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A Method of Golf Specific Proprioception to Address Physical Limitations of the Golf Swing

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ABSTRACT

An increasing amount of attention has been placed on sport specific training techniques; yet, very little research has been conducted on golf-specific training programs. Flexor Sports Training Program™ has been designed to improve golf-specific strength, flexibility, and balance using a proprioceptive approach. The purpose of this study was to determine the effects of this program on strength, flexibility, balance, swing mechanics, and golf performance in a group of 17 golfers (12 males and 5 females, average age: 43.3 ± 12.0 years, USGA handicap: 12.5 ± 7.9). After completion of the program, driving distance increased 14.9 yards on average that resulted from changes in swing mechanics, and increased ball and club head speed. Improvements in physical characteristics were bilateral hip flexion and abduction flexibility, bilateral hamstring flexibility, bilateral torso rotation flexibility, bilateral torso rotation strength, lead hip abduction/adduction strength, and balance while standing on the lead leg with eyes open. Changes in swing mechanics included decreased loads on the non-lead foot during the backswing, decreased trunk forward tilt angle during the whole time of the golf swing, decreased trunk side-bending angle during the downswing, and increased shoulder rotational velocity during the downswing. The Flexor Sports Training Program™ has resulted in significant improvements in unique golf-specific physical characteristics, swing mechanics, and golf performance. The program can be applied to enhance the driving performance of golfers.

Keywords: proprioception, neural function, functional stability, golf specific

INTRODUCTION

Biomechanical swing characteristics of successful golfers, such as greater and faster backswing (Cochran & Stobbs, 1968; McTeigue et al., 1994) greater separation between the pelvis and shoulder orientation (i.e. the X-factor) (McLean, 1992; Myers *et al.*, 2008), quicker trunk rotation (McTeigue *et al.*, 1994; Robinson, 1994) more and faster weight shift (Jorgensen, 1994; Koenig et al., 1994; Wallace et al., 1990) and later release of club (Cooper & Mather, 1994; Pickering & Vickers, 1999; Robinson, 1994) have been investigated and applied on golf instructions (Hume et al., 2005). However, achieving those desired swing movements can be very difficult for many people due to their physical limitations. For example, creating greater X-factor requires higher strength and flexibility of trunk muscles, and better balance is necessary to utilize greater and quicker body weight shift. It is known that more proficient golfers have significantly better strength, flexibility, and balance (Sell et al., 2007). Furthermore, playing on the unlevel surfaces of a golf course demands even greater physical ability to stabilize the swing and prevent compensatory movements. It is not surprising that more golfers and instructors have gradually realized the importance of physical training to golf performance.

Therefore, various physical training programs designed to enhance golf performance have been developed (Doan et al., 2006; Fletcher & Hartwell, 2004; Hetu et al., 1998; Lennon, 1998; Lephart et al., 2007; Thompson & Osness, 2004; Wescott & Parziale, 1997). With the exception of Lephart *et al.*'s study (2007), which involves simulated golf swing movements using elastic tubes, most of them only apply general strength and flexibility exercises. However, for a highly complex series of movements such as a golf swing, a performer needs not only strength, flexibility, and balance, but the neural ability to coordinate and utilize these factors of each body segment at proper magnitude and timing, which could hardly be achieved by general physical trainings that isolate local areas of the body and are not functionally golf-specific.

The Flexor Sports Training Program™ was designed to improve physical characteristics and golf performance for recreational golfers by providing proprioceptive stimuli. Besides its exercises that simulate the golf swing, the program is unique as it destabilizes the ground support to reinforce the overall body functional stability via the use of different platforms. The purpose of this research was to assess changes in physical characteristics, swing mechanics, and golf performance of recreational golfers following the Flexor Sports Training Program™. We hypothesized that the program will improve golfers' strength, flexibility, and balance, change the swing mechanics, and therefore increase golf performance.

METHODS

Participants and Design

Seventeen healthy, recreational golfers participated in this study (12 males and 5 females, average age: 43.3 ± 12.0 years, stature: 1.74 ± 0.11 m, mass: 72.6 ± 11.9 kg, USGA handicap: 12.5 ± 7.9). All subjects provided written informed consent in accordance with University's Institutional Review Board prior to participation.

