Zübeyde Aslankeser [1,*]
Bayram Ceylan [2]
Serkan Revan [1]

COMPARISON OF DOMINANT AND NON-DOMINANT LEG STRENGTH AND HAMSTRING: QUADRICEPS RATIO IN PROFESSIONAL BASKETBALL PLAYERS

PRIMERJAVA DOMINANTNE IN NEDOMINANTNE MOČI STEGENSKIH MIŠIC: RAZMERJE KVADRICEPSOV PRI PROFESIONALNIH KOŠARKARJIH

ABSTRACT

The literature has revealed that knee injuries are the most common injury among basketball players. The strength ratios dominant/non-dominant and posterior-anterior around the knee joint are used to evaluate strength balances. But there has been far less research published about strength evaluation in professional-level basketball. The objectives of the present study were: (i) to compare hamstring and quadriceps muscles' strength values during concentric knee extension and flexion at different angular velocities at professional level basketballers, (ii) to determine dominant and non-dominant strength values during these contractions. 13 professional male basketball athletes voluntarily participated in the study. The leg strength was evaluated with an isokinetic dynamometer at 240-180-120-60^0/s angular velocities. The hamstring and quadriceps unilateral peak torque ratio (H/Q) and dominant non-dominant strength ratio were calculated. The independent t-test was computed to bilateral and unilateral strength outputs. There was no statistically significant difference between dominant and non-dominant strength values at peak torque, normalized peak torque, and H/Q at all angular velocities. Relative peak torque outputs in both legs were similar at all angular velocities. Also, the H/Q was calculated as $\geq$0.60 in all velocities. The results of this study suggest there were not any significant differences in the unilateral and bilateral evaluations of professional basketballers. These non-significant differences could be related to the necessity to maintain similar strength of two legs.

Keywords: bilateral evaluation, flexion-extension ratio, knee strength

[1]Faculty of Sports Science, Selçuk University, Konya, Turkey
[2]Department of Coaching Education, Faculty of Sport Sciences, Kastamonu University, Kastamonu, Turkey

IZVLEČEK

Poškodbe kolena štejemo med najpogostejše poškodbe pri košarkarjih. Razmerja moči med dominantno-nedominantno in posteriorno-anteriorno stranjo kolenskega sklepa uporabljamo za vrednotenje ravnovesja moči. V raziskavi je prostovoljno sodelovalo 13 profesionalnih košarkarjev. Moč nog smo ocenjevali z izokinetičnim dinamometrom pri kotnih hitrostih 240-180-120-600/s. Izračunana sta bila razmerje enostranskega največjega navora za stegensko tetivo in kvadriceps (H/Q) ter razmerje prevladujoče nedominantne moči. Neodvisni t-test je bil izračunan za dvostranske in enostranske izhode moči. Med vrednostmi prevladujoče in nedominantne trdnosti pri največjem navoru, normaliziranem največjem navoru in H/Q pri vseh kotnih hitrostih nismo ugotovili statistično značilnih razlik. Rezultati te študije kažejo, da ni bilo pomembnih razlik v enostranskih in dvostranskih ocenah profesionalnih košarkarjev. Te nepomembne razlike bi lahko bile povezane s potrebo po ohranjanju podobne moči dveh nog.

Ključne besede: dvostransko vrednotenje, razmerje upogib-ekstenzija, moč kolena

Corresponding author:* Zübeyde Aslankeser,
Faculty of Sports Science, Selçuk University, Aleaddin Keykubat Campus, Konya, Turkey
E-mail: zaslankeser@gmail.com

