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Effects of Band Resistance Exercise and Balance Training on Improvement of SPORTS Injury and Performance of Men's University Bowling Players

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Abstract

This study was to investigate the effects of band resistance exercise and balance training on the improvement of sports injury and performance in the men's university bowling players. To achieve this purpose, the athletes who have been registered as a member of the Korea Bowling Association with more than 5 years of athletic career were selected, and after observing the enhancement of sports injury and performance through the band resistance exercise and balance training, the following conclusion is obtained. First, As for the Average score, there were significantly increased in score of the athletes in 2014 before the training was 191.26, while the average score of the athletes in 2015 after the training was 196.88, which increased by 5.62 compared to the pre-test. Second, as for the Frequency of Sports Injuries by Period, a total of 196 injuries occurred before training in 2014, of which 86.8% occurred during the preparation season. A total of 94 injuries occurred in 2015 after the training, which was significantly reduced compared to pre-training, yet 76.6% of the injuries occurred during the preparation season. The athletes' injury a rate was reletively higher during the preparation season compared to competition season and break season. Third As for the Sports Injury Type, there were decreased increased in 2015. As for the Sports Injury Type and Sports Injury Area, there were Overall improvement increased in 2015. However, there is a need for more specific exercise programs to be developed for the continual improvement of athletic performance in band resistance exercise and balance training along with further studies to confirm the physiological benefits of those programs.

[Keywords] ***Band Resistance Exercise, Balance Training, Sports Injury, Bowling, Men's University Bowling Players***

1. Introduction

It is required for athlete to participate in intense, continuous and repeated training to improve physical strength and specific skills, and athletes who have to exert a intense training may experience a physical imbalance and a decrease in performance due to an incorrect exercise habits and long-term one side movement[1][2]. Among them, trunk rotational exercise of bowling athletes affects body malalignment syndrome in posture and walking, and continuous unilateral movement of bowling athletes causes various sports injury due to a physical imbalance. In addition, physical imbalance hinders athlete's records, increases the risk of injuries to athletes and thereby slows the recovery rate of injuries that have occurred[3]. The improvement of complex factors required in bowling is related to improvement of performance directly and generally decisive factors that determine the performances are physical strength, specific skills and willpower, yet among them physical strength factor is the most basic, which is based on muscular strength[4]. Furthermore, among muscular strength required for bowling, lower body strength is especially needed since bowling is

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a continuous repetition of pitching while sliding a short distance in a short time[5]. Thus strengthening of the leg muscles is regarded as the first factor affecting the performance. In addition, among various functions, leg strength plays an important role especially in effectively controlling the center of the body[6].

A weight has been used often for the resistance exercise to improve the muscle strength, yet since weight training has a high risk of injury, so band resistance training is used nowadays. Band resistance exercise is especially useful in that it is easy to carry, easy to perform for everyone, has constant tension, and there is less injury unlike weight training[7][8]. Moreover, the characteristic of the band resistance movement is that it can provide a continuous resistance while any movement is performed in every human movement directions, so that it is especially effective in the multi-directional movement of daily life and muscle strength[9]. The spiral and diagonal movements are very similar to the movements caused by physical functional activity[10], and so if these movements can be combined with the band resistance exercise, a functional resistance exercise with a centrifugal force, centripetal force and isotonic contraction can be made. For bowling like this, balance and muscle strength is the most important, and balance movement is the ability to maintain and adjust to the center of gravity of the support surface[11], which is a process of maintaining posture stability continuously, and also influences on the performance of stability, weight control and walking[12], and balance movement exercise can enable optimal nerve adaptation which includes coordination of intramuscular and between the muscles. Intramuscular coordination is the ability of the muscles to participate in the movement unit and to have an enhanced movement unit identity[13].

As such, bowling is a typical unilateral exercise that causes body imbalance, which has a very high risk of sports injury. In addition, bowling skills are very sophisticated, so if posture stability is not achieved, then professional physical movement and technique can't be performed. Therefore, a bowling requires a training method to stabilize professional physical strength and technical movements.

Therefore, enhancement of balance and its function through band resistance exercise and balance training is a very important physical approach to bowling athletes. That is, if the band resistance exercise and the balance training are continuously applied, it is expected that these exercises will help the bowler to stabilize the body and to prevent injuries caused by physical imbalance, which will help improve the performance ultimately. Thus, the purpose of this study is to identify the effect of 12 week band resistance exercise and balance training on male college bowling athletes.

2. Materils & Methods

2.1. Subject of study

This study is conducted from March 2016 to June 2016 for J university bowling athletes, and the athletes who have been registered as a member of the Korea Bowling Association with more than 5 years of athletic career are selected. The 12 subjects who are willing to participate and fully understand the purpose of this research are selected. The physical characteristics of the subjects are shown in <Table 1>.

