EFFECT OF KNEE ISOKINETIC MEASUREMENT WITH DIFFERENT ANGULAR VELOCITIES ON ISOKINETICS H/Q RATIOS

ABSTRACT
The athlete's injury, performance and follow-up can be interpreted with isokinetic H/Q ratios. The purpose of this study was to investigate the effect of different position (prone and sitting) H/Q ratios in knee isokinetic measurement. For this purpose, 15 healthy sedentary males participated in the study. Isokinetic measurements of the subjects were carried out with Isokinetic dynamometer (CSMI Cybex Humac Norm, USA). Isokinetic measurements were performed in 3 different range of motion (240°s⁻¹ / 180°s⁻¹ / 60°s⁻¹). The test was carried out 10 repetitions with 240°s⁻¹ and 180°s⁻¹, and 5 repetitions at 60°s⁻¹ degrees angular velocities. Each movement angle was performed 45 second rest intervals. SPSS 20.0 package program was used for the analysis of the data. Significance level was accepted as p < 0.05. As a result of the analysis of the data, there was no significant difference between the two positions in the isokinetic H/Q peak torque, total work and average power parameters (p > 0.05). At angular velocities of 180°s⁻¹ and 60°s⁻¹, there was a significant difference between two positions in the isokinetic H/Q peak torque, total work and average power parameters (p > 0.05). As a result, the significant difference was determined in favor of the sitting position. In conclusion, it can be said that the isokinetic measurement in different positions has a significant effect on isokinetic knee H/Q ratios.

Keyword: isokinetic, H/Q ratio, position

1. INTRODUCTION
Sufficient degrees quadriceps and hamstring muscle strength are important in exercise performance. These two muscle groups have an antagonistic function. The contraction of the hamstring muscle group results in the flexion of the knee joint, while knee extension occurs with the contraction of the quadriceps muscle group. The muscle groups here work together to control the slowing and acceleration of the leg. Enough strength and thighs required for running, splashing, falling after splashing and other physical activities (Willigenburg, McNally & Hewett, 2014). Making the right decisions about muscle balance and dynamic stabilization of the knee joint depends on research to determine H/Q (hamstring/quadriceps) 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 & Al-Hazzaa, 2004), especially with unsystematic loading and without warm-up sessions (Tuzcuoğlu, 2016); considering the general health benefits of exercise (Özdal, Bostancı, Dağlıoğlu, Ağaoğlu & Kabadayı, 2016; Dağlıoğlu, Mendes, Bostancı, Özdal & Demir, 2013; Özdal, Dağlıoğlu & Demir, 2013), the value of studies involving isokinetic contraction is undeniable. Studies on isokinetic H/Q ratios are common in the literature. In these studies, it was observed that the angular velocity rate of isokinetic measurements increased and the H/Q rates increased in the same parallel. (Akin, Oner, Ozberk, Ertan & Korkusuz, 2004; Kayatekin, 1994). When other studies were examined, isokinetic H/Q ratios were examined in terms of different branches, age and gender and significant differences were found between the variables examined (Aagaard, Simonsen, Magnusson, Larsson & Dyhre-Poulsen, 1998). In addition, physiologically, it was detected that the effect of muscle length and muscle section was significant on the isokinetic H/Q ratios (Holcomb, Rubley, Lee & Guadagnoli, 2007; Nosse, 1982). In these studies, it has been found that
muscle cross section and muscle length have a significant effect on isokinetic strength and H/Q ratios. When the literature is investigated, there are no studies investigating the effects of different positions on the measured knee isokinetic H/Q ratios. For this reason, examining the effect of knee isokinetic H/Q ratios in different positions in our study will be important in terms of providing a new approach and information to the literature. In this way, the purpose of this study investigates the effect of knee isokinetic measurement with different position (sitting/prone) on isokinetic H/Q ratios.

2. MATERIAL METHOD

2.1. Experimental Design and Participants

This study was designed according to the cross-controlled experimental design. 15 healthy sedentary individuals voluntarily 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. On the second visit, the subjects were taken with an application card and it was determined in which position to measure. On the third visit, other position measurements were carried out. Necessary permissions were obtained from the Gaziantep University Clinical Research Ethics Committee for this study.

Table 1. Descriptive Characteristics of the Participants

| Characteristic      | Mean  | Std. Deviation |
|---------------------|-------|----------------|
| Age (years)         | 21.80 | 2.14           |
| Height (cm)         | 174.40| 4.88           |
| Weight (kg)         | 75.67 | 5.78           |

Table 1 shows the descriptive characteristics of the participant. According to the table, the mean age of the participants was determined as 21.80±2.14 years, height was 174.40±4.88 cm; weight was 75.67±5.78 kg.