INTRODUCTION

Basketball is a complex and multifactorial sport consisting of repetitive sprints, stops, jumps, landings, reversal of movement of sides, dribbling, and passes. Basketball, which is an extremely dynamic sport, requires specific actions such as muscle actions at different velocities during the game, sudden accelerations and decelerations, explosive speed, and jump skills related to power and strength (Gerodimos et al., 2003). In modern basketball, athletes are exposed to the high mechanic and physiological loads and thus basketball has been associated with a high incidence of injuries such as ankles, knees, and lower back. It is reported that knee injuries are the most common injury among basketball players (Jones et al., 2000; Meeuwisse et al., 2003; Hickey et al., 1997; Hootman et al., 2007; Louw et al., 2003). Knee injuries can cause considerable disability of the athletes and adversely affect athletic performance, and the recovery from the injury poses a significant economic burden (Wong et al., 2012). For these reasons, the prevention of injuries is considered a primary objective. It is reported that reduced muscle strength and strength imbalance are potential risk factors for injury (Griffin et al., 2000). While muscle weakness may cause muscle injuries, stronger muscles can supply protection from injuries (Garrett et al., 1987). In the knee joint, dominant- nondominant strength and hamstring/quadriceps ratio are used to determine muscular imbalance (Kong and Burns, 2010; Kim and Hong 2011; Croisier et al., 2002; Myer et al., 2009). Hamstring and quadriceps muscles surrounding the knee joint provide joint stability and athletic performance during running, stopping, and jumping.

The hamstring/quadriceps (H: Q) strength ratio has been used to evaluate strength imbalance, knee joint mobility, and lower extremity injury for decades. In many injury cases, in the extended knee movements, the hamstrings do not produce adequate counter torque and the hamstring strain can occur. Moreover, weak hamstring muscles can cause anterior cruciate ligament (ACL) injures during sports activities such as jumping and sudden changes in direction during sprints (Griffin et al., 2000). While the H: Q ratio is affected by contraction types (dynamic or isometric) and angular velocity of movement, the typical H: Q ratio is normally between 0.5-0.8 (Bennel et al., 1998; Wright et al., 2009; Coombs and Garbutt 2002; Tourny-Chollet et al., 2000) and when this ratio gets closer to 1, the injury risk decreases (Orchard et al., 1997).

In the assessment of the muscle strength, in addition to the H:Q ratio, the bilateral muscle strength ratio is prevalently investigated. Leg dominance, which is defined as the partial use of one leg over another has been registered as an internal risk factor for knee injuries. Due to the chronic sport-specific actions over time, the dominant side could be stronger than the non-dominant side in bilateral assessment. Besides, this side-to-side strength difference could induce the risk of injury (Croisier et al., 2008). It has been suggested that injury risk increases when a 10% or more difference between dominant and non-dominant leg strength occurs (Dvir, 2004; Dauty and Dupr, 2007; Daneshjoo et al., 2013; Fousekis et al., 2010). Thus, the assessment of unilateral and bilateral strength differences is important for evaluating injury risk and following the strength changes before and during competition season and after injuries. Isokinetic tests are used to evaluate the strength ratio of the unilateral and bilateral extremities. Isokinetic dynamometers have an advantage because of their force-velocity properties.

Chronic repetitions may lead to strength differences in the knees in basketball players. However, to the best of our knowledge, the magnitude of the strength improvements in professional basketballers has not been suggested clearly before. Therefore, the purpose of this study was to examine the isokinetic maximal voluntary contraction strength of the quadriceps and hamstring muscles and the strength ratio between these muscles and two legs at different velocities in professional male basketball players.

METHODS

Participants

Thirteen professional top-level male basketball athletes voluntarily participated in this study. All players were full-time professionals and competed at Turkish 1st Basketball League at national and international levels and they were healthy and had no injuries for 8 weeks before testing. All measurements were applied during the preparatory phase. The procedures of the study were explained to the participants in detail, and their written and informed consent were obtained. The experimental protocol was approved by the local ethic committee(E-40990478-050.99-34886) and the study was carried out in accordance with the latest version of the Declaration of Helsinki. All participants were familiarized with the strength dynamometer before the test.

Subjects arrived at the laboratory at 03:00 PM. Bodyweight and height were measured with Seca scale (Seca 711, Deutschland).

Table 1. The physical characteristics of the participants.

