International Journal of Science Culture and Sport
March 2018 : 6(1)
ISSN : 2148-1148
Doi : 10.14486/IntJSCS722

A Four-Week Upper-Extremity Exercise Program on a Balance Device Improves Power and Stability in Collegiate Golfers

Elise P. STRUTT[†1], Andrew L. SHIM[‡2], Michael WALLER[‡3], Daniel JUNG[‡4], Kathleen ZAJIC[‡5]
[1]Department of Kinesiology & Human Performance, Briar Cliff University, Sioux City, IA, USA
[2]Department of Kinesiology & Exercise Science, College of St. Mary, Omaha, NE, USA
[3]Department of Health & Physical Education, Arkansas Tech University, Russellville, AR. USA
[4]Department of Biology, Briar Cliff University, Sioux City, IA, USA
[4]Department of Health Professions, College of St. Mary, Omaha, NE, USA
Email: ashim@csm.edu
[†]Denotes graduate student author, [‡]Denotes professional author

Type: *Research Article (**Received:** 07.01.2018 – **Corrected:** 14.02.2018 – **Accepted:** 22.02.2018)*

Abstract

Relatively little research has been conducted examining the physical characteristics that are important to a golfer's performance. The investigators studied whether a series of upper-extremity exercises on a balance device would significantly improve upper-extremity stability and power in collegiate golfers. A total of 23 collegiate golfers (ages: 20.4 ± 1.4 years, height: 67.7 in ± 6.6 in, weight: 171.8 lb. ± 87.6 lb.) participated in the study. A two group non-equivalent pre-test/post-test design was selected for this study. Testing included shoulder flexion, hyper-extension (shoulder flexibility), and a Closed-Kinetic Chain Upper-Extremity Stability test (Upper-Extremity stability and power). Testing was conducted before and after a 4-week upper-extremity exercise conducted on a balance device. An independent t-test was selected to analyze differences if any between the experimental and control group. The experimental group revealed a significant improvement in upper-extremity power (p=0.01) and stability (p=0.01). The shoulder flexibility for the experimental group demonstrated no significance (p=0.058) in the left shoulder hyperextension but showed significant value (p=0.033) in the right shoulder hyperextension. The control group demonstrated a significant (p=0.044) decrease in shoulder flexion in the right shoulder. The results demonstrate that specific upper-extremity exercises on a balance device do improve upper-extremity power, upper-extremity stability, and over-head shoulder flexibility within 4 weeks.

Keywords: Closed-Kinetic Chain Upper-Extremity Stability Test (CKCUEST), Shoulder Flexibility, Golf, Conditioning

Introduction

In a basic description of golf, one would say golf is a sport where you hit a small white ball to a small hole over a few hundred yards. The truth is, golf is not so simple after all. A golf swing requires a set of relatively short but highly complicated movements, in a specific sequence. The golf swing consists of a slow, deliberate rotation away from the target, followed by a powerful trunk, shoulder, and hip rotation towards the target. The change from the backswing to the follow-through requires a quick shift of weight from the one side of the body to the other (Lindsay et al., 2014; Nesbit et al., 2015). The flexibility of the shoulders, the rate of force development at the top of the backswing, and the ability to shift weight smoothly are all variables which separate golf players with low stroke averages (handicaps >0) from average golf players (handicaps 1-20) (Gryc et al., 2015; Sell et al., 2007).

As demonstrated by elite golfers and tour professionals, to perfect a golf technique requires several hundred repetitions per day. Each repetition of the golf swing requires backward shoulder rotation, and a hyperextension of whichever shoulder is furthest from the target, a downward-shoulder motion followed by a hyperextension by the shoulder closest to the target (Lindsay et al., 2014; Mitchell et al., 2003). By consistently repeating the shoulder rotations and range of motions, the over-use of shoulder joints could easily cause an injury (Cohn et al., 2013; Lindsay et al., 2014). Gosheger et al. (2003) reported that 82.6% of golf-related injuries are caused by overuse of poorly conditioned joints and that shoulder injuries are among the top three most injured sites. By establishing an exercise program where the upper-extremities, especially the shoulder joints, are properly conditioned, the risk of injuries could be lowered (Cohn et al., 2013).