2.2. Isokinetic Measurement

Isokinetic knee strength measurements were performed with an isokinetic dynamometer (CSMI Cybex Humac Norm, USA). Measurements in both positions were carried out at 3 angular speed (240°s⁻¹ / 180°s⁻¹ / 60°s⁻¹). The test was carried out with 10 repetitions at 240°s⁻¹ and 180°s⁻¹ degrees angular velocities and 5 repetitions at 60°s⁻¹ degrees angular velocities. The rest interval between each angular velocity was set to 45 seconds.

In Isokinetic measurements performed in a sitting and prone position, the Isokinetic dynamometer was used to the same degrees in both measurements. The movement angle is set to 40° and the dynamometer tilt is also set at a high of 40° degrees and 8 cm. In the isokinetic measurements made by lying down, the subject lay face down on the isokinetic platform. In this way, both knees were measured for strength.

2.3. Statistical Analysis

SPSS 20.0 program was used for statistical analysis. Kolmogorov-Smirnov test was used for normality testing. Independent Samples t Test was used to compare two different measurement results. Values are presented as mean and standard deviation, and the significance level is examined as 0.05.

3. RESULTS

Table 2 shows the descriptive characteristics of the participant. According to the table, the mean age of the participants was determined as 21.80±2.14 years, height was 174.40±4.88 cm; weight was 75.67±5.78 kg.

Table 2. Comparison of the 240° isokinetic knee H/Q ratios analysis between trials

| Isokinetic Parameters       | Trial  | Mean  | SD   | t    | p    |
|-----------------------------|--------|-------|------|------|------|
| H/Q peak torque ratio (%)   | 1.Sitting | 82.36 | 15.29| -0.448| 0.662|
|                             | 2.Prone | 88.36 | 11.15|      |      |
| H/Q total work ratio (%)    | 1.Sitting | 87.00 | 29.62|      |      |
|                             | 2.Prone | 86.14 | 17.81|      |      |
| H/Q average power ratio (%) | 1.Sitting | 94.14 | 22.73|      |      |
|                             | 2.Prone | 103.79| 18.24|      |      |

Table 2 shows that the knee isokinetic H/Q ratios performed at 180°s⁻¹ are compared by positions. According to knee isokinetic H/Q ratios made at 240°s⁻¹ are compared according to positions. However, the results did not show significant differences between the sitting and prone positions.
to the table, no significant differences were detected between positions in H/Q peak torque, total work and average power ratio parameters (p > 0.05).

**Table 3.** Comparison of the 180° Isokinetic knee H/Q ratios analysis between trials

| Isokinetic Parameters     | Trial   | Mean   | SD     | t      | p    |
|---------------------------|---------|--------|--------|--------|------|
| H/Q peak torque ratio (%) | 1. Sitting | 80.07  | 7.70   | 3.623  | 0.003|
|                           | 2. Prone | 61.71  | 18.52  |        |      |
| H/Q total work ratio (%)  | 1. Sitting | 88.14  | 9.09   | 4.989  | 0.001|
|                           | 2. Prone | 61.00  | 17.57  |        |      |
| H/Q average power ratio (%) | 1. Sitting | 86.93  | 8.66   | 4.582  | 0.001|
|                           | 2. Prone | 61.86  | 18.19  |        |      |

Table 3 shows that the knee isokinetic H/Q ratios performed at 180°s⁻¹ are compared by positions. According to the table, significant differences were detected between positions in H/Q peak torque, total work and average power ratio parameters (p > 0.05). The resulting significant difference resulted in favor of the measurement performed in the sitting position.

**Table 4.** Comparison of the 60° Isokinetic knee H/Q ratios analysis between trials

| Isokinetic Parameters     | Trial   | Mean   | SD     | t      | p    |
|---------------------------|---------|--------|--------|--------|------|
| H/Q peak torque ratio (%) | 1. Sitting | 63.93  | 7.25   | 3.090  | 0.009|
|                           | 2. Prone | 52.57  | 12.40  |        |      |
| H/Q total work ratio (%)  | 1. Sitting | 79.86  | 9.26   | 9.487  | 0.001|
|                           | 2. Prone | 51.71  | 9.93   |        |      |
| H/Q average power ratio (%) | 1. Sitting | 79.50  | 8.94   | 9.554  | 0.001|
|                           | 2. Prone | 53.36  | 8.44   |        |      |

Table 4 shows that the knee isokinetic H/Q ratios performed at 180°s⁻¹ are compared by positions. According to, knee isokinetic H/Q ratios made at 60°s⁻¹ are compared according to positions. According to the table, significant differences were detected between positions in H/Q peak torque, total work and average power ratio parameters (p > 0.05). The resulting significant difference resulted in favor of the measurement made in the sitting position.

