Original article **Int. J. App. Sci. Physic. Edu 2017; 1(1) 1-6**

ISSN (Online): 2538-2438 Received: 04/19/2017 Accepted: 06/30/2017

Contents listsis available online

International Journal of Applied Science in Physical Education

Journal Homepage : www.ijaspe.com

A Comparison of Hamstring/Quadriceps Muscular Strength Ratio in Elite Karate Athletes Before and After Muscular Fatigue

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Keywords

Injury
Imbalances
Flexors and extensors strength
Karate athletes

Abstract

Imbalances between the agonist-antagonist muscles of the knee have been linked to a greater susceptibility to injury in the knee joint. The aim of the present study was to assess the Hamstring/Quadriceps muscular strength (H/Q) ratio of elite karate athletes before and after muscular fatigue. Thirteen female elite karate athletes (age: 15.5±1.5 years) were evaluated in an isokinetic dynamometer at 60 ◦ /s, 180 ◦ /s and 300 ◦ /s before and after hamstring and quadriceps muscular fatigue. Paired sample T-test and one way repeated measure were used for statistical analysis. α level was set at 0.05. After muscular fatigue, significant decrease were found in Hamstring/Quadriceps muscular strength ratio in the knee flexors and extensors strength (P>0.05) at the 60 ◦ /s, 1800 ◦ /s and 300 ◦ /s speeds (P<0.05). No significant difference was found in the knee (H/Q) ratio between three different speeds (F=1.23; P=0.30). Our results showed that lower limb muscle imbalances in elite female karate athletes that could predispose young karate athletes to injuries exist at the speed of 300◦/s speed and in three different speeds after fatigue protocol, but there are not any differences after fatigue between three speeds. So we can say that fatigue can probably increase the potential of knee joint injury and particularly ACL structure.

1. Introduction

Karate is a high demand activity but a light-contact style of martial arts (1, 2). In keeping with the rule of modern karate, there is a great emphasis on self-improvement. Not injuring one's opponent is the highest expression of the martial art (1, 3, 4). Whilst sparring, most trained practitioners aim to deliver strikes or kicks with the possible maximum speed and power, but they need to stop them at the moment of contact so that the opponent is not injured (2, 5). However, a swift-withdraw of reverse roundhouse- kick may lay a great stress on the athlete's ACL; especially when there is imbalances in hamstring and quadriceps strength. Imbalances between the agonist-antagonist muscles of the knee has also been linked to a greater susceptibility to injury in this joint (6-8). The Hamstring to quadriceps ratio has been used as a measure of knee muscle balance and hence linked to increased stress and injury susceptibility. Muscular fatigue may develop significant muscular asymmetries that could predispose athletes to injuries. Therefore, the assessment of the muscular function of elite athletes after muscular fatigue is important in order to identify muscle imbalances and establish injury prevention programs. Isokinetic strength testing received a great deal of popularity throughout 1980 in rehabilitation settings, primarily because it provides an objective means of quantifying the level of muscular strength (9). In isokinetic testing, the peak torque variable is considered the ''gold standard'' measurement (10, 11) and, therefore, it is an important parameter to be assessed, especially in the athletic population during different conditions such as after muscular fatigue. Therefore, the purpose of this study was to compare the Hamstring/Quadriceps muscular strength ratio in elite karate athletes before and after muscular fatigue in 60, 180 and 300 °/s speeds.

2. Material & Method

Thirteen female competitive elite karate athletes (15.5±1.5 years; 161.7±5.0 cm of height; 54.0±7.4 kg of body mass) volunteered to this study, and all the athletes who volunteered for this study were signed an informed consent. They were outstanding athletes who had recently obtained prominence in state, national and international tournaments. Inclusion criteria for the study were: 18 to 30 years of age; current participation in organized competitions; and daily training frequency of at least 2 hours. Exclusion criteria were: previous injury or current instability in the knee joints; regular participation in other sports activities; and presence of reported cardiovascular disease (8).

