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INVESTIGATION OF THE CORRELATION BETWEEN ISOKINETIC H/Q RATIOS AND STATIC-DYNAMIC LEG STRENGTH

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The aim of this study was to investigate the correlation between knee isokinetic hamstring / quadriceps (H / Q) ratios and leg static-dynamic strength in sedentary subjects. For this purpose, a total of 14 sedentary individuals (22.80±1.48) participated in the study. Isokinetic measurements of the participants were performed with isokinetic dynamometer (CSMI Cybex Humac Norm, USA). Isokinetic tests were performed at 3 different motion angles (60os-1 / 180os-1 / 240os-1). Each movement angle was performed with 15 repetitions and 45 second rest intervals. Static leg strength was measured with a dynamometer. Dynamic leg strength was evaluated by vertical jump test. SPSS 20.0 package program was used for the analysis of the data. Significance level was accepted as $p < 0.05$. According to the results, a significant correlation was found between the knee isokinetic H / Q ratios and dynamic leg strength ($p < 0.05$), while no significant correlation was found between static leg strength ($p > 0.05$). In conclusion, it can be said that there is a significant correlation between knee isokinetic H / Q ratios and dynamic leg strength.
Keywords: isokinetic, static strength, dynamic strength

1. INTRODUCTION

Strength can be defined as the nerve-muscle ability that overcomes internal and external resistances. The highest strength that an athlete can produce depends on the biomechanical properties of the movement and the contractile size of the muscle groups involved. During a physical activity that requires strength, a proper order must be found between the muscle groups involved. Muscles often participate consecutively in a certain sequence (Bompa, 2007). The capacity of the muscle to produce tension in all or part of the joint movement angle is known as dynamic contraction. A muscle can produce dynamic tension either by shortening or lengthening. If joint movement exerts a strength opposite to gravity and the tension generated by the muscle exceeds the external resistance encountered, this is a shortened contraction, in a concentric contraction. If the joint movement is in the direction of normal power and the resistance encountered is above the muscle's capacity to produce tension, this is an eccentric contraction (Perrin, 1993).

Hamstring / quadriceps (H / Q) balance plays an important role in joint stabilization. When the H/Q ratio is abnormal, it may be a risk factor for joint and muscle injuries (Burkett, 1970; Doğan, Yılmaz, Kabadayı, Bostancı & Mayda, 2019; Gilliam, Sandy, Freedson & Villanicci, 1979).

The H/Q ratio is used to examine the similarities of moment-velocity patterns between hamstring and quadriceps and to evaluate knee functional adequacy and muscle balance. This ratio refers to conventional concentric hamstring quadriceps strength and eccentric hamstring-quadriceps strength

(Rosene et al., 2001; Yılmaz, Kabadayı, Bostancı, Özdal & Mayda, 2019). Accurate decisions about muscle balance and stabilization of the knee joint depend on research to determine H/Q strength ratios. The H/Q ratio is calculated by the ratio of the peak torque of the hamstring and quadriceps to the measurements of the same angular velocity and concentric contraction. The H/Q ratio depends on the speed and position. This ratio is also known as a suitable tool to show trends in injury. Because of the importance of flexor - extensor muscle strength balance, H/Q ratio is used for rehabilitation in case of knee injury (Alangari and Al-Hazzaa, 2004). When the studies in the literature are examined, it is important that our study is not very common because of the correlation between knee isokinetic H/Q ratios and leg static and dynamic strength. The aim of this study is to investigate the correlation between isokinetic H/Q ratios of knee and leg static-dynamic strength.

2. MATERIAL METHOD

2.1. Experimental Design and Participant

This study was designed according to the cross-controlled experimental design. A total of 14 sedentary individuals participated in the study. G Power 3.1 program was used to determine the number of subjects participating in the study. The subjects visited the laboratory three times in total. During the first visit, the participants were given detailed information about the measurements. In the second visit, isokinetic knee measurements were carried out. In the last visit, static and dynamic leg strength were measured. Our study was conducted according to the Declaration of Helsinki and the ethics committee permission was obtained from Gaziantep University Clinical Research and Ethics Committee.

