



The Influence of 8 Weeks Plyometrics Training on Golfers Hitting Distance

—Taking the Hitting of Driver as an Example

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Abstract: Plyometrics training, can improve the club speed, ball speed and the hitting distance in swinging and hitting. According to the experimental method, 15 professional golfers were randomly selected as the reference object, and 24 golfers joined the 8 weeks of plyometrics training. The conclusion was that after 8 weeks of plyometrics training, the experimental group had an increase of the club speed, ball speed and smash factor more obviously than that of the control group. Affected by training years, there is still a gap between the two and professional players. With the increase of club speed and ball speed, both groups have a certain increase in the carry length and total length. Compared to the control group, the experimental group has further hitting distance, but there are still significant differences between them affected by training years. It is suggested that during the teaching and training of golf techniques, practice of the stability of the lower limbs and the instability of the upper limbs should be increased, to improve the hitting distance.

Key words: Golf, driver, hitting distance, experimental study, plyometrics training.

1. Introduction

Amrinder Singh (2015) [1] pointed out that plyometrics training is a stretch and contraction link which stretches the muscles first and activates the storage and release of the potential energy of the muscles, thus bringing a fast and powerful form of motion of centripetal contraction. According to Iain M. Fletcher, Amy C. Scarfe (2004), Doan (2006) [2-4], Mark Bull (2012) [5] and Michael T Schofield (2015) [6], plyometrics training plan can obviously improve the club speed and hitting distance of golfers. Scott M. Lephart et al. (2007) [7] pointed out that when the 8 weeks special golf training program is used to evaluate the flexibility, balance, swing mechanics and golf skills of the players, the strength of torso rotation strength and hip abduction strength were enhanced, the flexibility of the trunk, hip and shoulder was improved

evidently, and the balance ability was lifted after training, which resulted in a significant increase in the club speed, ball speed, carry length and total length. According to Randall L. (2007) [8], load intensity and frequency are important factors affecting the effect of enhanced training. Fatouros et al. [9] pointed out that the combination with traditional strength and plyometrics training is better than single training method in improving lower limb strength. The above researches lack quantitative comparative analysis of research indicators, while the opening distance of driver determines the competition strategy of the hole, which has a great influence on the club selection adjustment and tactical arrangement of the whole match. This research is aimed to observe the changes of parameters such as club speed, ball speed, smash factor, carry length and total length, according to the 8 weeks TrackMan test and analysis training of 24 golfers, and analyze the effect of plyometrics training on improving the athletic ability of golf players, to

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provide reference and help for advancing the overall technical level and competition performance of the golfer, and better popularize the golf game, based on the background that golf movement back to the Olympic family with a wave of golf in China.

2. Research Object and Research Methods

2.1 Research Object

The relative parameters of driver hitting distance of 24 golf players were taken as research objects. A random selection of 15 golfers from China, Britain, Italy, the United States and Australia in 2016 US golf tour (China Wuhan Station) is taken as the reference. The 24 players with a handicap of 10-20 were selected as the subjects (all right-handed players), and randomly divided into experimental group and control group. After *t* test, the *p*-value was greater than 0.05, indicating no significant difference.

2.2 Research Methods

2.2.1 Literature Study

Input key words as “golf performance, golf carry distance, golf swing system, ball speed” through databases such as Wuhan Institute of Physical Education library, CNKI database, EBSCO, Sports Discus, ProQuest, Springer and Taylor & Francis, arrange and classify the collection of Chinese and English Literature, to lay a theoretical foundation for the study.

2.2.2 Experimental method

Experimental Time and Place. From April 11, 2016 to June 5, 2016, teaching experiments and tests were carried out at the golf course in Wuhan Institute Of Physical Education for 8 weeks. The training was carried out three times a week, each time 90 min.

Training Plan. The control group only carried out driver swinging and hitting practice and physical training on the basis of regular teaching and training. On the determination of the plyometrics training method, Jiang Hongbin (2013) [10, 11] pointed out that the strength of the weekly load should be kept at