Before all testing, the subjects performed a typical warm-up consisting of 5 min cycling on a Monark ergometer. They were instructed to follow a self-select cycling resistance and pedal cadence at which they would feel comfortable. After that, the main testing session began. An isokinetic dynamometer Biodex Multi-joint System (Biodex Medical Systems, Inc, Shirley, New York, USA) was used for assessment of Knee flexor and extensor strength.

The device was calibrated before each assessment and all procedures, including gravity correction of the torque measures, were conducted according to the specifications of the equipment's instructions manual. The dominant lower limb was determined by asking them. For the knee joint testing, subjects were stabilized in the dynamometer chair with straps across the chest, pelvis and thigh and were oriented to maintain the arms crossed in front of the chest during the test (12) (Figure.1). The mechanical axis of rotation of the dynamometer was aligned to the femoral lateral epicondyle. The resistance was applied immediately above the medial malleoli (13) and the established range of motion was 20◦ to 90◦ of knee flexion (0◦ = full extension). All tests were performed in the reciprocal concentric mode and each test was composed of five repetitions at 60, 180 and 300◦/s before and after muscular fatigue protocol. The test was always initiated by the slowest velocity, with 2 minutes of rest between test velocities. the examiner was encouraged the subjects verbally to perform maximal effort during each test. The submaximal isokinetic fatigue protocol consisted of reciprocal knee extension and flexion at 60% of peak torque at 60º/ s. The submaximal protocols were adjusted on the basis of torque decline. Particularly the protocol was matched in a way that torque decline was in the range of 50±5% of the maximal pre-fatigue peak torque. This was determined in multiple visits for each subject and required familiarization with the dynamometer and intensity level. In the data collection, the peak torque was considered to be the highest point at the chosen velocity in each curve. The peak torque values were normalized by the subject's body mass and multiplied by 100. The Hamstring/Quadriceps ratio was calculated by dividing the mean peak torque of flexors to the mean peak torque of the extensors, with the obtained result multiplied by 100. The statistical analysis was carried out using the SPSS 18 for Windows software. The Shapiro-Wilks and Kolmogorov-Smirnoff tests were used to test the normality of distribution. Accordingly, One-way analysis of variance with Repeated Measurements was used to compare the main effect of fatigue on Hamstring/Quadriceps ratio between 3 different angular velocities. The paired t-tests or Wilcoxon tests were used to compare the differences between the scores for dependent variable (peak torque) before and after fatigue protocol at each angular velocity test (60, 180 and 300◦/s). The level of significance (α) was set at 5% for all statistical analyses.

Figure 1.

Table 1. hamstring to quadriceps ratio before and after fatigue protocol in three different speeds

Speeds	Pre fatigue	Post fatigue	Header 2	P value
60	65±6	59±5	3.6	0.004
180	61±6	51±5	3.9	0.002
300	56±6	48±6	6.3	0.000

3. Results

Data from the isokinetic assessment of the flexion and extension of the knee before and after fatigue in three different speeds is presented in Table 1. Results showed significant decrease ($P<0.05$) in hamstring to quadriceps ratio after fatigue protocol in three different speeds.

Data from Hamstring/Quadriceps ratio change before and after fatigue for knee at three speeds is presented in Fig. 2. No significant difference was found in the knee Q/H ratio change between three different speeds ($F=1.23$; $P=0.30$).

