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ScienceDirect

Journal of Sport and Health Science 5 (2016) 219–225

www.jshs.org.cn

Original article

Effects of core and non-dominant arm strength training on drive distance in elite golfers

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Received 29 May 2014; revised 25 August 2014; accepted 15 December 2014

Available online 23 April 2015

Abstract

Background: Various training schemes have sought to improve golf-related athletic ability. In the golf swing motion, the muscle strengths of the core and arms play important roles, where a difference typically exists in the power of arm muscles between the dominant and non-dominant sides. The purposes of this study were to determine the effects of exercises strengthening the core and non-dominant arm muscles of elite golf players (handicap < 3) on the increase in drive distance, and to present a corresponding training scheme aimed at improving golf performance ability.

Methods: Sixty elite golfers were randomized into the control group (CG, $n = 20$), core exercise group (CEG, $n = 20$), and group receiving a combination of muscle strengthening exercises of the non-dominant arm and the core (NCEG, $n = 20$). The 3 groups conducted the corresponding exercises for 8 weeks, after which the changes in drive distances and isokinetic strength were measured.

Results: Significant differences in the overall improvement of drive distance were observed among the groups ($p < 0.001$). Enhancement of the drive distance of NCEG was greater than both CG ($p < 0.001$) and CEG ($p = 0.001$). Except for trunk flexion, all variables of the measurements of isokinetic strength for NCEG also showed the highest values compared to the other groups. Examination of the correlation between drive distance and isokinetic strength revealed significant correlations of all variables except trunk flexion, wrist extension, and elbow extension.

Conclusion: The combination of core and non-dominant arm strength exercises can provide a more effective specialized training program than core alone training for golfers to increase their drive distances.

Keywords: Core exercise; Drive distance; Elite golfer; Isokinetic strength; Non-dominant arm strength exercise

1. Introduction

Over 35 million people enjoy playing golf, and this game has been gaining popularity globally.[1] Scientific approaches to improving the golf ability have recently focused on physical strength, in contrast to the past where consistent accuracy and putting techniques were regarded as having more significance.[2] This shifting of the focus has been occurring in recent years due to lengthening of the course yardage. For this reason, golfers require more physical strength to endure the extended time of a typical round, and to provide explosive swing power to cover longer distances, which can be intensified by a widened range of motion (ROM).[3]

Specialized training programs such as plyometrics training,[4] golf specific muscle power training,[5,6] or core training[7,8] have been applied to golfers with positive outcomes. The trunk of a golfer is the most vulnerable part to injury,[9] typically attributable to bad posture and improper swing mechanism, or weakened trunk muscle strength due to exercise deficiency. Strengthening of the core muscles could protect against injury while also improving golfing ability.

Core muscles are defined as the essential peripheral muscles of the spine and abdomen required for stabilizing the backbone, and for maintaining the balance of the pelvis.[10] In

Peer review under responsibility of Shanghai University of Sport.

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http://dx.doi.org/10.1016/j.jshs.2014.12.006

2095-2546/

a study applying core muscle training to golfers for 12 weeks, the flexibility, core muscle strength, and performance of drives were improved.[7] The club head speed was also found to increase after the application of training for 11 weeks.[11] The reason for the benefits can be understood by examining the mobilization of core muscles in the swing span of the club. The rectus abdominus muscle in the stance position, the external oblique muscle for the back swing, and the external oblique and rectus abdominus muscles for creating power for the down swing all play important roles for each segment of the swing.[12]

Another important contributor to the swing motion is the non-dominant arm. The non-dominant arm controls the club, from the back swing to the down swing.[13] In the back and down swing aspects, including gripping the club, the roles of the extensor carpi ulnaris, flexor carpi ulnaris, and posterior deltoid in the non-dominant arm are as important as the muscles in the dominant arm.[12] In addition, the non-dominant arm complex is also influential in generating power in the swing,[14] as the forearm could lead the flexor burst in the acceleration section of the swing.[15]