Variable	Mean	SD
Age(y)	27.2	±3.2
Body weight(kg)	96.1	±16.3
Body height(cm)	193.6	±10.9

Isokinetic Strength Assessments

The subjects were requested to avoid any strenuous physical activity before the test. Cybex isokinetic dynamometer (Cybex Norm, CSMI, USA) was used to assess the concentric strength of the subjects.

During the strength measurements, the subjects were seated in the dynamometer's chair and all measurements were applied according to the instructions of the Cybex manual. The rotation axis of the dynamometer was set in a way to the rotation axis of the knee. The subjects were seated and stabilized to the dynamometer's chair with the straps placed over the pelvis, chest, and the opposite leg. Moreover, they held the handles of the seat on both sides to stabilize the arms. The gravity factor was calculated by the dynamometer automatically before and during the measurements. The knee range of motion was fixed 100±10 ^{0} of flexion from active maximum extension and each movement was started in the extended position (0^0=full extension).

Before testing, a standardized warm-up was performed by cycling for 5 minutes with 100 W, 60 rpm. Following the warming up, the preliminary test including four submaximal contractions at 240^0/sec was conducted. An adequate familiarization was provided with the dynamometer by submaximal contractions.

The subjects were rested between preliminary and maximal contraction tests for one minute. Maximal concentric strength was measured from fast to slow angular velocities (240-180-120-60^0/sec). The subjects were provided with visual and verbal feedback to make the maximal effort. The test started with the dominant extremity for each athlete. Leg dominance was identified by asking the subject which leg he would use to kick a ball (Alonso et al., 2011).

Each velocity was repeated 5 times with 60 s rests between different velocities to minimize the influence of fatigue (Parcell et al., 2002). The best repetition was used for analysis. The strength values were normalized to subjects' body mass (Nm/kg). H/Q ratio was calculated by using the below equation (1) for each angular velocity (Kong and Burns 2010).

H/Q ratio= (peak hamstring torque/peak quadriceps torque) x100% (1)

Statistical analysis

Data were given as means ± SD. SPSS (16) was used for statistical analysis. Data normality was verified using the Shapiro-Wilk test and independent t-tests were used to compare the mean values of each variable. Statistical significance was set at $p < 0.05$.

RESULTS

The physical characteristics of the participants are presented in Table 1.

Absolute means and SD of peak torque of the quadriceps and hamstring muscle groups in the dominant and non-dominant leg are presented in Figure 1. The peak torque values increased with the decrease in velocity and the maximal peak torque was recorded in the lowest angular velocity.

No significant differences were found between dominant and non-dominant sides during concentric extension and flexion in 240-180-60^0/s ($p>0.05$). Torque values normalized to body weight can be found in Figure 2. Relative peak torque outputs in both legs were similar at all angular velocities ($p>0.05$).

Figure 1. Isokinetic peak extension and flexion torque of the dominant and non-dominant legs ($p>0.05$).