The greater shoulder rotation and shoulder hyperextension can create a larger swing arch. A larger arch means there is more distance to create a high club head velocity. Nesbit and Serrano (2005) describe how the primary generation of power (the initial movement) in a golf swing comes from the torso, but the secondary generation of power (the generation of the club head velocity) comes from the shoulders. They conclude that the generation of joint power is mostly dependent on joint range of motion. Therefore, club head velocity is reliable on the joint range of motion.

Not only is golf performance reliant on shoulder flexibility and upper-extremity power, the ability to shift weight smoothly from a backswing to a follow-through quickly and the ability execute shots from even and uneven ground surfaces is essential in golf. Wells et al. (2009) found a strong positive correlation between balance and greens in regulation and another strong positive correlation between balance and the distance of putts after a chip shot. Gryc et al. (2015) found similar results by comparing four elite golfers. The top ranked golfer in the group had significantly higher stability and club head speed. This indicates that the proprioceptive ability to transfer weight while making a powerful swing motion is critical to generate powerful and controllable golf swing.

The introduction of balance devices into conditioning programs is a relatively accepted practice among many sport activities. Very few studies have been conducted regarding upper-extremity specific exercises on a balance device. With regards to an upper extremity movement such as golf, exercises on balance devices should be recommended since stability is a variable which increases club head velocity greatly (Gryc et al., 2015; Mitchell et al., 2003). By incorporating a balance device in a golf conditioning program that could develop power, improve stability, and increase shoulder flexibility simultaneously would be beneficial towards performance. Very little research has been done to study adequate conditioning programs for golf players, especially in the specific areas of upper extremity stability and power. The purpose of this study was to examine whether a series of upper-extremity exercises on a balance platform would improve upper-extremity power, stability, and shoulder range of motion in college golfers.

Methods

Participants

Twenty three collegiate golfers were asked to participate in the study. All participants completed a medical history and signed the informed consent according to the university's Institutional Review Board who granted permission to conduct this study. Participants were divided into an experimental and control group. Thirteen of the participants agreed to be part of the experimental group and 10 participants agreed to be placed in the control group. The experimental group consisted of 4 males and 9 females. The control group consisted of 9 males and 1 female. All the participants were physically active, exercising 2 times a week prior to the study.

Table 1. Subject Characteristics.

	Ages (years)	Height (in.)	Weight (lb.)
Control			
Male (n=4)	20.5 ± 1	69.79 ± 1.94	160.25 ± 26.25
Female (n=9)	20.2 ± 0.97	65.04 ± 2.3	166.29 ± 42.4
Group (n=13)	20.31 ± 0.95	66.5 ± 3.11	164.43 ± 37.14
Experimental			
Male (n=9)	20.44 ± 1.42	69.51 ± 4.28	176.47 ± 31.63
Female (n=1)	21	63.87	160.4
Group (n=10)	20.5 ± 1.35	68.95 ± 4.41	174.86 ± 30.26

Protocol

The exercises prescribed to the experimental group were practiced on a balance device (StrongBoard LLC, El Segundo, CA.)). This board was designed to create an unstable surface on which a variety of exercises could be done. It consisted of two platforms, joined by 4 compression springs. The compression springs were in the middle of the two platforms, allowing the top board to become unstable when weight is placed on it. All testing procedures and exercises were conducted in the university motor behavior research laboratory. Before every exercise session, all participants were required to complete a 15-minute general warm-up.

Upper-body stability and power were tested by using the Closed-Kinetic Chain Upper-Extremity Stability test (5). It is a test which requires two spots at three foot apart. The participant acquires a push-up position with hands between the two spots. The participant touches each spot with the opposite arm and continues alternating to each side for 15 seconds as fast as possible. The first set is done as a warm-up, proceeded by three trials with a 40 second break between sets. The average amount of touches for the three sets is calculated and used to calculate a normalized score and a power score. Power is calculated by multiplying the average number of touches by 68% of the subject's body weight (lb.) divided by 15. Shoulder flexion and hyperextension on both the left and right side were measured by a goniometer according to procedures described by Norkin and White (1985).

