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BILATERAL STRENGTH TESTING IN DOMINANT AND NON-DOMINANT PLANT LEG IN SOCCER PLAYERS

Barbara L. Warren and Melissa Abellanida

University of Puget Sound, Tacoma, WA, USA

The purpose of this study was to examine bilateral dynamic strength differences of the knee flexors and extensors in both the dominant and non-dominant plant legs (PL) in NCAA Division III collegiate players. Sixteen male and female soccer players participated in the study. The strength of the knee flexors and extensors of both dominant and non-dominant PL was measured using a CYBEX NORM isokinetic dynamometer at 60, 120, and 180 deg/sec with a 1-minute rest between each velocity set. Dependent t-test (alpha <0.05) results suggest there was no significant strength difference between dominant and non-dominant PL. Therefore it was concluded that these Division III soccer players did not exhibit significant bilateral strength differences as was found in other studies.

KEY WORDS: isokinetic, peak torque.

INTRODUCTION: "Most soccer players have a favored foot for kicking the ball, and it is believed that this preference may lead to an asymmetry in the strength and flexibility of the lower extremities" (Rahnama, Lees, and Bambaecichi, 2005, p.1568). The discrepancy between the dominant and non-dominant leg not only leads to bilateral differences in strength and flexibility, but also leads to asymmetry biomechanically (Dorge, Andersen, Sorensen, and Simonsen, 2002). It is believed that these disparities could lead to a decline in performance and could also lead to injury (Croisier, Ganteaume, Binet, Genty, and Ferret, 2008; Dorge, et al., 2001; Lehance, Binet, Bury and Croisier, 2009; Rahnama, et al., 2005). "Although most of the literature on soccer has focused on the mechanics of the kicking leg, 99% of all ACL injuries occur to the limb that is in contact with the ground" (Fauno and Jakobsen, 2006, p.76). Because of this, it is important to understand the strength differences between the dominant and non-dominant plant leg (PL). The purpose of this study was to examine bilateral dynamic strength differences of the knee flexors and extensors in the dominant and non-dominant PL.

METHOD: Sixteen NCAA Division III male and female soccer athletes from the University of Puget Sound were recruited to participate in the study and were tested pre and post season. Prior to participation, each subject signed an informed consent that was approved by the IRB at the University of Puget Sound. The mean and standard deviations of the demographic information are as follows: height 169.2 ± 8.0 cm and weight 66.4 ± 5.8 kg. Fourteen of the subjects' dominant PL was the left leg and two of the subjects' dominant PL was the right leg. The strength of the knee flexors and extensors of both the dominant and non-dominant leg was measured using a CYBEX NORM isokinetic dynamometer (CYBEX). Before all testing sessions, subjects performed a 5-minute warm-up on a cycle ergometer at a self-selected pace, followed by ten-minutes of self-selected static stretches. Prior to experimental data collection, subjects were familiarized with the CYBEX on two separate occasions. Subjects were fitted into the CYBEX according to the manufacturer's protocols and given verbal instructions prior to beginning the test. After completing the warm up, each subject completed a sub-maximal knee flexion and extension familiarization protocol of four repetitions at velocities of 60, 120, and 180 deg/sec with a 1-minute rest between each velocity set. This was followed by a set of four maximal repetitions at velocities of 60, 120, and 180 deg/sec with a 1-minute rest between each velocity set. Subjects were given both verbal encouragement and visual feedback during the familiarization trials. During experimental testing only verbal encouragement was given. Both dominant and non-dominant legs performed sub-maximal and maximal protocols during familiarizations and experimental testing. Testing velocities were chosen according to those used by Croisier, et al. (2008) and Lehance, et al. (2009). This same protocol was used during the pre and post season testing sessions and data were not normalized. Data were analyzed using a dependent t-test to assess differences between the dominant and non-dominant legs and a 2 (pre vs post) X 3 (velocity) repeated measures ANOVA was used to assess differences in strength pretest to posttest as well as any differences in peak torque by velocity set. All tests were conducted at alpha < 0.05.