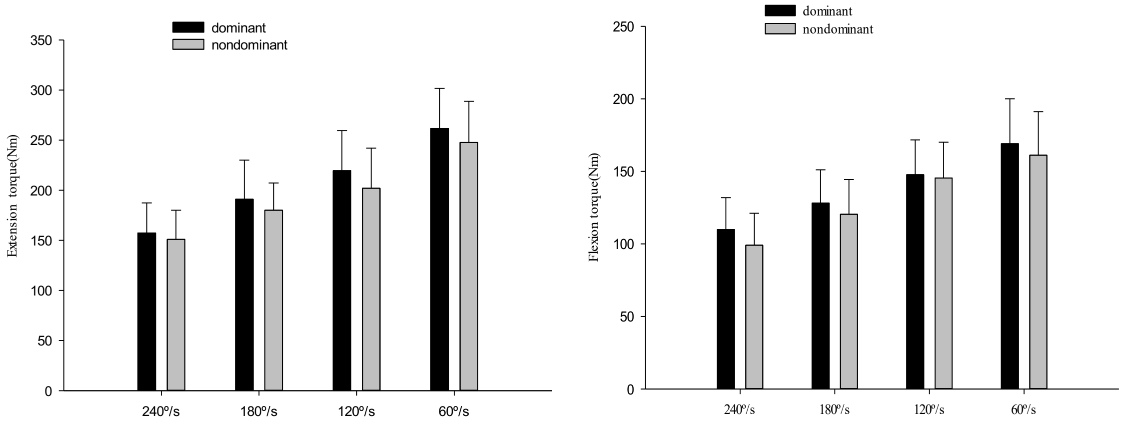
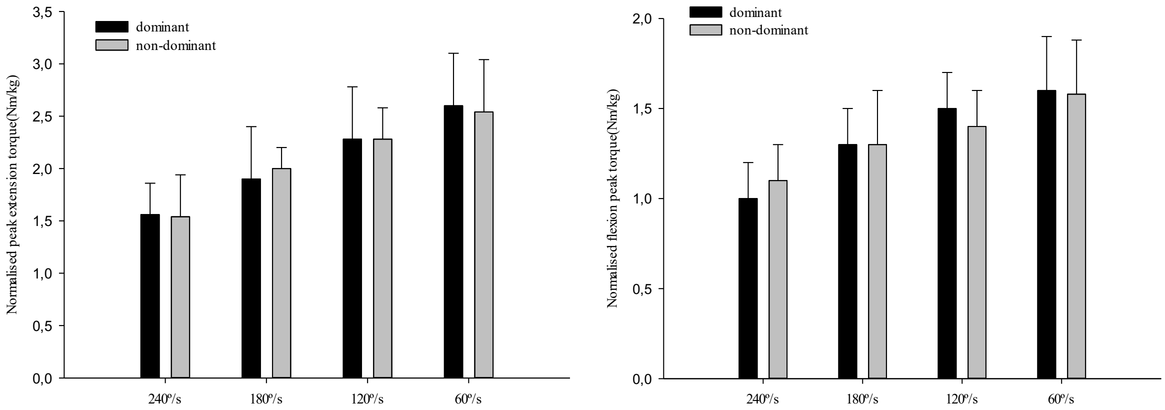


Figure 2. Isokinetic concentric normalized peak torque outputs (mean±SD) in dominant and non-dominant legs.



The profile of the Hamstring/Quadriceps strength ratios is given in Table 2. There was not any significant difference between dominant and non-dominant legs' H/Q ratio ($p>0.05$)

Table 2. H/Q ratios in dominant and non-dominant legs.

H/Q ratio	Dominant	Non-dominant	p value
240°/s	0.70 ± 0.17	0.64 ± 0.10	
180°/s	0.69 ± 0.15	0.90 ± 0.37	p>0.05
120°/s	0.71 ± 0.24	0.66 ± 0.08	
60°/s	0.65 ± 0.08	0.66 ± 0.10	

The H/Q in professional basketball players is presented in table 2. The H/Q was calculated as ≥0.60 in all velocities. Furthermore, there was no significant difference in H/Q between dominant and non-dominant legs (p>0.05).

DISCUSSION

The present study evaluated the concentric strength output and H/Q of professional male basketball athletes. The findings reported here indicated that there were not any significant differences between dominant and non-dominant legs and the H/Q ratio in professional basketball players. We conclude that the professional basketball players in this study do not have an abnormal isokinetic profile in terms of H/Q ratio evaluation. All players were competing in national and international-level professional matches, and they do not have any injury history in the lower extremities.