This study utilized a pretest-posttest experimental design. All subjects reported for two testing sessions separated by eight weeks of home-based training. Subjects returned at week 3 and 6 to learn advanced exercises. All testing sessions were performed at the Golf Fitness Laboratory (GFL) of the Neuromuscular Research Laboratory.

Testing Methods

Balance Assessment

Single-leg balance was assessed with a force platform (Kistler Instrument Corp., Amherst NY). Data were recorded using Peak Motus System version 7.3 (Peak Performance Technologies, Inc., Englewood CO). Each subject was asked to perform 5 trials (10 seconds) on each leg.

Isokinetic Strength Assessment

Isometric strength of the hips (abduction/adduction) and isokinetic (60 °/s) strength of the torso (rotation) was assessed with the Biodex System III Multi-Joint Testing and Rehabilitation System (Biodex Medical Inc., Shirley NY). Torque values were normalized to body weight.

Flexibility Measurements

Flexibility was measured using a standard goniometer following standard procedures used in the clinical practice by a physician. Passive examination was performed for hip abduction and flexion, torso rotation. Hamstrings flexibility was assessed with the active knee extension test.

Swing Mechanics and Performance Assessment

Swing kinematics and weight shift were assessed with an 8-camera 3-D motion analysis system and two force plates. Ball speed, carry distance and total driving distance were measured within the GFL Golf Simulator (Flight Scope Sim Sensor (EDH, Ltd., South Africa)).

The Training Program

The Flexor Sports Training Program™ employs affordable and easy to use training equipment, including a physio-ball, a foam tube, and rubber discs, in a series of exercises completed in a specific order and “in-position™” of a golf swing (i.e., the exercises are performed in exactly the positions a golfer will use in the golf swing). The exercises work the entire body in all phases of the golf swing and reinforce the neurological response associated with all the relevant muscle groups in the sequence that they would in the golf swing.

There are three primary conditions in which the exercises are performed including lying supine (Figure 1A), seated on a physio-ball (Figure 1B), and standing (Figure 1C) with one foot on a rubber disc, with movements into both the backswing and forward swing within these conditions. The first progression of the exercises occurs on week 3, while the 4th condition of

lunging with one knee on a rubber disc, and a finish drill that simulating the pivoting and follow-through of the golf swing added into the routine. Another progression occurs on week 6, while an additional rubber disc is added to the standing condition, and the back foot's toe is instructed to be off the floor. (See Appendix for more details.)

Statistical Analysis

With the expectation that the training program would increase the strength, flexibility, balance, and performance, one-tailed paired t-tests were used to compare each variable (pre-training vs. post-training). Statistical analysis was performed with SPSS 11.5 (SPSS Inc., Chicago IL). Statistical significance was determined at $p < 0.05$.



Figure 1. Examples of exercises in the training program.

RESULTS

Physical Characteristics:

Physical characteristics demonstrated significant improvement with the training program (Table 1). Torso rotation strength increased over 18% in both directions, while the lead hip abduction and adduction also increased over 10%. Torso, hip, and hamstrings flexibility all significantly increased (Lower value in hamstrings indicates better flexibility). Single-leg balance was also significantly improved for 8% ($p=0.016$) and 13% ($p=0.026$) for left and right leg, respectively.

Swing Mechanics:

Significant changes in swing mechanics included decreased body weight distributed on the lead foot during the backswing (4.5% decrease at the top of swing), 6.4° of decrease in trunk forward tilt throughout the swing, 1.9° decrease in torso side-bending during the downswing, and

increased shoulder rotational velocity of 17°/s at the acceleration point (i.e. 2/3 of the time from top to impact) and 21°/s at the impact.

Performance:

Ball speed increased from 134.3 mph to 139.6 mph ($p=0.002$), with club head speed increasing from 90.7 to 93.4 mph ($p=0.025$). Driving distance (carry) improved 13.8 yards (209.5 to 223.3 yards, $p=0.002$), and total distance increased 14.9 yards (222.8 to 237.7 yards, $p=0.001$).

Table 1. Significant changes in strength and flexibility.