The training program was a 4-week training program, consisting of 8 exercises, 3 times a week. Each exercise was a dynamic upper-body exercise with a certain number of repetitions. The exercises had a 2-minute break in between to achieve maximal effort for every exercise. The Closed-Chain Upper-Extremity Stability Test is widely used by physical therapists to evaluate shoulder stability and upper-extremity power. Thus, making it the perfect test in this study. Flexibility was measured by finding the shoulder flexion and hyper-extension of both the right and left shoulders. The shoulder flexibility test was The CKCUEST and the shoulder flexibility test were conducted before and after the 4-week exercise program

Statistical Analysis

SPSS (ver. 24; Chicago, IL) was used to calculate all the data. A Levene's Test for Equality was calculated to determine equal variances assumed. A two-tailed independent t-test was used to compare inter-group means of the upper-extremity power, upper-extremity stability, average amount of touches and shoulder flexibility. For the inter-group calculations, the differences between the pre-and post-tests results were calculated and used to find group means and to further calculate the t-test. The intra-group calculations used the pre- and post-test result means to calculate the upper-extremity power, upper-extremity stability, average amount of touches and shoulder flexibility ($p=0.05$).

Results

Upper-Extremity Power

Statistically significant ($p=0.01$) improvements were observed in the inter-group comparison of upper-extremity power in the CKCUEST (refer to Table 2). The mean difference of the pre-and post-test for the experimental and control group were 63.34 and 4.05 respectively. The intra-group results agree with the inter-group results as the experimental group's pre- and post-test comparison reflected a significant ($p=0.01$) result. However, the pre- and post-test of the control group had no statistical significance ($p=0.498$).

Table 2. CKCUEST Power Pre- and Post-Test Mean ± SD

	Pre-Test	Post-Test
Control	215.68 ± 35.5	219.73 ± 44.51
Experimental	162.75 ± 45.13*	226.09 ± 49.61*

The * indicates significance at the 0.05 level.

Upper-Body Stability Test

The results for the stability calculations in the CKCUEST mirror the results of the power calculations (refer to Table 3). The inter-group differences of the pre- and post-test were significant ($p=0.01$). The experimental group showed a great improvement when the pre- and post-tests were compared ($p=0.01$). Yet again, the control group failed to show any significance when their pre- and post-test scores were compared ($p=0.796$).

Table 3. CKCUEST Stability Pre- and Post-Test Mean ± SD

	Pre-Test	Post-Test
Control	.40 ± .09	.40 ± .09
Experimental	.33 ± .07*	.46 ± .07*

The * indicates significance at the 0.05 level.

Flexibility

Table 4 revealed no significance in the right shoulder flexion of the inter-group comparison (p=0.555) and the left shoulder flexion (p=0.421). However, for the shoulder hyperextension on the right side, there was a significant difference (p=0.033) and the left shoulder hyperextension had no significance (p=0.56).

No significance was found in the pre- and post-test comparison of the experimental group's right shoulder flexion (p=0.106) nor was there a significance in the left shoulder flexion (p=0.415). The experimental group did have a significant result for the right shoulder hyperextension (p=0.033) and no significance in the left shoulder hyperextension (p=0.058) was found. The control group had an interesting significance in the right shoulder flexion (p=0.044). The difference is significant but the pre-test mean (193.27) was significantly higher than the post-test mean (180.69). The left shoulder flexion had no significant results (p=0.121), as did the right shoulder hyperextension (p=0.804) and left shoulder hyperextension (p=0.451).

Table 4. Shoulder Flexibility Pre- and Post-Test Measurements Mean ± SD

	Pre-Test	Post-Test
Right-Shoulder Flexion		
Control	193.27 ± 21.1*	180.69 ± 5.35*
Experimental	190.37 ± 21.38	198.64 ± 26.88
Left-Shoulder Flexion		
Control	196.93 ± 31.11	181.33 ± 5.97
Experimental	189.2 ± 35.25	195.36 ± 24.63
Right-Shoulder Hyperextension		
Control	81.76 ± 8.43	82.16 ± 10.84
Experimental	74.36 ± 10.95	84.54 ± 15.33
Left-Shoulder Hyperextension		
Control	79.63 ± 9.07	81.93 ± 11.89
Experimental	74.98 ± 11.28*	82.2 ± 8.45*

The * indicates significance at the 0.05 level.