Table 1. Physical characteristics of subjects mean±SD.

	N	Age (Years)	Height (Cm)	Weight (Kg)	BMI(kg/㎡)	Percent body Fat(%)

Bowler	12	22.15 ±1.13	177.25 ±5.15	78.21 ±9.63	24.82 ±2.12	19.73 ±1.57

2.2. Exercise program

2.2.1. Band resistance exercise

A band resistance exercise was performed 3 times a week for 12 weeks, and total 60 minutes of exercise consist of 10 minutes of preparation, 40 minutes of exercise and 10 minutes of warm down exercise. The band resistance exercise program is shown in <Table 2>.

Table 2. Band resistance exercise program.

Item	Week	Intensity (Band color)	Program	Time	Frequency	Rest
1	1~4	Medium (Red)	Plantar flexion Dorsi flexion Inversion Eversion Plantar flexion Dorsi flexion Inversion Eversion	30min	15times × 4sets	30sec
2	5~8	Heavy (Green)				
3	9~12	Extra heavy (Blue)				

2.2.2. Balance training

The subjects of this study was participating in the college exercise program, and this study's program was performed during the off season in the winter. In other words, balance training was not carried out independently in specific time but additionally after the normal training.

The balance training was carried out 3 times a week for 12 weeks, and total 60 minutes of exercise consist of 10 minutes of preparation, 40 minutes of exercise and 10 minutes of warm down exercise. The balance training consisted of three steps: the first 4 weeks of exercise program of securing the basic balance and strength, the next four weeks of securing dynamic balance and enhancing muscle strength, and the last four weeks of combining dynamic balance with the muscle strength. The balance training program of this study is shown in <Table 3>.

Table 3. Balance exercise program.

Stage	Exercise program		Rest			Motion frequency
			1~4 Week (reps/set)	5~8 Week (reps/set)	9~12 Week (reps/set)	
Warm-up (10 min)	Skipping Side steps Carioca Back slaps		10/3	10/3	10/3	RPE 8~10
Work-out	Prone	1. elbow stand	10/2	10/3	10/5	RPE

(40min)	position Supine position Lateral position	2. elbow stand left(light) leg up 3. hand stand left(light) leg up				11~13
	Elastic band training	1. Squirt 2. Lunge 3. Side lunge				
	Balance ball training	1. One feet balancing 2. Two feet balancing 3. Walking in balance ball 4. Run in balance ball				
Cool-down (10min)	Ham string stretch Shoulder stretch Calf stretch Adductor stretch Quadriceps stretch It band stretch		10/3	10/3	10/3	RPE 8~10

3. Measure and Method

3.1. Performance evaluation

To asess the performance of bowling athletes at J University in C region, an average score per game was calculated based on 8 major championships in 2014 and 8 major championships in 2015.

3.2. Sports injury investigation

The subjects, who had a medical treatment due to orthopedic injury during a season or who were absent from a team training, were selected for this study. In cases of medical examination, the cases were limited to new patients while excluding existing patients or medical treatment for simple examination, and in cases of absence from team training, cases of injury recurrence after recovery were included. Records were collected with accurate date and time of injury, area of injury, diagnosis and position of injured player from each club's medical trainer. All data were based on medical records and medical logs.

The collected data were classified as follows to analyze.

1)Season: preparation season / championship season / break season

2)Injured area: ankle, knee, quadriceps, hamstring, foot, shoulder, neck, elbow, wrist, finger, waist, hip joint, trunk, tibia, calf, achilles tendon, ect.

3)Type of injury: sprain, strain, muscle tear, ligament tear, myalgia, fracture, meniscus injury, chondral injury, HIVD, SLAP, tendinitis, impingement syndrome, ect.

4. Data Process

For the data analysis of this study, the mean and standard deviation of all collected data were calculated using SPSS 20.0(window statistical package), and frequency analysis was performed for injury rate. Paired t-test was carried out for significance test before and after experiment within the group. At this time, the significance level was $p<.05$.

5. Results

5.1. Average score

Changes in the average score as a result of the band resistance exercise and balance training are shown in <Table 4>. For the changes in the average score due to the band resistance exercise and balance training, the average score of the athletes in 2014 before

the training was 191.26, while the average score of the athletes in 2015 after the training was 196.88, which increased by 5.62 compared to the pre-test.

Table 4. The changes of average score.

