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Original Article

Analysis of isokinetic muscle strength for sports physiotherapy research in Korean ssireum athletes

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Abstract. [Purpose] The purpose of the present study was to elucidate the muscle conditions such as the isokinetic muscle of Korean ssireum athletes. [Subjects and Methods] This study enrolled 25 elite ssireum athletes. We measured body composition and peak torque at an angular speed at 60°/s using an isokinetic muscle strength dynamometer. [Results] The lean body mass of the left upper limb was significantly higher than that of the right upper limb. However, the lean body mass of the left lower limb was significantly lower than that of the right lower limb. The peak torque for left elbow flexion was significantly higher than that for right elbow flexion. Conversely, the peak torque for left elbow extension was significantly lower than that for right elbow extension. Furthermore, the peak torque for the left knee was significantly lower than that for the right knee for both flexion and extension. [Conclusion] The data from this study elucidate in part the muscle conditions of Korean ssireum athletes, which can be used to establish a reference for the scientific study of sports physiotherapy.
Key words: Isokinetic muscle strength, Ssireum athletes, Sports physiotherapy

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INTRODUCTION

Ssireum is a traditional Korean sport in which two athletes hold on to a satba (a cloth-sash tied around the waist and the thigh of the right leg) and use strength and various skills to throw their opponent to the ground[1)]. The weight classifications depend on the level of ssireum such as gyungjang, sojang, chungjang, yongjang, yongsa, yeoksa, and jangsa[1)]. Many previous studies have suggested that different sports require athletes to have different physical characteristics according to the way in which the sport is played[2–5)]. For example, judo athletes have a robust skeleton (that is, strong bone density) and well-developed muscles to enable them to withstand and transmit the forces applied during the fight[6)]. Likewise, ssireum athletes have special physical characteristics such as higher weight, muscle mass, and body fat in order to enhance their physical performance[1)]. In recent years, an isokinetic muscle test has begun to be used in sports science for the assessment of muscle performance and injury prevention in athletes[7–9)]. Isokinetic muscle testing can also be used to estimate muscle imbalance in athletes. Athletes may develop significant muscle imbalance that is specific to the style of the sport they play. Muscle strength imbalance is assessed by comparing the strength of the right muscle group with that of the left muscle group, as well as by determining the agonistic and antagonistic balance relationship. Muscle

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strength imbalance as it relates to injuries in athletes has been studied, and bilateral imbalance of muscle strength has been suggested as a risk factor for injury in many sports[10–13]. Agonistic and antagonistic balance also influences injury in athletes. Many previous studies about injury in athletes have shown that imbalance in the hamstring-to-quadriceps peak torque ratio (H:Q ratio) is correlated with a greater incidence of lower extremity injury[7, 14, 15]. Overall muscle imbalance can be estimated through not only muscle strength but also through muscle architecture. A previous study suggested that bilateral structural imbalance of the muscles is related to lower extremity injuries in professional basketball players[16]. Muscle structure imbalance can be estimated through the use of a body composition analyzer, which can analyze lean body mass (LBM), fat-free mass (FFM), fat mass (FM), body fat (BF), and lean mass of each limb[4]. Although many studies on muscle imbalance in different types of sports activities have been conducted, research on ssireum athletes has rarely been performed. Therefore, our study provides information regarding the muscle conditions of ssireum athletes for the purpose of informing decisions related to training and rehabilitation.