Average Number of Touches

When the between-groups means of the pre- and post-test were compared, the results were significant (p=0.01). The mean amount of touches from the experimental group increased from 22.1 touches in 15 seconds to 30.66 in the pre- and post-tests and resulted in a significant difference (p=0.01). The control group had little difference as the mean went from 27.23 touches in 15 seconds to 27.59, thus, resulting in no significance (p=0.630). When the differences of the pre- and post-test results were compared between the groups, the results were significant once again (p=0.01).

Table 5. CKCUEST Average Number of Touches Pre- and Post-Test Means ± SD

	Pre-Test	Post-Test
Control	27.23 ± 6.3	27.59 ± 6.37
Experimental	22.1 ± 5.38*	30.61 ± 5.53*

The * indicates significance at the 0.05 level.

Discussion and Conclusion

Upper-extremity power between the groups greatly improved in the experimental group. The pre-test mean for the experimental group was 162.75 W and for the control group it was 215.68 W. However, by the post-test measurements, the experimental group had a mean power of 226.09 W and the control group had a power mean of 219.73 W. A golf swing requires work to be done to create kinetic energy in the club head. The greater the kinetic energy (club head speed), the greater impact the club head will have on the ball, causing the ball to go further and even spin faster (Nesbit et al., 2005). The individual requires power to be able to accelerate the club head speed after the work is done to generate a greater club head speed. Research comparing golfers from different skill levels were examined and it was found that advanced level golfers had significantly greater arms speed during the swing (Wrobel et al., 2012). A study which was similar to the current study and found similar results is Lephart et al. (2007). By developing a golf-specific training program, golfers significantly improved power and stability, which resulted in an increased club head velocity, carry distance and total distance. The current study improved upper-extremity power and stability as well and will also likely assist in club head velocity, carry distance, and total distance.

Stability was another variable which demonstrated improvement. Wrobel et al. (2012) found that players from more advanced levels of golf had significantly better postural stability than intermediate golfers. Therefore, if this exercise program improves postural control, it could greatly benefit the smooth transition between the back-swing and follow-through. Wrobel et al. (2012) also found better postural control during the point of maximal arm speed. This means that the more advanced golfers could shift weight during a high-speed movement more comfortably. The exercises used in the study were designed to exercise stability as well as a full range of motion in dynamic power movements simultaneously. Therefore, upper-extremity exercises on a balance device will improve an individual’s comfort with shifting weight during a power movement, in turn, improving a golf swing.

The shoulder flexibility displayed an interesting result as the shoulder flexion had no significant results in either group. The hyperextension on the right-shoulder did reveal a significant result. The hyperextension of the left-shoulder came very close to being accepted as significant as the significance level is 0.058. The means for the hyperextension of the left shoulder was a 7.2^{o} improvement for the experimental group and a -2.3^{o} decline for the control group. Even if the significance level is insignificant, the means show an improvement in the experimental group. A study which found a similar result was conducted by Santos et al. (2010). They found that sedentary women improved flexibility during an 8-week resistance training program, in the current study shoulder hyperextension improved during a 4-week power and stability program. When exercising resistance training, tendon and ligament strength improves and will create a more powerful contraction. This contraction will pull joints and ligaments, causing them to stretch, which would increase flexibility (Spirduso et al., 1995). In the current study, the increase in muscle power may have gradually stretched the pectoralis major tendon, creating a larger range of motion. The golf swing does not require a shoulder flexion during the swing, but considering the exercises used on the balance device, many shoulder movements which resemble an over-head extension were exercised. The hyperextension movement is used in the back-swing and follow-through. Recent studies have found that golfers who could create a shoulder rotation and had a greater shoulder rotation had lower stroke averages (Sell et al., 2007). Therefore, if the series of exercises could improve hyperextension in the shoulder rotator cuff, it will likely assist in the individual's full range of motion on the backswing arch and in the follow-through arch (Gryc et al., 2015; Nesbit et al., 2005).

Mitchell et al. (2003) describe the movements of the left and right shoulder during the golf swing. In a sample group of right-handed golfers, they concluded that the right shoulder does have a larger hyperextension in the backswing compared to the left shoulder in the follow-through part of the swing. In the current study, with 22 out of 23 participants being right-hand golfers as well, the right shoulder's hyperextension was more than the left shoulder, which would agree to the study of Mitchell et al. (2003).

