Stretch-shortening cycle (SSC)
- Ground-up swing

Issues

- Planar (2D) nature
- Trunk/shoulder rotation-centric
- Too simple
- Exaggeration
- Relationship with performance?



Role of science

- Identify key performance factors
- Eliminate misconceptions
- Provide big-picture/holistic understanding
- Promote evidence-based practice

TWU's Golf Swing Analysis

Motion capture attire


- Men: no shirt & spandex shorts
- Ladies: sport bra (preferred) or sleeveless spandex shirt & spandex shorts

Reflective markers

- 65 markers placed on golfer's body, club, and ball mat
- Mostly on the skin to minimize marker motion artifacts

Analysis

- Kwon3d XP software
- C3D importing



TWU's Golf Swing Analysis

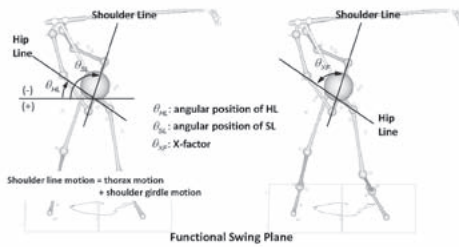
Golfers

- 150+ elite golfers since Nov 2013
- Mainly elite golfers (professional players and competitive amateurs)
- Local junior golfers

PGA/Champions/European/Japanese Tours	Richard Lee	LPGA/KLPGA/LPGA/LE Tours	Long Driver
Kiradech Aphibornrat	Richard Lee	Nia Yoon Choi	Jamie Sadkowski
Tommy Armour III	Jamie Lovemark	Julietta Granada	Will Hogue
Aaron Baddeley	Toru Nakajima	Hye Youn Kim	
Lucas Berregard	Vijay Singh	So Young Kim 2	
Mark Brooks	Mads Søgaard	Sue Kim	
Brad Elder	Scott Stallings	Meena Lee	
JJ Henry	Daniel Summerhays	Mi Hyang Lee	
Mark Hensby	Tyrone Van Aswegen	Daisy Neilson	
Charles Howell III	Grant Waite	Yuling Shi (Seki)	
Trevor Immelman	Tim Wilkinson	Saehye Son	
Matt Kuchar	YE Yang	Jennifer Song	
Lucas Lee		Marissa Steen	

7

On-Plane Angles



11

Areas of Analysis

Temporal

- Event/phase times

Functional swing plane

- Slope/direction
- Swing styles

Body center of mass motion

- Frontal plane

Pelvis/thorax motions

- Linear/angular

Functional double-pendulum

- Shoulder/hip lines
- X-factor
- Upper/lower levers

Kinematic sequence

- Transition sequence
- Peak angular speeds

Ground reaction force

- Ground reaction force
- Center of pressure

Foot-ground interaction torque

- GRF torque
- Pivoting torque

Mid-hand force & torque

Mid-trunk torque

Question 1:
 Are X-factor parameters associated with peak clubhead speed in skilled golfers?

8

12

Application Example: X-Factor Issues

X-factor

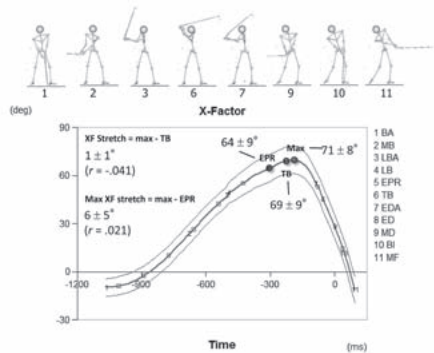
- Separation of the upper torso (shoulder line) from the lower torso (hip line) in the overhead view
- Force-length relationship of the skeletal muscle
- Large x-factor → high clubhead speed?



X-factor stretch

- Increase in the x-factor after top of backswing
- Stretch-shortening cycle (SSC)
- Large x-factor stretch → high clubhead speed?

9



13

Database

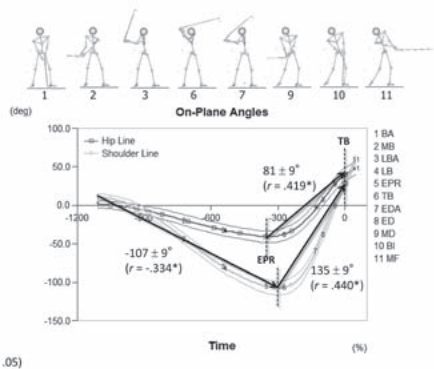
63 elite golfers

- Tour players (PGA, European, Champions, Web.com, & mini tours)
- College varsity players
- Teaching professionals

	Unit	M ± SD	Min	Max
Age	(years)	30.9 ± 8.6	18	55
Mass	(kg)	83.6 ± 8.8	63.5	106.0
Height	(cm)	182 ± 6	170	193
Clubhead Speed (Driver)	(m/s)	48.5 ± 2.4	43.3	54.2
	(mph)	108.7 ± 5.3	96.9	121.2
	(BH/s)	26.8 ± 1.3	24.1	30.0

(BH: body height)

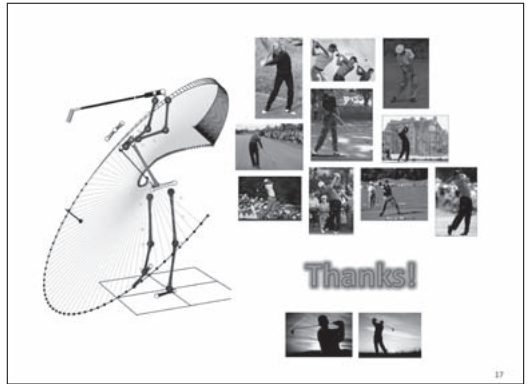
10



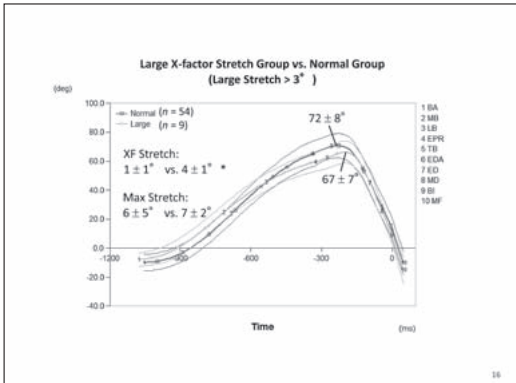
14

Question 2:
Is a large X-factor stretch good?

15



17



16