SUBJECTS AND METHODS

The present study enrolled 25 elite ssireum athletes with no physical or psychological conditions who provided voluntary written informed consent to participate in this study. The seven weight categories were as follows: gyungjang (up to 75 kg), sojang (up to 80 kg), chungjang (up to 85 kg), yongjang (up to 90 kg), yongsa (up to 95 kg), yeoksa (up to 110 kg), and jangsa (up to 150 kg)[1]. The subjects were asked to complete a questionnaire administered by individual in-depth interviews that took about 30 min per person. The protocol for the study was approved by the Committee of Ethics in Research of the University of Yongin, in accordance with the terms of Resolution 5-1-20, December 2006. In the present study, the modified somatotype method for the analysis of body type was used[1, 5, 17–20]. To confirm body composition, a 4 pole-8 pole contacted electronic method was applied. LBM, FFM, FM, BF, and lean mass of both limbs of participants were measured using a precision body composition analyzer (InBody 720; Biospace, Korea). Measurements were taken with the participants wearing only ssireum pants in a standing position with slight abduction of both arms[1]. To measure the isokinetic peak torque of the elbow and knee flexion/extension on both sides, we used an isokinetic muscle strength dynamometer (Isomed 2000; Isomed, Germany). For elbow joint testing, participants were positioned sitting on the dynamometer chair and stabilized using straps across the chest and pelvis. The shoulder joint was positioned in 45° abduction with 30° flexion, and the forearm was supine. The mechanical rotation axis of the dynamometer was aligned with the lateral humeral epicondyle and the established range of motion was 20° to 110°. For examination of the knee joint, the participants were positioned sitting on the dynamometer chair and stabilized by straps across the chest and pelvis and femoral region. The mechanical axis of rotation of the dynamometer was aligned to the femoral lateral epicondyle. Resistance was applied immediately above the ankle joint, and the established range of motion was 20° to 90° of knee flexion. Tests were performed in the reciprocal concentric mode and composed of three repetitions at 60°/s velocity to measure peak torque. Prior to testing, the subjects performed three sub-maximal contractions for familiarization. The examiner verbally encouraged the subjects during the test to help bring forth maximal efforts. Statistical analyses were conducted using PASW Statistics version 18.0 (SPSS/IBM; Armonk, NY, USA) to calculate averages and standard deviations. The measurements are expressed as mean ± standard error (SE). The significance level was set to α=0.05 when performing a paired t-test.

RESULTS

Table 1 shows the general characteristics and somatotypes of the Korean ssireum athletes. The LBM of the left upper limb was significantly higher than that of the right upper limb. However, the LBM of the left lower limb was significantly lower than that of the right lower limb (Table 2). The peak torque for left elbow flexion was significantly higher than that for right elbow flexion. Conversely, the peak torque for left elbow extension was significantly lower than that for right elbow extension. Furthermore, the peak torque for the left knee was significantly lower than that for the right knee for both flexion and extension (Table 3). The peak torque/body weight (PT/BW) ratio for both, elbows and knees showed a similar pattern to the respective peak torques (Table 3). However, the H:Q ratio was not significantly different between the knee joints (Table 3).

DISCUSSION

In the present study, body composition results showed that the lean mass of the upper limbs was higher on the left side than on the right; for the lower limbs, lean mass was higher on the right side. Bilateral muscle peak torque in ssireum athletes also showed an imbalance. Unexpectedly, peak torque and the PT/BW ratio for elbow extension was higher on the left side than on the right. Many previous studies have suggested that muscle strength would be higher on the dominant side than on the non-dominant side in athletes irrespective of whether the upper or lower limbs were evaluated[7, 10–12, 21, 22]. According to previous studies, Brazilian national handball players have significantly stronger throwing-side shoulders than non-dominant-side shoulders, and elite karate athletes have greater elbow strength on the dominant side[21, 22]. However, even though almost all participants in our study were right-handed, body lean mass and peak flexor torque were higher for the left upper limb. This can probably be explained by the nature of ssireum. During a ssireum match, athletes face their right shoulders; they grab the “close waist’s” satba with the right hand and the far leg’s satba with the left hand. Using this position, the athlete pulls the opponent into his body. This technique of ssireum may result in superior left elbow compared to right elbow flexor strength, possibly because the left hands are farther from what they are reaching for during this pulling motion. The risk of bilateral muscle imbalance is greater

Table 1. General characteristics of the Korean ssireum athletes included in the study

