

Isokinetic performance of shoulder external and internal rotators in judo and karate female elite athletes

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Abstract

The aim of this study was to determine the isokinetic profile of shoulder internal and external rotators in judo and karate female elite athletes.; Methods: Study sample consisted of senior 13 female karate athletes (21.23 ± 2.83 years) and 13 female judokas (21.00 ± 2.51 years). For testing the isokinetic muscle strength of the external and internal rotation of the shoulder joint, the HUMAN NORM isokinetic dynamometer has been used. Testing the maximum muscle strength of subjects was carried out at an angular speed of 60° / sec and 180° / sec; Results: Judo female athletes had higher isokinetic peak torque for right and left shoulder internal rotators than karate athletes at 60°/s and 180°/s, with a large effect size, Cohen's d = 0.89, 1.02, 0.97, 0.95, respectively. Also, large differences were observed between the judo and karate subjects in peak muscle torques of the right shoulder external

shoulder rotator muscles of both limbs were greater in judokas than karate athletes. Isokinetic testing should be an integral part of training process in combat sports because in order to decrease the number of injuries and improve performance.

Keywords martial arts • shoulder • torque • differences.

Introduction

Strength development is considered as an important element in combat sports (Blais and Trilles, 2006). Additionally, muscle strength is commonly assessed to determine the outcome of different interventions and rehabilitation as well as for diagnostic purposes (Land and Gordon, 2011). According to Kotrljanovic, et al. (2016), muscle strength testing can provide valuable information in combat sports in order to detect possible differences and asymmetries between muscle groups (Kotrljanovic, Atanasov, Veljovic, Drid, 2016). This is of great importance because shoulder muscle strength imbalance could possibly lead to overuse injuries (Berckmans et al., 2017; Trajkovic et al., 2019).

Combat sports are physically demanding activities with variety of performance characteristics that are required to achieve a high level in competition and to succeed (Franchini, Brito, Fukuda, Artioli, 2014). Striking movements in karate require explosive strength and power,

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while grappling movements in Judo can require a greater emphasis on isometric greater emphasis on isometric and concentric strength (Loturco, Artioli, Kobal, Gil, Franchini, 2014; Ratamess, 2011). Accordingly, these sports-specific movements in combat sports could influence the physical load.

Therefore, to be effective in combat sports it is important to understand the characteristics of elite athletes (Franchini, Del Vecchio, Matsushigue, Artioli, 2011; Drid et al., 2015; Bojanić et al., 2019). However, Pion, Fransen, Lenoir, & Segers (2014) stated that it is possible that basic requirements for combat sports are similar. On the contrary, Drid et al. (2011), have stated that international half-heavyweight male medalists in judo are superior compared with the national medalists in fitness components (Pion, Fransen, Lenoir, & Segers, 2014).

Judo is a dynamic, high-intensity intermittent sport that requires complex skills and tactical excellence and physical demand of a single match is very high (Degoutte, Jouanel, & Filaire, 2003). Similarly, karate athletes have to perform several high-intensity actions during the match (Baker, & Bell, 1990; Vujkov, Calleja-Gonzalez, Krneta, Drid, & Ostojic, 2015). Top-level karate athletes have high fitness levels and, according to Baker & Bell (1990), karate fighting is considered a high-intensity event.

In order to determine the physical characteristics in combat sports it is important to assess the muscle performance of the dominant and non-dominant limbs of elite competitive athletes. The isokinetic testing can provide valuable information in combat sports regarding strength of certain muscle groups and its imbalance detection (Pion, Fransen, Lenoir, & Segers, 2014). Moreover, concerning the shoulder joint, external and internal rotators were the two most accessed muscle groups and extensively used in research (Dvir, 2014). According to Lystad (2015), the greatest risk of injury is in hybrid styles (e.g. mixed martial arts), intermediate in striking styles (karate), and lowest in grappling styles (judo).

Previous studies have investigated the muscular balance of shoulder rotator cuff muscles in an attempt to identify imbalances that may be associated with shoulder injuries (Mikesky, Edwards, Wigglesworth, & Kunkel, 1995; Ellenbecker, & Davies, 2000; Andrade, Fleury, de Lira, Dubas, & da Silva, 2010; Kotrljanovic, Atanasov, Veljovic, & Drid, 2016). However, studies that compare combat sports with striking and grappling movements are limited according to authors knowledge.

Considering the importance of the shoulder joint in combat sports, the detailed study of the external and internal rotator muscles of the shoulder is fundamental for the improvement of muscular performance and prevention of overuse injuries of the shoulder in combat sport athletes. Therefore, the aim of this study was to determine the isokinetic profile of shoulder internal and external rotators in judo and karate female elite athletes.