The control group's decrease in both the left and right shoulder flexion should be a concern. Lack of shoulder mobility places an athlete at a high risk for an injury (Mitchell et al., 2003). Daneshmandi et al. (2010) state that by not appropriately incorporating stretching of the muscle joints in exercise programs, the muscle joints will decrease range of motion. Also, if the flexibility of a joint is not maintained, over time the joint will decrease in range of motion (Daneshmandi et al., 2010). Perhaps the standard exercise program continued by the control group lacked appropriate shoulder stretching and this caused the decrease in shoulder flexion. This also proves that the upper-extremity exercises on a balance device properly maintain shoulder flexion.

This study concluded that a 4-week upper-extremity program on a balance device does improve upper-extremity power, stability, and shoulder hyperextension. The benefits of exercising the upper-extremities on a balance device are the combination of variables which are exercises and increase rapidly over a 4-week period, each exercise session was timed at 30 minutes. The space needed for these exercises is little and only one device is needed, which means an individual can exercise anywhere and will not need much storage space for the device. The study did not directly test whether there was an improvement in clubhead speed or ball spin, but according to the literature, upper-extremity power, stability, and flexibility are variables which will contribute to a longer, more powerful, and smooth golf swing. Nonetheless, a direct study of upper-extremity exercises on a balance device and golf swing mechanics is encouraged.

Conflict of Interest

The authors have not declared any conflicts of interest.

REFERENCES

Cohn MA, Lee SK, Strauss EJ (2013). Upper Extremity Golf Injuries. Bulletin of the Hospital for Joint Diseases. 71(1): 32-38.

Daneshmandi H, Rahmaninia F, Shahrokhi H, Rahmani P, Esmaeili S (2010). Shoulder Joint Flexibility in Top Athletes. Journal of Biomedical Science and Engineering, 3(8), 811.

Gosheger G, Liem D, Ludwig K, Greshake O, Winkelmann W (2003). Injuries and over-Use Syndromes in Golf. Am J Sports Med. 31(3), 438-434.

Gryc T, Zahalka F, Maly, T, Mala L, Hrasky P (2015). Movement Analysis and Weight Transfer During the Golf Swing. Journals of Physical Education and Sport. 15(4), 781-787.

Lee DR, Kim LJ (2015). Reliability and Validity of the Closed Kinetic Chain Upper-Extremity Stability Test. J Phys Ther Sci, 27: 1071-1073.

Lephart SM, Smoliga JM, Myers JB, Sell TC, Tsai YS (2007). An Eight-Week Golf-Specific Exercise Program Improves Physical Characteristics, Swing Mechanics, and Golf Performance in Recreational Golfers. Journal of Strength and Conditioning Research 21(3), 860-869.

Lindsay DM, Vandervoort AA (2014). Golf-Related Low Back Pain: A Review of Causative Factors and Prevention Strategies. Asian J Sports Med 5(4): e24289.

Mitchell K, Banks S, Morgan D, Sugaya H (2003). Shoulder Motions During the Golf Swing in Male Amateur Golfers. Journal of Orthopaedic & Sports Physical Therapy, 33(4), 196-203.

Nesbit SM, Serrano M (2005). Work and Power Analysis of the Golf Swing. Journal of Sport Science and Exercise 4, 520-533.

Norkin, CC, White, DJ (1985). Measurement of Joint Motion: A Guide to Goniometry. Philadelphia, PA: F.A. Davis Company.

Santos E, Rhea MR, Simão R, Dias I, de Salles, BF, Novaes J, Leite T, Blair J, Bunker DJ (2010). Influence of Moderately Intense Strength Training on Flexibility in Sedentary Young Women. The Journal of Strength & Conditioning Research, 24(11), 3144-3149.

Sell TC, Tsai YS, Smoliga JM, Myers JB, Lephart SM (2007). Strength, Flexibility, and Balance Characteristics of Highly Proficient Golfers. Journal of Strength and Conditioning Research 21(4), 1166-1171.

Spirduso WW, Francis KL, MacRae PG (1995). Physical Dimensions of Aging. Champaign, IL: Human Kinetics.

Wells GD, Elmi M, Thomas S (2009). Physiological Correlates of Gold Performance. Journal of Strength and Conditioning. 23(3), 741-750.

Wrobel JS, Marclay S, Najafi B (2012). Golfing Skill Level Postural Control Differences: A Brief Review. Journal of Sports Science and Medicine. 11,452-458.