2-3 times; plyometrics training (5~15 times) should be combined with resistance exercise (2~8 times), 2 to 5 times combined exercises each time, with 2-10 minutes in interval. Hartwell (2004) [2] carried out 8 weeks free resistance and reinforcement training for the golfers. The club speed of the experimental group increased significantly. The load was twice a week for training, 90 min each time, free resistance exercise ($3 \times 6-8$ times), and 3 kg plyometrics training (3×8 times). According to the related literature and the characteristics of the project, the training methods are as follows: solid ball push up, side throwing solid ball, back throwing solid ball, single knee standing right, left and right leg swapped straight arm rotation swing, solid ball hands supporting the left and right legs for 1 minute alternately, Z type jump, single leg lateral obstacle jump, leg squat jump, half squat jump and so on. This training is carried out by increasing repetitions first, then increasing repeated groups, and reduction from incremental load to load constant of the same load with the first and second weeks until the last two weeks, which means, first to 8 weeks, according to the 10 times/group $\times 2$, 12 times/group $\times 2$, 10 times/group $\times 3$, 12 times/group $\times 3$, 12 times/group $\times 3$, 12 times/group $\times 3$ group, 10 times/group $\times 2$, 12 times/group $\times 2$, 1 min interval for each group. Load and load intensity are monitored and adjusted with the plan. During the experiment, subjects could not participate in other special technical exercises or competitions.

2.2.3 TrackMan Index Test and Methods

TrackMan [12-18] can measure 26 sets of data by hitting an effective ball each time. The indicators to be selected for research are as follows:

Club speed is the speed of the center of the club faced at the moment before the club touches the ball, and it has a decisive effect on the total length.

Smash factor is the ratio of the ball speed to the club speed, indicating the solid level of hitting. The bigger the club speed is, the bigger the ball speed is; the bigger the smash factor is, the stronger the batting is; and vice

versa.

The hitting angle, that is, attack angle, means the angle between the club surface and the ground. The attack angle affects the launch angle of driver, the degree of influence is 15%.

Dynamic loft is the loft of club, which is the angle perpendicular to the ground at the moment of hitting the ball. It has a great influence on the launch angle of driver, reaching 85%.

Launch angle is the angle between the ball leaving the club surface and the ground. The angle of hit ball and the angle of dynamic loft affect the launch angle of Professional Golfer' Association of America (PGA) player's driver, which is between 6-15 degrees. This value does not include special strokes.

Ball speed is the speed of the ball leaving the club surface at the moment of hitting. Club speed determines ball speed, they have positive proportions.

Carry length is the distance between the first landing point and the starting point when the ball passes through the horizontal plane.

Total length is the total distance of hitting, that is, the total distance from the landing platform to the tee and from the tee to the golf ball when it is finally stationary, including the carry length, the bouncing length and the rolling length.

The distance of hitting can reflect the level of a golf player to some extent. It is influenced by club speed, ball speed and smash factor, which further affects the carry length and total length.

2.2.4 Comparative Analytic Method

By sorting out the relevant data of hitting distance of driver between professional golfers, experimental group and control group, the longitudinal comparative analysis is carried out by this study to find out whether the 8 weeks plyometrics training can effectively improve the hitting distance of driver of the golf player, thus narrowing the gap between them and professional players.

2.2.5 Mathematical Statistical Method

By sorting out the data of the test through Excel 2007, at the same time using SPSS16.0 software to analyze the mathematical statistics of the control group and the experimental group, significance level test was carried out by applying independent sample *t*-test and paired-samples *t* test. The significance level was 0.05.

3. Results and Analysis

3.1 Comparison and Analysis of Test Indexes before and after the Experiment

According to the paired sample *t* test in Table 1, the *p*-values of the club speed and the ball speed in the control group and the experimental group were all less than 0.05, and the differences were significant before and after the experiment. However, the variations in the club speed and the ball speed in the experimental group were greater than those in the control group. They are faster to improve. It shows that after 8 weeks of enhanced training, the club speed and the ball speed increase faster than the regular teaching and training, which are significant. The experimental group makes

Table 1 Statistical table of kinematic parameters of test index.

		Club speed (mph)	Ball speed (mph)	Attack angle (deg)	Launch angle (deg)	Dynamic loft (deg)
Professional player		113.6 ± 2.9	167.2 ± 6.1	-0.1 ± 2.7	9.8 ± 2.0	11.4 ± 2.0
Control group	Before	102.1 ± 3.7	147.5 ± 4.8	12.5 ± 2.1	-0.6 ± 2.8	14.7 ± 1.4
	After	103.5 ± 3.0	151.3 ± 3.8	12.8 ± 1.0	0.1 ± 2.2	15.0 ± 1.5
	Variation	-1.4 ± 0.9	-3.9 ± 2.3	-0.4 ± 1.4	-0.8 ± 1.4	-0.3 ± 0.4
	<i>p</i> -Value	0.012*	0.001**	0.393	0.079	0.060
Experimental group	Before	103.5 ± 1.8	150.4 ± 4.3	11.2 ± 1.4	-1.5 ± 2.0	13.4 ± 1.5
	After	106.5 ± 2.4	156.1 ± 5.4	12.4 ± 0.6	0.6 ± 1.0	14.5 ± 0.8
	Variation	-3.0 ± 1.1	-5.7 ± 3.3	-1.2 ± 1.0	-2.1 ± 1.4	-1.0 ± 1.2
	<i>p</i> -Value	0.000**	0.000**	0.002*	0.000**	0.014*