Method

The study sample consisted of senior 13 female karate athletes (21.23 ± 2.83 years) and 13 female judokas (21.00 ± 2.51 years). All subjects are active athletes that won medals at national and international competitions. Athletes with a previous and/or current upper limb injury that had not yet been fully rehabilitated were not included in the study. Ethical approval was granted by the Ethics Committee at the Faculty of sport and physical education in Novi Sad and each subject participating in the measurements was presented with an explanation of the procedure provided for the research and measurement. In the end, participants signed the consent confirming that they are familiar with the purpose and objectives of measurement, measurement protocol and possible risks of measurement and that they are voluntarily accept the measuring process.

Table 1. Physical characteristics of subjects studied

	Judo (N=13)	Karate (N=13)	t	p
Age (yrs)	21.00 ± 2.51	21.23 ± 2.83	-0.220	0.828
Weight (kg)	62.20 ± 8.83	64.43 ± 7.36	-0.699	0.491
Height (cm)	162.76 ± 6.96	167.07 ± 5.15	-1.793	0.086

For testing the isokinetic muscle strength of the external and internal rotation of the shoulder joint, the HUMAN NORM isokinetic dynamometer has been

used. Before each of tests, the device is calibrated. Range of motion of the tested extremity was 90 degrees. One person performed both giving

instruction to the patients prior to testing and measurement. Dynamometers were set for each subject according to the protocol. The testing started with the warm up and was followed by a period of rest for 2 minutes before performing maximal contraction. Testing the maximum muscle strength of subjects was carried out at an angular speed of 60° / sec and 180° / sec in sitting position. Four maximal contractions were performed in a row. The following isokinetic parameters have been recorded by using the dynamometer used in the research: peak torque (PT, N/m) for external/internal rotator and the external/internal rotator ratio (ER/IR ratio) for left and right arm.

Isokinetic variables such as absolute peak torque (PT, N/m), right-left asymmetry and the external/internal rotator ratio (ER/IR ratio) (%) were used for the analysis. The mean values for PT and the ER/IR ratio for the shoulder joint musculature were evaluated statistically on the SPSS 17.0 software (Statistical Package to Social Science for Windows). To verify the normality of the data distribution, the Shapiro-Wilk test was used, and an independent T-test determined differences between the groups at the significance level of 0.05. If T-test had not been applicable, Mann-Whitney U test was used.

Calculating Cohen's d effect sizes, the magnitude of any change was judged according to the following criteria: d = 0.2 was considered a "small" effect size; 0.5 represented a "medium" effect size; and 0.8 a "large" effect size

Results

The peak muscle torques of the shoulder external and internal rotators in judo and karate female athletes

In Table 2 mean values, standard deviations, t- and p-values are presented. Judo female athletes had higher isokinetic peak torque for right and left shoulder internal rotators than karate athletes at 60°/s and 180°/s, with a large effect size, Cohen's d = 0.89, 1.02, 0.97, 0.95, respectively. Also, large differences were observed between the judo and karate subjects in peak muscle torques of the right shoulder external rotators at both speeds, in favor of the judo subjects, Cohen's d = 0.93, 0.95, respectively. However, the difference between judo and karate athletes in peak muscle torque of left shoulder external rotators was not significant at 60°/s and 180°/s, Cohen's d = 0.5, 0.49, respectively.

Table 2. Mean values (\pm SD) of peak muscle torques of the shoulder external and internal rotators

	Judo (N=13)	Karate (N=13)	%diff	t	p
Isokinetic Con 60°/s					
IR-R (N/m)	31.53 \pm 6.45	26.53 \pm 4.70	15.9%	2.259	0.033
IR-L (N/m)	30.46 \pm 6.95	24.15 \pm 5.35	20.7%	2.590	0.016
ER-R (N/m)	26.92 \pm 6.92	21.76 \pm 3.72	19.2%	2.364	0.026
ER-L (N/m)	23.07 \pm 4.21	20.84 \pm 4.72	9.7%	1.271	0.216
Isokinetic Con 180°/s					
IR-R (N/m)	27.84 \pm 6.70	22.23 \pm 4.65	20.2%	2.480	0.021
IR-L (N/m)	26.00 \pm 6.84	20.23 \pm 5.18	22.2%	2.423	0.023
ER-R (N/m)	22.15 \pm 5.24	18.00 \pm 3.24	18.7%	2.430	0.023
ER-L (N/m)	19.23 \pm 3.13	17.15 \pm 5.08	10.8%	1.254	0.222

Legend: IR-R: internal rotator right limb; IR-L: internal rotator left limb; ER-R: external rotator right limb; ER-L: external rotator left limb.

Bilateral strength difference of the shoulder internal and external rotators

Small non-significant differences between judokas and karate group were noticed in the right-left

strength ratio of shoulder internal rotators and external rotators as well, at 60°/s and 180°/s, Cohen's $d = 0.29, 0.24, 0.20, 0.37, p > 0.05$, respectively (Table 3).