Table 1. Descriptive Characteristics of the Participants

	Mean	Std. Deviation
Age (years)	22.80	1.48
Height (cm)	177.60	7.75
Weight (kg)	70.00	5.96
Static leg strength (kg)	79.75	19.46
Dynamic leg strength (cm)	39.70	4.47
60º H/Q peak torque ratio (%)	73.60	9.35
60º H/Q total work ratio (%)	81.10	14.69
60º H/Q average power ratio (%)	85.40	13.12
180º H/Q peak torque ratio (%)	77.00	6.57
180º H/Q total work ratio (%)	82.30	11.92
180º H/Q average power ratio (%)	79.00	9.56
240º H/Q peak torque ratio (%)	82.60	8.66
240º H/Q total work ratio (%)	85.70	12.16
240º H/Q average power ratio (%)	86.20	12.23

Table 1 shows that the descriptive characteristics of the participants. According to the table. the mean age of the participants was determined as 22.80 ± 1.48 years. height was 177.60 ± 7.75 cm. weight was 70.00 ± 5.96 kg. static leg strength was 70 ± 19.46. dynamic leg strength was 39.70 ± 4.47.

2.2. Static and Dynamic Leg Strength Measurement

Static leg strength of the subjects was measured by a back and leg dynamometer (Takei- Back & Lift, Japan). After placing the legs on the dynamometer table with the knees (130-140º), the arms were stretched, the back straight and the trunk slightly tilted forward, with the hands grasping the dynamometer bar vertically at the maximum rate, using the legs until the knees were extensible (Heyward, 2002). All strength measurements were repeated 3 times and the best grades were recorded as kg.

Dynamic leg strength was measured by vertical jump test (Sargent Jump) (Sevim and Şengül, 1987). In this measurement, the distance between the height at which the participant could reach to the standing and the point where he could jump and touch was measured in meters. Then, the dynamic strength calculation was made with the formula by using the body weights of the subjects (Garnbetta, 1989; Günay, Sevim, Savaş & Erol, 1994; Tamer, 1995).

2.3. Isokinetic Measurement

Isokinetic knee strength measurements were measured with an isokinetic dynamometer (CSMI Cybex Humac Norm, USA). Isokinetic tests were performed at 3 different motion angles ($60^{o}s^{-1}$ / $180^{o}s^{-1}$ / $240^{o}s^{-1}$) and 15 repetitions at each angle. The measurement was made for the right side of the knee first, and the rest of the rest of the angular velocity was calculated as the sum of rest intervals isokinetic measurement of the left knee. 10 repetitive warm-up exercises were performed on an isokinetic dynamometer at $300^{o}s^{-1}$ before testing at each angular velocity. The rest interval between each angular velocity was set to 45 seconds (Perrin, 1993).

2.4. Statistical Analysis

SPSS 20 program was used for statistical analysis. Pearson correlation analysis was used to examine the data in a correlational dimension. Values are presented as mean and standard deviation, and significance level is examined as 0.05.

3. RESULTS

Table 2. Correlation Between 60^{0} Isokinetic Knee Ratio Values and Static-Dynamic Leg Strength

		Static	Dynamic
60º H/Q peak torque ratio (%)	r	,384	**,699**
	p	.274	**.042**
60º H/Q total work ratio (%)	r	.032	**.772**
	p	.929	**.009**
60º H/Q average power ratio (%)	r	.258	**.705**
	p	.471	**.023**

Table 2 shows the correlation between the 60º H/Q ratios of the participants and the dynamic and static leg strength. As a result of statistical analysis, a positive correlation was found between 60º H/Q peak torque, total work and average power values and dynamic leg strength values ($p < 0.05$), but no statistically significant correlation was found between static leg strength values ($p > 0.05$).

Table 3. Correlation Between 180º Isokinetic Knee Ratio Values and Static-Dynamic Leg Strength

		Static	Dynamic
180º H/Q peak torque ratio (%)	r	-.243	**.686**
	p	.499	**.041**
180º H/Q total work ratio (%)	r	-.085	**.640**
	p	.815	**.037**
180º H/Q average power ratio (%)	r	-.383	**.656**
	p	.275	**.039**

Table 3 shows the correlation between the 180º H / Q ratios of the participants and the dynamic and static leg strength. As a result of statistical analysis, a positive correlation was found between 180º H/Q peak torque, total work and average power values and dynamic leg strength values ($p <0.05$), but no significant correlation was found between static leg strength values ($p> 0.05$).