	Pre		Post		p-value
	Mean	±SD	Mean	±SD	
Torso Rotational Strength - Left 60°/Sec (%Body Weight)	122.74	31.23	153.68	38.96	<0.001
Torso Rotational Strength - Right 60°/Sec (%Body Weight)	122.60	37.07	144.85	38.87	0.005
Hip Strength - Lead Hip Abduction (%Body Weight)	131.24	37.77	144.77	35.80	0.034
Hip Strength - Lead Hip Adduction (%Body Weight)	128.29	38.17	152.74	50.42	0.002
Torso Flexibility - Left (°)	73.19	6.12	76.00	6.17	0.033
Torso Flexibility - Right (°)	72.63	9.93	78.47	8.19	<0.001
Hip Flexibility - Left Hip Flexion (°)	140.47	7.52	144.53	6.75	0.003
Hip Flexibility - Right Hip Flexion (°)	139.65	8.41	142.82	5.71	0.010
Hip Flexibility - Left Hip Abduction (°)	29.59	6.58	33.65	6.41	0.037
Hip Flexibility - Right Hip Abduction (°)	27.82	6.72	32.47	4.36	0.025
Hamstrings Flexibility - Left (°)	22.78	9.75	17.78	9.77	0.009
Hamstrings Flexibility - Right (°)	20.82	8.90	16.06	9.14	0.028

DISCUSSION

The purpose of this study was to assess the effect of the Flexor Sports Training Program™ on physical characteristics, swing mechanics, and golf performance in recreational golfers. With the belief that the training should approximate the real sporting activity as closely as possible, the Flexor Sports Training Program™ is not only one of few training programs that involve golf-specific movements, but also addresses the effect of the unlevel surface during real game situation.

By mimicking the multi-segment movements of golf swing, the program provides proprioceptive stimuli that functionally enhance the strength and flexibility that meet the demand of golfing, and remodels the motor program of the swing, to improve the golf performance. Furthermore, with performing most of the drills on physio-ball or rubber disc, the program develops the balance and establishes the stability and control needed to maintain the swing pattern on unlevel surface. The results of this study demonstrated post-training changes in swing mechanics, as well as improvement in strength, flexibility, balance, and performance.

APPLICATION

The Flexor Sports Training Program™ was designed based on the idea that the ability to produce the force necessary to swing the golf club at the right time in the right plane for the desired ball flight is not only a function of strength and flexibility, but is also highly balance dependent. To improve the swing ability, repetitive golf-specific movements are utilized in the training program to functionally stimulate the proprioceptive response, and therefore enhance and remodel the overall movement pattern that coordinates multiple segments of the whole body, while building the physical capability of golfers simultaneously. The Flexor Sports Training Program™, which involves affordable equipment and simple drills, can be applied by golfers and golf instructors to fix and improve the swinging skills for desired performance without creating unexpected compensatory movements.

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APPENDIX**The Exercise Log of The Flexor Sports Training Program™**

Basic Drills	Week 1 - 2	Week 3-5	Week 6-8
I. Lying Down with Stability Ball	3 Movements	2 Movements	1 Movement
Back Swing	5 Counts * 5 Reps	5 Counts * 10 Reps	5 Counts * 10 Reps
Forward Swing	5 Counts * 5 Reps	5 Counts * 10 Reps	5 Counts * 10 Reps
II. On the Stability Ball	4 Movements	3 Movements	2 Movements
Back swing with R foot on disc	5 Counts * 5 Reps	5 Counts * 10 Reps	5 Counts * 10 Reps
Forward swing with L foot on disc	5 Counts * 5 Reps	5 Counts * 10 Reps	5 Counts * 10 Reps
III. Standing	4 Movements	3 Movements	2 Movements (Both Feet on Discs)
Back swing with R foot on disc	5 Counts * 5 Reps	5 Counts * 10 Reps	5 Counts * 10 Reps
Forward swing with L foot on disc	5 Counts * 5 Reps	5 Counts * 10 Reps	5 Counts * 10 Reps
Additional Drills		Week 3-5	Week 6-8
I. On one knee		3 Movements	3 Movements (Toes up off the Floor)
Back swing with L knee on disc		5 Counts * 10 Reps	5 Counts * 10 Reps
Forward swing with R knee on disc		5 Counts * 10 Reps	5 Counts * 10 Reps
Back swing with R foot on disc		5 Counts * 10 Reps	5 Counts * 10 Reps
Forward swing with L foot on disc		5 Counts * 10 Reps	5 Counts * 10 Reps
II. Finish Drills		3 Counts * 10 Reps	3 Counts * 10 Reps
Exercise Frequency: 3 to 4 Times a Week			