Notes: * indicates that $p < 0.05$ (bilateral) is significant, ** indicates that $p < 0.01$ (bilateral) is very significant.

the cooperation between muscles such as the upper arm muscles, latissimus dorsi, trapezius, lumbar rectus abdominis, and lower rectus femoris muscles smoother by impact training and resistance exercises for the upper and lower limbs and waist and waist to match the golf swing characteristics. They increase ground reaction to the body and delay the club to release more power when the player swings his ball and turns his hip, thus this power is converted into club speed, which improves the ball speed.

The paired sample t test in Table 1 shows that the p -values of the attack angle, launch angle, and the dynamic loft of the control group were all greater than 0.05 after the experiment. There was no variation of them before and after the experiment, still showing an instability of positive or negative angles hitting the ball up or down.; p -values of the three indicators of the experimental group were all less than 0.05. After the TrackMan test feedback, the attack angle changed from -1.5° to 0.6° , and the ball maintains an overall upward (+) attack angle, increasing the launch angle and dynamic loft, which is in line with the principle of hitting driver.

3.2 Comparison and Analysis of Test Indexes of Professional Players after the Experiment

According to the independent sample t test in Table 2, compared with professional golfers, the p -values of the club speed and ball speed in the control

and experimental groups after the experiment were all less than 0.05. There is still a significant difference in club speed and ball speed between both of them and professional players. Table 3 shows that the average number of years of training for professional golfers is about 12 years longer than that of the control and experimental groups. No matter whether it is regular training or 8 weeks of plyometrics training, it cannot significantly improve the club speed and ball speed of golfers in the short term. The experimental group carried out 8 weeks of plyometrics training, through the methods like single leg standing straight, arm rotation swinging, solid ball supporting left and right legs to strengthen the practice of waist rectus abdominis, external oblique muscle, gluteal muscle and other muscle parts. It shows the trend of narrowing the gap with professional players in club speed and ball speed. It plays a role in the short term, a long period of cycling physical fitness training program and practice for specific technical skills is needed to reach the level of professional golfers.

Independent sample t test in Table 2 shows that compared with professional golfers, p -values of attack angle of control group and experimental group after the experiment are more than 0.05. The gap between them and professional players is not obvious. The p -values of launch angle and dynamic loft are less than 0.05. Due to the inability to unify the club angle of professional golfers and subjects during the test, and

Table 2 Kinematics parameter T test of club at the moment of hitting after the experiment.

	Groups	F -value	T -value	p -Value
Club speed	Control group	0.104	8.855	0.000**
	Experimental group	0.817	6.873	0.000**
Ball speed	Control group	3.254	7.858	0.000**
	Experimental group	0.080	4.921	0.000**
Attack angle	Control group	0.125	-0.246	0.794
	Experimental group	8.857	-0.883	0.386
Launch angle	Control group	8.291	-4.990	0.000**
	Experimental group	17.557	-4.231	0.000**
Dynamic loft	Control group	2.790	-5.122	0.000**
	Experimental group	13.775	-4.995	0.000**

Notes: * means $p < 0.05$ (bilateral) is significant; ** means $p < 0.01$ (bilateral) is very significant.

Table 3 Basic situation of golf course students and professional golfers.

	Height (cm)	Weight (kg)	Age (years)	Training years	Handicap
Professional group	181.4 \pm 5.5	81.2 \pm 11.1	26.2 \pm 4.5	17.2 \pm 6.6	Pro
Control group	175.1 \pm 4.1	70.9 \pm 6.3	24.2 \pm 2.9	4.3 \pm 1.4	14.8 \pm 3.6
Experiment group	178.5 \pm 4.6	72.3 \pm 6.1	24.6 \pm 2.0	5.3 \pm 2.7	12.0 \pm 2.4

Table 4 Statistics of carry length, total length and smash factor.