Table 4. Correlation Between 240º Isokinetic Knee Ratio Values and Static-Dynamic Leg Strength

		Static	Dynamic
240º H/Q peak torque ratio (%)	r	-.006	.358
	p	.986	.310
240º H/Q total work ratio (%)	r	-.026	-.018
	p	.943	.960
240º H/Q average power ratio (%)	r	-.063	.318
	p	.863	.370

Table 4 shows the correlation between participants' 240º H/Q ratios and dynamic and static leg strength. As a result of statistical analysis, no significant correlation was found between 240º H/Q peak torque, total work and average power values and dynamic and static leg strength values ($p> 0.05$).

4. DISCUSSION

The aim of this study was to investigate the correlation between isokinetic H/Q ratios of the knee and leg static and dynamic strength. For this purpose, a total of 14 sedentary males participated in the study. Knee isokinetic strength measurement and static and dynamic leg strength measurement were performed. As a result of the data analysis, a significant positive correlation was found between the knee isokinetic $60^{o}s^{-1}$ H/Q peak torque, total work and average power values and dynamic leg strength values. In the same way no significant correlation was found in static leg strength. In the other angular velocity values of the participants, a positive correlation was found between $180^{o}s^{-1}$ H/Q peak torque, total work and average power values and dynamic leg strength values. Similarly, no significant correlation was found between static leg strength. At the last measured angular velocity (240^{o} H/Q), no significant correlation was found between the static and dynamic leg strengths of the participants.

Today, isokinetic strength measurements and isokinetic strength trainings enable the use of different and up-to-date methods thanks to developing technological devices and equipment. Isokinetic measurements allow the objective and measurable data collection opportunity to monitor the athletes' strength gain values. Muscle performance can be classified as normal or abnormal according to isokinetic test results. This is also important in terms of quantifying the exercise management (Gürol and Yılmaz, 2013).

In our study, peak torque values were at the expected levels. In the literature, young groups showed higher peak torque values compared to older and younger groups (Frontera, Hughes, Lutz & Evans 1991; Murray, Gardner, Mollinger & Sepic, 1980; Pousson, Lepers & Hoecke, 2001). Isokinetic strength values appear to be high in the determination of muscle ratios after rehabilitation and measurements made to prevent disability (Holcomb, Rubley, Lee & Guadagnoli, 2007; Martens, Axtell & Stofan, 1995; Maurer, Stem, Kinossian, Cook & Schumacher, 1995; Osteras, Augestad & Tondel, 1998; Umay, Tezelli, Dinç & Rükşen, 2012 The ratios obtained in isokinetic measurements are informative about how to perform the application. Low peak torque values indicate that more strength training should be done, low average power values indicate lack of endurance and high repetitive training. Isokinetic applications are a valuable method in rehabilitation after disability, in evaluating the increase in sport performance, strength development and follow-up, in terms of providing the opportunity to work with different joints (Gürol and Yılmaz, 2013).

Although H/Q ratio shows muscular balance, it is used as a determinant in prevention of disability. It is known that the imbalance between agonist and antagonist muscle groups, in particular the weakness of the hamstring muscle group, will result in injuries. The H/Q ratio is influenced not only by age, sex and dominance but also by angular velocity. Therefore, it is seen that H/Q ratio increases as speed increases. It is stated in the literature that the rates are between 50-60% at 30-60 °/ s, 60-70% at 120-180 °/ s and 70-80% at angular velocities above 180°/ s. This rate was found to be higher than 60% in footballers and higher than sedentary individuals (Alexander, 1990; Grace, Sweetser, Nelson, Ydens & Skipper, 1984; Kannus, 1989; Kayatekin, 1994; Öberg, Möller, Gillquist & Ekstrand, 1986). In our study, a significant positive correlation was found between dynamic strength values and isokinetic H/Q ratios. High strength values in lower extremity and good ratio of hamstring and quadriceps muscle can be evaluated as an important factor in preventing disability. Dynamic strength is an expression that can be used to define the strength produced by the lower extremity (Sevim and Şengül, 1987). The fact that dynamic strength values are at good levels can be said to indicate that individuals are better in terms of muscular fitness and power generation. The fact that dynamic strength values are at good levels can be said as an indicator that individuals are better in terms of muscular fitness and power generation. In our study, it can be said that the significant positive correlation between dynamic strength and static strength is supportive of this information.

As a result, knee isokinetic values may be an important factor in determining the degree of strength of individuals and in implementing necessary arrangements and programs according to needs. Considering these values, it can be said that the preparation of training programs is important both for preventing disability and for increasing the existing capacity in a balanced way.

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