Variable	Mean ± standard error/n (%)
Age (yrs)	21.6 ± 0.7
Gender	
Male (%)/Female (%)	25 (100.0)/ - (-)
Height (cm)/Weight (kg)	178.0 ± 1.0/98.1 ± 4.1
BMI (kg/m^2)	30.5 ± 1.1
Weight division	
Gyungjang	5 (20.0)
Sojang	3 (12.0)
Chungjang	4 (16.0)
Yongjang	3 (12.0)
Yongsa	3 (12.0)
Yeoksa	3 (12.0)
Jangsa	4 (16.0)
Career (yr)	10.4 ± 0.5
Dominant side	
Upper limb	
Right/Left	24 (96.0)/1 (4.0)
Lower limb	
Right/Left	24 (96.0)/1 (4.0)
Body composition	
LBM (kg)/FFM (kg)	40.6 ± 2.6/74.3 ± 2.2
FM (kg)/BF (%)	21.6 ± 3.8/20.7 ± 2.3
Somatotype	
Endomorphy	-
Mesomorphy	23 (92.0)
Ectomorphy	2 (8.0)
Central	-
Endo. C	4.7 ± 0.4
Meso. C	6.4 ± 0.3
Ecto. C	0.7 ± 0.1

BMI: body mass index; LBM: lean body mass; FFM: fat-free mass; FM: fat mass; BF: body fat; Endo. C: endomorphic component; Meso. C: mesomorphic component; Ecto. C: ectomorphic component

Table 2. Differences in the lean mass of the limbs on both sides in the Korean ssireum athletes

Variable	Limb side	
	Right side	Left side
Upper limb (kg)	4.4 ± 0.2	4.6 ± 0.2**
Lower limb (kg)	11.0 ± 0.3	10.9 ± 0.2**

All data are presented as the mean ± standard error. **p < 0.01.

Table 3. Difference in the isokinetic muscle strength of the limbs on both sides in the Korean ssireum athletes

Variable		Limb side	
		Right side	Left side
Elbow	PT-Flex (Nm)	68.4 ± 3.0	73.7 ± 3.5*
	PT-Ext (Nm)	67.2 ± 2.8	58.0 ± 3.0*
	PT/BW-Flex (%)	74.6 ± 3.6	78.7 ±4.2
	PT/BW-Ext (%)	71.8 ± 3.4	62.3 ± 3.4*
Knee	PT-Flex (Nm)	139.2 ± 7.4	126.2 ± 6.7**
	PT-Ext (Nm)	224.7 ± 13.7	205.7 ± 10.5*
	PT/BW-Flex (%)	150.0 ± 7.4	133.4 ± 5.7**
	PT/BW-Ext (%)	236.4 ± 11.8	211.7 ± 7.4*
H:Q ratio (%)		63.4 ± 2.1	62.0 ± 1.9

All data are presented as the mean ± standard error. *p < 0.05, **p < 0.01. PT-Flex: peak torque of flexion; PT-Ext: peak torque of extension; PT/BW-Flex: peak torque/body weight of flexion; PT/BW-Ext: peak torque/body weight of extension; H:Q ratio: hamstring-quadriceps ratio

in the lower limbs than in the upper limbs[7, 10–12]. Bilateral muscle imbalance of the lower limbs was suggested as a risk factor for hamstring and anterior cruciate ligament injuries. A previous study suggested that there is an increased rate of injury in cases of a difference of 15% or more in knee flexor or hip extensor strength in collegiate athletes[14]. In addition, an imbalance in the H:Q ratio was shown to correlate with a higher incidence of lower extremity injury. The typical H:Q ratio of a healthy knee ranges from 50 to 80%; it is commonly accepted that an H:Q ratio of 60% or higher is desirable in rehabilitation[8, 15, 23]. In this study, ssireum athletes experienced no issues with respect to H:Q ratios in their knee joints. However, the bilateral muscle strength of the lower limbs in ssireum athletes was imbalanced; thus, ssireum athletes have a potential risk of knee injuries. According to our previous study on injuries in combat sports, almost 50% of ssireum athletes have experienced a knee injury. Although other factors are definitely contributory, this result may be evidence of muscle strength imbalance leading to knee joint injuries in ssireum athletes[24]. Balance training exercises, which may involve the use of resistance or unstable surfaces, can decrease lower limb asymmetry with the aim of reducing the risk of injury[25]. We suggest that ssireum athletes undertake balance training exercise to reduce the risk of injury to their knees. In conclusion, this study revealed a bilateral imbalance in muscle condition in ssireum athletes, suggesting that more studies are needed to assist in proper training, injury prevention, and rehabilitation.

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