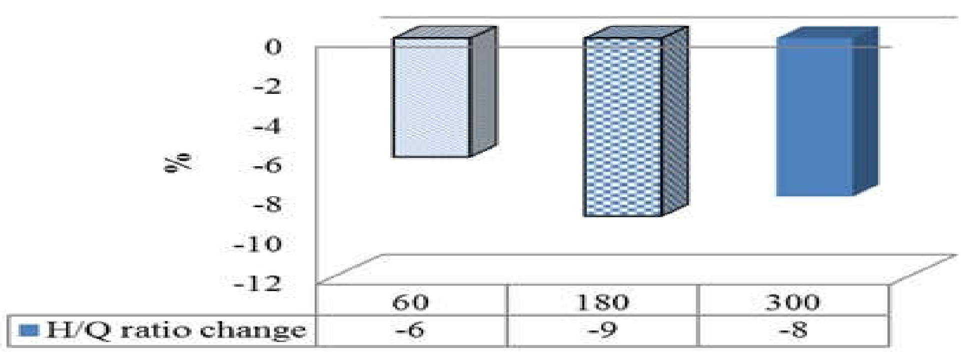

Figure 2. Hamstring/Quadriceps ratio change (after fatigue-before fatigue) for knee at three speeds.

4. Discussion

Our objective was to compare the Hamstring/Quadriceps muscular strength ratio in elite karate athletes before and after muscular fatigue in 60, 180 and 300 °/s speeds, and to identify muscle torque imbalance that could predispose these individuals to injuries after fatigue. Our results showed significant decrease in hamstring to quadriceps ratio after fatigue protocol in three different speeds. No significant difference was found in the knee H/Q ratio change between three different speeds. H/Q ratio decrease after fatigue could probably be caused by the fact that quadriceps muscles are unipennate. Moreover, quadriceps have four muscles and hamstrings have three muscles that indicates more chiggers. Physiological cross-section in quadriceps due to this point, quadriceps produce more energy and have more power, therefore when exposed to fatigue they show less energy decrease in comparison to hamstrings. On the other hand, most karate mores particularly kicks are accompanied by quick knee extension that contains concentric quadriceps muscles contraction and tibia forward movements. Hamstrings and ACL[1] respectively are the structures that actively and passively stop this movement. Thus, since hamstring is a dynamic stabilizer factor of knee joint and an ACL supporter, it probably cannot play its role as dynamic stabilizer after fatigue and ACL has to be in charge of stabilizing sagittal plate of knee joint, as a result it is at risen of injury. Studies assessing isokinetic muscle recruitment patterns are extremely scarce in the literature, therefore, comparison of our results is difficult. The knee H/Q ratio (hamstrings to quadriceps ratio) has been considered a useful measure in detecting lower limb muscle imbalances that could predispose young athletes to injuries such as hamstrings muscle strains (14) knee overuse syndromes (6) and ACL injuries (7, 15). It has been stated that knee H/Q ratios below 60% at slower speeds (60◦/s) and below 80% at faster speeds (300◦/s) are significantly related to lower limb injuries (6, 7) and, therefore, need to be addressed in injury prevention programs. The athletes from our study presented H/Q ratios smaller than these values before (just at 300◦/s speed) and after fatigue protocol (in 60, 180 and 300 º/s speeds), suggesting that they might be at increased risk of injury. Inconsistent with our results, Aagaard et al, reported karate athletes showed knee H/Q ratios greater than 60% at 60◦/s (16). In contrast to our results, Scattone-Silva et al (2012) stated that the elite karate athletes had knee H/Q ratios lower than 60% at 60◦/s. We couldn't find any other study assessing the knee H/Q ratio of karate athletes at higher isokinetic speeds and effect of fatigue, so no direct comparison can be made from our results.

Our results showed that lower limb muscle imbalances in elite female karate athletes that could predispose young karate athletes to injuries exist at the speed of 300◦/s speed and in three different speeds after fatigue protocol, but there are not any differences after fatigue between three speeds. So we can say that fatigue can probably increase the potential of knee joint injury and particularly ACL structure. Therefore in order to avoid knee injuries especially ACL structure, it is suggested that athletes and trainers emphasize more on resistance exercises on hamstrings, so that indicator of maximum muscle strength of H/Q ratio reaches 0/6.

[1] Anterior cruciate ligament

5. References

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