Table 3. Mean percent values (\pm SD) of absolute right-left asymmetry

	Judo (N=11)	Karate (N=11)	t	p
Isokinetic Con 60°/s				
IR (%)	10.78 \pm 5.69	13.18 \pm 10.38	-0.731	0.472
ER (%)	12.37 \pm 10.44	10.07 \pm 8.49	0.615	0.545
Isokinetic Con 180°/s				
IR (%)	9.79 \pm 9.02	11.97 \pm 12.10	-0.521	0.607
ER (%)	12.94 \pm 8.31	10.06 \pm 7.36	0.935	0.359

Legend: IR: right-left asymmetry for internal rotation; ER: right-left asymmetry for external rotation; isokinetic con:

The shoulder rotation strength ratio in judo and karate female athletes

Small to medium non-significant differences were noticed between female judokas and karatekas in the

agonist-antagonist rotation strength balance of right and left shoulders at 60°/s and 180°/s, Cohen's $d = 0.16, 0.68, 0.20, 0.53, p > 0.05$, respectively (Table 4).

Table 4. Mean and standard deviation values of external/internal rotators ratio of limb's shoulder

	Judo (N=11)	Karate (N=11)	t	p
Isokinetic Con 60°/s				
ER/IR ratio (%)	Right 85.9 \pm 16.6	83.4 \pm 15.2	0.397	0.695
	Left 77.4 \pm 14.1	87.3 \pm 14.8	-1.745	0.094
Isokinetic Con 180°/s				
ER/IR ratio (%)	Right 80.1 \pm 9.3	82.2 \pm 11.9	-0.499	0.622
	Left 77.0 \pm 16.1	85.8 \pm 17.1	-1.363	0.088

ER/IR ratio: external/internal rotators ratio.

Legend: ER/IR ratio: external/internal rotators ratio.

Discussion

The purpose of this study was to evaluate shoulder rotator isokinetic profile, concentrically measured at 60 and 180°/s in female judokas and karatekas, and to investigate whether differences exist between them. The peak torques produced at 60 and 180°/s by the internal shoulder rotator muscles of both limbs were greater in judokas than karate athletes. Also, judo athletes showed higher torque production of the external shoulder rotators on the right side than karate athletes, at both velocities. Isokinetic strength of left internal shoulder rotators did not diverge between judo and karate athletes. In both groups and for both limbs, higher peak torque of shoulder internal rotation was observed in regard to external rotation. Within this context, previous studies have also shown that

internal rotator muscles are stronger than external rotators (Ivey, Calhoun, Rusche, & Bierschenk, 1985; Wilk, Andrews, Arrigo, Keirns, & Erber, 1993; an Cingel et al., 2006; Pontaga, & Zidens, 2014). This is believed to be due to muscle hysteresis, where in the acceleration phase, the internal rotators contract concentrically as the main agonists, while the external rotators eccentrically maintain the shoulder stability (Lin, Ko, Lee, Chen, & Wang, 2015). Moreover, average isokinetic peak torque of shoulder internal and external rotation was lower for higher angular velocity, because at higher velocity muscles fail to develop maximal tension due to lack of time (Land, & Gordon, 2011).

Shoulder rotator bilateral strength differences were similar in judo and karate athletes, without any significant difference between them. In this study,

bilateral strength ratio of internal rotation did not overshoot recommended value, which was previously reported (Eagle, Connaboy, Nindl, & Allison, 2018). In their cohort study, >20% internal rotation right-to-left strength ratio was labeled as a possible risk factor for shoulder injury, as it increases odds of reporting a previous shoulder injury. Likewise, bilateral strength ratio of external rotation was within the recommended value.

Also, judokas and karatekas did not differ in the shoulder rotation strength ratio of right and left limb. Sample mean for agonist/antagonist ratios at both speeds, which represent the imbalance in the strength of external and internal shoulder rotator muscles, was 85.9%, 77.4%, 80.1%, 77%, 83.4%, 87.3%, 82.2%, and 85.8% for right and left limb in judo and karate athletes, respectively. In regard to the recommended isokinetic muscle strength ratios of external and internal rotators of the shoulder, both groups of athletes have optimal performance of shoulder rotators, which is important due to a fact that its decrease below 76% may contribute development of shoulder movement dysfunctions (Myer et al., 2009; Berckmans et al., 2017).

Conclusions

The peak torques produced at 60 and 180°/s for both, the internal and external shoulder rotator muscles of both limbs were greater in judokas than karate athletes. Isokinetic testing should be an integral part of training process in combat sports because in order to decrease the number of injuries and improve performance.

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Conflicts of Interest

The authors declare no conflict of interest.

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