		Carry length (yard)	Total length (yard)	Smash factor
Professional group		268.7 \pm 10.3	290.4 \pm 11.2	1.49 \pm 0.01
Control group	Before	233.6 \pm 7.9	249.8 \pm 8.7	1.44 \pm 0.02
	After	238.8 \pm 8.5	253.5 \pm 5.8	1.46 \pm 0.02
	Variation	-5.2 \pm 3.9	-3.7 \pm 5.3	-0.02 \pm 0.02
	<i>p</i> -Value	0.001*	0.034*	0.001*
Experimental group	Before	235.6 \pm 11.7	255.9 \pm 6.4	1.44 \pm 0.02
	After	249.5 \pm 11.7	272.2 \pm 9.9	1.47 \pm 0.03
	Variation	-13.9 \pm 4.0	-16.3 \pm 6.1	-0.03 \pm 0.02
	<i>p</i> -Value	0.000**	0.000**	0.000**

Notes: * means $p < 0.05$ (bilateral) is significant; ** means $p < 0.01$ (bilateral) is very significant.

the only uniform requirements for subjects, there might be difference between these two indexes. This study does not include deeper research. But overall, the launch angle and dynamic loft have been increased in experimental group, which can increase the initial angle of the flying and hitting distance, reduce the gap between them and professional players.

3.3 Comparison Analysis of Horizontal Length and Smash Factor before and after the Experiment

According to the paired sample *t* test in Table 4, the *p*-values of smash factor and carry length of the control group were all less than 0.01; the *p*-value of total length was greater than 0.01, and the three indexes' *p*-values of the experimental group were all less than 0.01, which indicates that, smash factor increases with the improvement of club speed and ball speed, thereby increasing the carry length and total length of the hitting. In terms of overall variation, 8 weeks of plyometrics training can more effectively improve the students' ability of club speed, ball speed and smash factor compared with regular teaching and training in the same teaching time. Through the side-throwing solid ball practice of the upper limb, and simulating the

golf swinging action, the development of the upper limb muscle group and the lower limb half-jumping exercise are increased, so that the power efficiency of sports link in the moment of hitting the ball is increased, as well as the carry length while in the control group, the degree increase of regular teaching and training irritation to body in each index was not significant.

3.4 Comparison Analysis of Each Test Index between Professional Golfers and Subjects after the Experiment

Table 5 shows an independent sample *t* test. Compared with professional golfers, the *p*-values of the control group and the experimental group in the carry length, total length, and the ball speed are less than 0.05, and the difference is significant, although the 8 weeks plyometrics training in short-term has certain positive influence on the parameters such as the club speed and the ball speed of the experimental group, improves the smash factor and has a positive effect on the horizontal length. Due to the gap between the training period and the competition experience, there is a difference in the parameters between experimental group and professional players. But from the perspective of the total length of hitting, the short-term effect is still

obvious. In golf teaching and training, with the combination of special features, the enhancement of

core strength and instantaneous explosiveness training, the stability of the swinging dynamic model as well as

Table 5 Statistics of horizontal length and smash factor of professional golfers and subjects after the experiment.

	Groups	<i>F</i> -value	<i>T</i> -value	<i>p</i> -Value
Carry length	Control group	0.476	8.115	0.000**
	Experimental group	0.198	4.535	0.000**
Total length	Control group	8.300	10.500	0.000**
	Experimental group	0.697	4.146	0.000**
Smash factor	Control group	0.251	3.398	0.002*
	Experimental group	2.316	2.292	0.031*

Notes: * means $p < 0.05$ (bilateral) is significant; ** means $p < 0.01$ (bilateral) is very significant.

the club speed of hitting is improved, bringing a faster ball speed and further flying distance.

4. Conclusions and Suggestions

4.1 Conclusions

(1) The hitting distance of golf driver hitting is mainly affected by the speed of club speed, ball speed and the smash factor.

(2) The 8 weeks plyometrics training can obviously improve the 6 test indexes of the golfers. The enhanced and resistance compound training methods to the upper and lower limbs is used to strengthen the flexibility and the core exercises of the waist and abdomen to develop the golf muscle group, and bring a positive influence on the hitting distance.

(3) Based on the TrackMan test, the adjustment of the parameters of the golfer's attack angle can effectively optimize the swing system of driver, increase the launch angle, which is accorded with the principle of driver hitting, and increase the total distance of the batting.

4.2 Suggestions

(1) The 8 weeks plyometrics training can be combined with the traditional golf teaching methods. The formulation of sports prescriptions in accordance with their aptitude, the training methods of increasing the club speed and the ball speed, can effectively increase the hitting distance and improve the technical level of the golfer.

(2) Emphasize the establishment of the swing system; use more interesting training; carry out strengthen training; deal with the relationship between physical ability and skills; and rationally allocate technical exercises and physical training time.

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