	Average score	t	p
2014	191.26 ± 12.73	-1.688	.135
2015	196.88 ± 4.47		

5.2. Sports injury

5.2.1. Frequency of injury by season

As shown in <Table 5>, for the difference in frequency of injuries by season in relation to the band resistance exercise and balance training, a total of 196 injuries occurred before training in 2014, of which 86.8% occurred during the preparation season. A total of 94 injuries occurred in 2015 after the training which was significantly reduced compared to before training, yet 76.6% of the injuries occurred during the preparation season. The athletes' injury rate was relatively higher during the preparation season compared to competition season and break season.

Table 5. Frequency of sports injuries by period.

	2014 Year		2015 Year	
	Frequency	%	Frequency	%
Preparation	171	86.8	72	76.6
Match period	20	10.2	20	21.3
Rest period	5	2.5	2	2.1
Total	196	100	94	100

5.2.2. Type of injury

The differences of type of injury in relation to the band resistance exercise and balance training are shown in <Table 6>. As shown in <Table 6>, for the difference of the type of injury in relation to the band resistance exercise and balance training, there were 148 cases of sprains which is 75.5% of the all injuries occurred in 2014 before the training, followed by 15.3% of contusion, 7.7% of cartilage torn and 1.5% of fracture, and in 2015 after the training, there were 71 cases of sprains which is 75.5% of the injuries, followed by 22.3% of contusion and 2.1% of cartilage torn. However, there was no fracture before and after the training.

Table 6. Sports injury type.

	2014 Year		2015 Year	
	Frequency	%	Frequency	%
Fracture	3	1.5	0	0
Sprains	148	75.5	71	75.5
Contusion	30	15.3	21	22.3
Cartilage	15	7.7	2	2.1
Total	196	100	94	100

5.2.3. Injured area

The difference of the injured area in relation to the band resistance exercise and balance training is shown in <Table 7>. As shown in <Table 7>, for the difference of the injured area in relation to the band resistance exercise and balance training, there were 41 cases of wrist injures which is 20.9% of the all injuries occurred in 2014, followed by 16.8% of waist, 12.8% of shoulder, 12.2% of elbow and 12.2% of hip, and for the injuries in 2015 after the training, 21.3% were wrist, followed by 19.1% of waist and 16% of elbow. The order of the injured parts before and after the training was the same, but the number of injuries decreased greatly overall.

Table 7. Sports injury area.

	2014 Year		2015 Year	
	Frequency	%	Frequency	%
Neck	0	0	0	0
Chest	8	4.1	0	0
Waist	33	16.8	18	19.1
Hip	24	12.2	8	8.5
Knee	16	8.2	8	8.5
Ankle	17	8.7	12	12.8
Shoulder	25	12.8	11	11.7
Elbow	24	12.2	15	16.0
Wrist	41	20.9	20	21.3
Groin	8	4.1	2	2.1
Total	196	100	94	100

6. Discussion

Nowadays sports can be called as a sports of a science. It is because athletes try to improve their performance by using scientific methods even from the training. However, despite the enhancement of equipment safety, coaching ability and knowledge of physical condition as a result of development of science and technology, sports injuries are increasing in all sports[14]. Bowling has a very high rate of sports injury as well. Bowling is deemed as a typical unilateral exercise that causes physical imbalance, which can lead to muscle dysfunction and pain, and may cause disruption of life quality such as neurological atrophy, kidney weakness and fatigue[15]. In addition, a decline in competitiveness due to an injury leads to an athlete's and team's performance as well. In order to make up for this, posture stabilization program and balance training program of bowling athletes are applied to improve performance and prevent injuries. Thus, the purpose of this study is to verify the effects of the band resistance exercise and balance training of men's college bowling athletes for 12 weeks on sports injury and performance.

A bowling is a sport in which a good balance and rhythmic movement is especially important, and an excellent performance is achieved when technical skills such as swing, step, release, turning and lifting are harmonized with the ability to adjust the direction of the ball. In order to perform this sophisticated and exact movement, a repeated training as well as appropriate morphological properties are needed[16][17][18]. In order to achieve correct posture and physical balance, a training method that can correct physical imbalance should be applied, and the balance training is used as one of the methods. The balance training maximizes the effect of relaxation by relaxing the time that the

nerve signal is delivered to the brain through the homaxial contraction of the muscle for each movements for more than 6 seconds. Through this effect, the balance training helps to relieve tension, strengthen muscle, improve flexibility and posture, and reduce the risk of injury[19]. For the difference in frequency of injuries by season in relation to the band resistance exercise and balance training, a total of 196 injuries occurred before training in 2014, of which 86.8% occurred during the preparation season. A total of 94 injuries occurred in 2015 after the training which was significantly reduced compared to before training, yet 76.6% of the injuries occurred during the preparation season. The athletes' injury rate was relatively higher during the preparation season compared to competition season and break season. Among them the frequency of injuries was especially higher during the preparation season than the championship season, but it is because most athletes endure the pain and injury during the competition season to participate in the match.