4. **DISCUSSION**

The purpose of this study was to determine the effect of knee isokinetic measurement with different position (sitting/prone) on isokinetic H/Q ratios. For this purpose, 15 healthy sedentary males participated in the study. Isokinetic measurements of the study subjects were carried out with Isokinetic dynamometer (CSMI Cybex Humac Norm, USA). Isokinetic measurements were performed in 3 different ranges of motion (240°s⁻¹ / 180°s⁻¹ / 60°s⁻¹). The test was carried out with 10 repetitions at 240°s⁻¹ and 180°s⁻¹ degree’s angular velocities and 5 repetitions at 60°s⁻¹ degree’s angular velocities. Each movement angle was performed 45 second rest intervals. When the data from the study are analyzed; there was no significant difference between positions in H/Q rates obtained at 240°s⁻¹. At 180°s⁻¹ and 60°s⁻¹ angles, significant differences were found between positions in peak torque, total work and average power ratio parameters.

H/Q strength ratio plays an important role in accurately assessing athletes’ muscle strengths, creating appropriate training programs, improving performance, preventing injuries caused by athlete’s lack of strength, and creating programs suitable for the treatment process after injury (Kannus, 1989; Osteras, Augestad & Tondel, 1998). Previous studies show that the H/Q strength ratio ensures that accurate decisions can be made about dynamic stabilization and muscle balance in the knee joint (Çolakoğlu, Selamoğlu, Gündüz, Acarbay & Çolakoğlu, 1993; Koutedakis, Frischknecht & Murthy, 1997). In isokinetic measurements, as the speed increases, the H/Q ratio decreases. (Perrin, 1993). While the results obtained in the current study showed that the high degrees of H/Q ratio were both reduced and there was no significant difference between positions, H/Q values increased at low angular speeds and the difference between positions was significantly revealed. It is emphasized in the literature that the hamstring muscle group at high speeds have higher strength than the quadriceps muscle group (Rankin &Thompson, 1983).

Isokinetic H/Q ratios were also affected by the physical necessity of different branches (Özçaldıran, Acar & Durmaz, 1998; Magalhaes, Oliveira, Ascensao & Soares, 2004). Other studies conducted in the...
literature it has been observed that the isokinetic H/Q ratios had reduced because of prolonged training time, differentiation of study techniques and other physical and physiological reasons (Rankin & Thompson, 1983). In our study, it could be said that the muscle groups participating in the movement as the reason for the differences we achieved in angular speeds were missing in the production of strength with full capacity when they made the movement faster and that imbalance occurred due to lack of coordination. As the angular velocity of the isokinetic dynamometer increases, the movement must be performed at a certain speed and constant tempo. Therefore, it is difficult for the hamstrings and quadriceps muscles to produce strength in a balanced way while mutually participating in the movement (Pincivero, Lephart & Karunakara, 1997; Holcomb, Rubley, Lee & Guadagnoli, 2007). Another issue; In our study, we can say the following as the reasons for the difference between the knee isokinetic H/Q strength ratios measured in two different positions in favor of the measurement performed in the sitting position. In the sitting position, the joint hip is anatomically in the flexion position and the lumbar is fixed. In this position, it is inevitable for the knee to perform the flexion and extension movements more firmly. In this movement, the number of muscles involved in the contraction is better controlled (Miller et al, 2006). The person vertical position against gravity allows for more comfortable control of the lower extremity muscle functions. The position that extends above the face, the whole body in a parallel position against gravity, in the lower part, especially the lower extremity muscles, make it a little more difficult to control (Dvir, 1996).

As a result of the investigation of the positional differentiation in the measurement of knee isokinetic H/Q force ratios performed in two different positions; it could be said that the isokinetic H/Q ratios are different according to the positions and this differences revealed in favor of the knee isokinetic H/Q ratios performed in a sitting position.

REFERENCES

AAGAARD, P., SIMONSEN, EB., MAGNUSSON, SP., LARSSON, B. & DYHRE-POULSEN, P. (1998). A new concept for isokinetic hamstring: quadriceps muscle strength ratio. The American journal of sports medicine, 26(2), 231-237.

AKIN S., ÖNER Ö. ÖZBERK ZN. ERTAN H. & KORKUSUZ F. (2004). Profesyonel ve amatör futbolcuların fiziksel özellikler ve izokinetik diz kaslarının konsantrik kuvvetinin karşılaştırılması. Clinical Research, 15 (3), 161-167.