Despite these important roles of the non-dominant arm, specialized strength training for this arm is uncommon. The muscle force of the dominant arm is reportedly about 10% greater than the non-dominant arm.[16,17] However, studies have lacked findings on the influence of strengthening muscles of the non-dominant arm (typically the left one in a right handed golfer) on swing performance. Golfers who utilize the dextral arm muscles are typically unskilled in the use of sinistral arm muscles; strengthening of the non-dominant upper limb to balance the power between both arms is required.[18]

The combination of accuracy and drive distance is important in modern golf ability.[13,19] Golf relies on a successful drive,[20] and the drive distance is highly correlated with the scores of elite golfers.[21] Numerous studies have reported the effects of various training methods on drive distance,[4–7] but the effects of strengthening training of the non-dominant arm on golf ability remain unclear. Therefore, this study examined the influence of such strength training on drive distance and assessed the correlation between strength and drive distance. We hypothesized that a combination of core and non-dominant training would increase drive distance, and that there would be a positive correlation between isokinetic strength of the non-dominant arm and drive distance.

2. Materials and methods

2.1. Participants

The sample size was determined to have a set effect size, error, and power value of 0.42,[22,23] 0.05, and 0.8, respectively, to use the F-value through power analysis (G-power program 3.1.3, Kiel, Germany).[24] Sixty golfers participated in this study, all of whom were right handed male Korean elite golfers with careers of over 5 years and handicaps of less than 3, who also periodically participated in tournaments. They were free from any musculoskeletal system disorders and had never participated in resistance training to improve their golfing abilities, apart from regular training. This study was approved by the Konkuk University Research Ethics Committee. After agreeing to participate, the participants were informed about the procedures and aims of the study and signed a written informed consent.

The 60 participants were randomly assigned to a control group (CG, n = 20), a core muscle exercise group (CEG, n = 20), and a group with combined strengthening exercises of the non-dominant arm (in this study, the left arm) and core muscles (NCEG, n = 20). All participants visited the biomechanics laboratory at Konkuk University for measurement of body composition (InBody 4.0; Biospace, Seoul, Korea).

2.2. Exercise program

The 60 participants completed the entire 8 weeks of the study program, and all participants in the CEG and NCEG attended an 8-week training program without withdrawal.

The CG did not receive any specific intervention other than conventional golf swing training. The CEG only performed core exercise, which was carried out for 60 min per day, 3 times a week, for 8 weeks. An initial core muscle exercise program aimed to achieve basic balance and muscle force during the first 4 weeks, after which it was configured to secure dynamic balance by active improvement in muscle strength, aiming for the combination of dynamic balance and strength for the remaining 4 weeks (Fig. 1 and Table 1). The NCEG performed non-dominant arm exercise in addition to the core exercise. The non-dominant arm strength exercise program for NCEG consisted of 6 exercises which were highly relevant to the golf swing motion to improve the function of the forearm, biceps, and shoulder. The NCEG carried out exercise 60 min per session, 6 times a week, for 8 weeks. Core and non-dominant arm strength exercises were applied alternately each day.

A 10-min stretching session was included in all exercise programs as a warm-up and at the close of each exercise session. Before application of the exercise programs, all participants were tested to measure the maximum muscle force for each weight training exercise, and the corresponding exercise intensities were assigned to each participant based on the test results. The 1 repetition maximum (1RM) was measured again 3 weeks after starting of the exercise programs to adjust the exercise loads to accommodate for respective strength gains, as described previously.[25]

2.3. Measurement of drive distance

Drive distance was measured using a radar-based detecting device, Flight Scope KUDU (EDH, Orlando, FL, USA), with data collected from measurements within the range of ±15 m (the right and the left deviation) for balls hit with correct club impacts (Smash factor ≥1.47). Performance of the Flight Scope KUDU was comparable to the laser-based rangefinder. Average error and standard deviation of the Flight Scope KUDU was 0.50 m and 2.02 m, respectively. The drive distances of participants were measured 5 times using their