For the difference of the type of injury in relation to the band resistance exercise and balance training, there were 148 cases of sprains which is 75.5% of the all injuries occurred in 2014 before the training, followed by 15.3% of contusion, 7.7% of cartilage torn and 1.5% of fracture, and in 2015 after the training, there were 71 cases of sprains which is 75.5% of the injuries, followed by 22.3% of contusion and 2.1% of cartilage torn. However, there was no bone fracture before and after the training. For the difference of the injured area in relation to the band resistance exercise and balance training, there were 41 cases of wrist injures which is 20.9% of the all injuries occurred in 2014, followed by 16.8% of waist, 12.8% of shoulder, 12.2% of elbow and 12.2% of hip, and for the injuries in 2015 after the training, 21.3% were wrist, followed by 19.1% of waist and 16% of elbow. The order of the injured areas before and after the training was the same, but the number of injuries decreased greatly overall. This is consistent with the studies that the balance training program is implemented extensively to protect athletes from various injuries that may occur during exercise, and the balance ability contributes to reduce the frequency rate of the injuries to athletes[20][21]. In addition, even if the imbalanced posture, repeated movements and muscle overload may cause deformation of the muscle skeletal system, the same movements has to be carried out repeatedly for the better performance[22], which results in physical changes and defects that have a continuous effect on performance[23]. A muscle strengthening training using a band has positive effects on stabilizing posture[12], reducing physical pain[24], increasing the stability of the ankle on an unstable surface, and activating abdominal muscles, back muscles, leg muscles and flexor muscles of knees. In addition, statistically significant difference was found in the repeated throwing training since leg muscle strength and endurance is especially required to maintain sliding movement during the throwing stage[25]. In this study, the average score of the athletes in 2014 before the training was 191.26, while the average score in 2015 after the training was 196.88, which increased by 5.62 compared to pre-training.

Putting all the above results together, the band resistance exercise and balance training help improve sports injury and performance of bowling athletes, and an excellent performance is achieved by harmonizing posture stabilization, technical skills through balanced posture and the ball adjusting ability. Furthermore, in order to perform sophisticated and stabilized movement like above, a repeated training as well as a development of training suitable for bowling athletes are required.

Therefore, this study, which was conducted to investigate the effects of 12 weeks band resistance exercise and balance training on male college bowling athletes, verified that the program helped to improve sports injury and performance.

7. Conclusion

The purpose of this study was to find out the effects of the band resistance exercise and balance training on sports injury and performance of male college bowling athletes,

and verifies that an improvement of sports injury and performance can be achieved through the band resistance exercise and balance training, and thus provides basic data for development of training method to prevent injury and enhance performance by stabilizing balance of bowling athletes.

To achieve this purpose, the athletes who have been registered as a member of the Korea Bowling Association with more than 5 years of athletic career were selected, and after observing the enhancement of sports injury and performance through the band resistance exercise and balance training, the following conclusion is obtained.

1. For the changes of an average score after the band resistance exercise and balance training, the average score of the athletes in 2014 before the training was 191.26, while the average score of the athletes in 2015 after the training was 196.88, which increased by 5.62 compared to the pre-test.

2. For the difference in frequency of injuries by seasons after the band resistance exercise and balance training, a total of 196 injuries occurred before training in 2014, of which 86.8% occurred during the preparation season. A total of 94 injuries occurred in 2015 after the training, which was significantly reduced compared to pre-training, yet 76.6% of the injuries occurred during the preparation season. The athletes' injury arate was reletively higher during the preparation season compared to competition season and break season.

3. For the difference of the type of injury after the band resistance exercise and balance training, there were 148 cases of sprains which is 75.5% of the all injuries occurred in 2014 before the training, followed by 15.3% of contusion, 7.7% of cartilage torn and 1.5% of fracture, and in 2015 after the training, there were 71 cases of sprains which is 75.5% of the injuries, followed by 22.3% of contusion and 2.1% of cartilage torn. However, there was no fracture before and after the training.

4. For the difference of the injured area after the band resistance exercise and balance training, there were 41 cases of wrist injures in 2014 which is 20.9% of the all injuries, followed by 16.8% of waist, 12.8% of shoulder, 12.2% of elbow and 12.2% of hip, and for the injuries in 2015 after the training, 21.3% were wrist injuries, followed by 19.1% of waist and 16% of elbow. The order of the injured parts before and after the training was the same, but the number of injuries decreased greatly overall.

In conclusion of this study, the band resistance exercise and balance training are verified to be effective for improving the sports injury and performance of college male bowling athletes. In addition, in order to perform sophisticated and stabilized movement through improving physical imbalance and posture, a repetitive training as well as a development of training suitable for bowling athletes are needed.

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