ALANGARI, AS. & AL-HAZZZAA, HM. (2004). Normal isometric and isokinetic peak torques of hamstring and quadriceps muscles in young adult Saudi males. Neurosciences, 9(3), 165-170.

ÇOLAKOĞLU, M., SELAMOĞLU, S., GÜNDÜZ, N., ACARBAY, Ş. & ÇOLAKOĞLU, S. (1993). Sprinter ve atlayıcıların hamstring/quadriceps kuvvet oranlarının düzelttilmesinde izometrik egzersizin etkileri. Spor Bilimleri Dergisi, 4(1), 24-33.

DAGLIOGLU, OM., MENDES, B., BOSTANCI, O., OZDAL, M. & DEMIR, T. (2013). The effect of short-term exercise on oxygen saturation in soccer players. Australian Journal of Basic and Applied Sciences, 7(10), 446-9.

DVIR, Z. (1996). Isokinetic Muscle Testing Interpretation and Clinical Application. Churchill, Livingstonstone Edition, 245-55.

HOLCOMB, WR., RUBLEY, MD., LEE, HJ. & GUADAGNOLI, MA. (2007). Effect of hamstring-emphasized resistance training on hamstring: quadriceps strength ratios. Journal of Strength and Conditioning Research, 21(1), 41.

KANNUS, P. (1989) Hamstring/quadriceps Strength Ratios in Knees with Medial Collateral Ligament Insufficiency. The Journal of Sports Medicine and Physical Fitness, 29(2), 194-198.

KAYATEKİN, B. M. (1994). Düzenli antrenmanın futbocularla diz fleksör ve ekstansör kas kuvvetlerine etkisi, Doktora Tezi, Dokuz Eylül Üniversitesi Tip Fakültesi, İzmir.

KOUTEDAKIS, Y., FRISCHKNECHT, R. & MURTHY, M. (1997). Knee flexion to extension peak torque ratios and low-back injuries in highly active individuals. International journal of sports medicine, 18(04), 290-295.
MAGALHAES, J., OLIVEIRA, J., ASCENSAO, A. & SOARES, J. (2004). Concentric Quadriceps and Hamstrings Isokinetic Strength in Volleyball and Soccer Players. J. Sports Med Phys Fitness, 44(2), 119–25.

MILLER, LE., PIERSON, LM., NICKOLS-RICHARDSON, SM., WOOTTON, DF., SELMON, SE., RAMP, WK. & HERBERT, WG. (2006). Knee extensor and flexor torque development with concentric and eccentric isokinetic training. Research quarterly for exercise and sport, 77(1), 58-63.

NOSSE, L. J. (1982). Assessment of selected reports on the strength relationship of the knee musculature. Journal of Orthopaedic & Sports Physical Therapy, 4(2), 78-85.

OSTERAS, H., AUGESTAD, LB. & TONDEL, S. (1998). Isokinetic muscle strength after anterior cruciate ligament reconstruction. Scandinavian Journal of Medicine Science in Sports, 8(5 Pt 1), 279-282.

ÖZÇALDIRAN, B., ACAR, M. & DURMAZ, B. (1998). Yüzücülerde İzokinetik Tork Değişimi. Kurbağalamacı Dizi. Performans Dergisi, Ege Üniversitesi, 3(4), 93-98.

ÖZDAL, M., BOSTANCI, Ö., DAĞLIOĞLU, Ö., AĞAOĞLU, S.A. & KABADAYI, M. (2016). Effect of respiratory warm-up on anaerobic power. Journal of Physical Therapy Science, 28(7), 2097-8.

ÖZDAL, M., DAĞLIOĞLU, O. & DEMİR, T. (2013). Effect of aerobic training program on some circulatory and respiratory parameters of field hockey players. International Journal of Academic Research, 5(4), 97-103.

PERRIN, DH. (1993). Isokinetic Exercise and Assessment. Human Kinetics, USA.

PINCIVERO, DM., LEPHART, SM. & KARUNAKARA, RA. (1997). Reliability and precision of isokinetic strength and muscular endurance for the quadriceps and hamstrings. International journal of sports medicine, 18(02), 113-117.

RANKIN, JM. & THOMPSON, CB. (1983). Isokinetic evaluation of quadriceps and hamstrings function: normative data concerning body weight and sport. Ath. Train.- 18, 110-114.

TUZCUOĞULLARI, Ö.T. (2016). Injury variances and reasons of traditional Turkish folk dance players. European Journal of Physical Education and Sport Science, 2(6), 30-38.

WILLIGENBURG, N. W., MCNALLY, M.P. and HEWETT, T.E. (2014). Quadriceps and hamstrings strength in athletes. Hamstring and quadriceps injuries in athletes. Springer, Boston, MA. 15-28.