Previous studies have reported isokinetic strength differences (Şahin and Aslankeser, 2016; Magalhaes et al., 2004) in different sports. Muscle strength asymmetries between legs are considered an injury risk and this deficit can be rehabilitated using strength exercises. 10% or more difference between dominant and non-dominant side has been accepted as one of the potential injury risks. (Dvir, 2004; Dauty and Dupr, 2007; Fousekis et al., 2010; Brito et al., 2010). Comparative analysis in this study displayed no significant differences in muscle strength between the right and left sides and the mean bilateral ratio was found lower than 10%, accepted as the normal ratio, in extension and flexion at all velocities. Other studies also reported no significant bilateral differences in basketball players (Theoharopoulos et al., 2000; Rouis et al., 2015; Rosene et al., 2001). Similar results were presented by Theoharopoulos et al., (2000) using a similar protocol in professional basketball athletes. These results are important since the strength evaluations in elite professional basketball are very limited. These non-significant differences could be related to the necessity to maintain similar strength of two-leg. In basketball, the athletes use both legs equally during offensive and defensive techniques (Kabacinski et al., 2018).

Some studies have linked knee injuries with inter-limb asymmetries (Paterno et al., 2010; Ross and Guskiewicz 2004). In some cases, explosive unilateral jumping in basketball can lead to the development of asymmetric adaptations in lower extremities and strength differences (Hewit et al., 2012). Strength asymmetries between legs can affect the control of body movements during sports activities (Grygorowicz et al., 2010) and the asymmetries between two legs have been reported as a potential risk related to the inability of a weaker limb in basketball (Theoharopoulos et al., 2000). Delextrat and Cohen (2008) have compared elite and lower-level basketball players and they reported strength outputs are dependent on the performance level. Compared to lower-level players, elite players performed significantly higher strength outputs (Delextrat and Cohen, 2008). In our study, all players are at the professional level and the relative and absolute strength performance are higher than in previous studies. (Bamaç et al., 2008; Delextrat and Cohen, 2009).

During sports activities, the agonist's muscles contract concentrically to accelerate the limb forward while the antagonist's muscles contract eccentrically. This agonist and antagonist muscle coupling is critical for joint stability and optimal function during athletic activities.

The evaluation of quadriceps and hamstring strength and H: Q ratio was similar to some studies (Carvalho et al., 2011a; Carvalho et al., 2011b; Theoharopoulos et al., 2000). Schiltz et al. (2009) have evaluated isokinetic strength profiles in professional basketballers. In their study, relative flexion and extension torques at 60º/s and 240º/s were lower than in this study. Different results can be related to athletes' characteristics. In this study, all participants were professional level. With regard to muscular strength balance, none of the subjects had a history of lower extremity injuries. Previous injuries are reported to cause bilateral or unilateral strength imbalances due to muscular, biomechanical situations, and motivational factors (Dauty and Potiron-Josse,2004). Moreover, the intense efforts of the basketball players to gain elite basketball status can affect muscle strength. The strength output and deficit ratio change according to age, sex, sports branches, performance level, and position.

The training background of the participants was reported to influence the strength and H/Q ratio (Voutselas et al., 2007). The quadriceps muscles play an important role in many sports during running and jumping. Quadriceps and hamstring muscles, tendons, and ligaments around the knee joint stabilize and control the joint during rest and sports activities. The hamstring muscles (knee flexors) during running and sprinting are more important to control the joint integrity. The concentric H/Q ratio is dependent upon velocity, gravity correction, and participants' population. Nevertheless, there is a low consensus of normative value for the H/Q ratio. The value changes 50-70% although 60% appears to have gained general acceptance (Heiser, 1984; Coombs and Garbutt, 2002; Kannus, 1994). In this study, H: Q ratio values were found ≥0.6 and this range is accepted as the normal ratio (Kannus, 1994).

The evaluation of the isokinetic strength of the knee during the preseason is important to determine the potential risk of injury in the athletes as well as optimize the deficits. Furthermore, strength deficits can be determined and rehabilitated by using an isokinetic dynamometer (Wollin et al., 2016).

Limitations

The study had several limitations. Firstly, the participants' number was low. Secondly, all participants (except two) had right dominance. Also, all basketballers were on the same team. A wider range of participants from different performance levels can be advised to confirm study protocol.

CONCLUSION

In conclusion, the results of this study are important in regard to leg muscle strength in professional basketball athletes. These results can be used for the evaluation and rehabilitation of professional basketballers.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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