RESULTS: Tables 1 and 2 represent the means and standard deviations for right and left dominant PL subjects in preseason and postseason testing. Subjects with either right or left dominant PL had no significant difference in peak torque between dominant and non-dominant PL in either pre or post season as indicated by dependent t-tests.

Table 1
Mean peak torque of right dominant PL subjects at three isokinetic velocities (N=2)

	Preseason Peak Torque		Postseason Peak Torque	
Velocity	Mean (Nm)	SD (Nm)	Mean (Nm)	SD (Nm)
RT EXT 60	115.90	41.20	170.10	46.95
RT EXT 120	92.14	28.74	124.70	42.16
RT EXT 180	72.49	27.78	107.00	26.83
RT FLX 60	65.72	14.37	100.30	1.92
RT FLX 120	50.13	13.41	75.21	20.12
RT FLX180	38.62	6.71	56.91	19.16
LT EXT 60	111.80	22.04	166.70	38.32
LT EXT 120	87.40	31.62	128.00	18.20
LT EXT 180	68.43	27.79	101.60	38.33
LT FLX 60	60.97	15.33	86.04	14.37
LT FLX 120	52.17	22.03	76.56	23.95
LT FLX 180	45.39	16.29	60.30	18.20

RT=Right LT=Left EXT=Extension FLX=Flexion

Table 2
Mean peak torque of left dominant PL subjects at three isokinetic velocities (N=14)

	Preseason Peak Torque		Postseason Peak Torque	
Velocity	Mean (Nm)	SD (Nm)	Mean (Nm)	SD (Nm)
RT EXT 60	142.70	49.51	179.20	54.24
RT EXT 120	118.40	43.63	152.30	57.30
RT EXT 180	93.50	37.55	127.00	55.47
RT FLX 60	82.36	30.11	107.10	36.97
RT FLX 120	66.69	27.09	86.53	35.44
RT FLX180	55.85	26.33	68.52	35.80
LT EXT 60	138.40	48.22	171.70	45.54
LT EXT 120	111.90	38.91	138.90	50.95
LT EXT 180	88.95	36.44	116.20	54.05
LT FLX 60	82.66	28.58	109.20	26.50
LT FLX 120	72.20	27.80	87.30	36.68
LT FLX 180	54.78	54.78	71.72	32.49

RT=Right LT=Left EXT=Extension FLX=Flexion

Results of the two way ANOVA revealed significant strength differences between pre and post season for the entire group as follows: right leg extension $F=4.06$ (1,30); left leg extension $F= 4.334$ (1,30); and left leg flexion $F=4.29$ (1, 30). As expected there were significant differences in peak torque between each of the three velocities (60, 120, 180 deg/sec). Figures 1 and 2 illustrate the pre and postseason mean peak torques of each leg at each velocity.

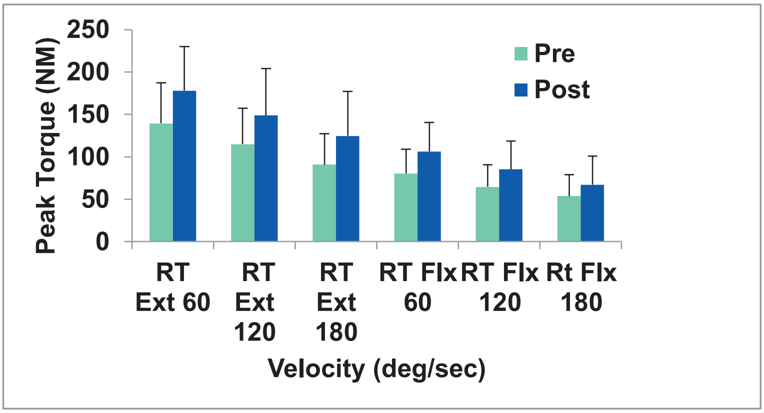

Figure 1: Pre and post season peak torques for right leg of all athletes.

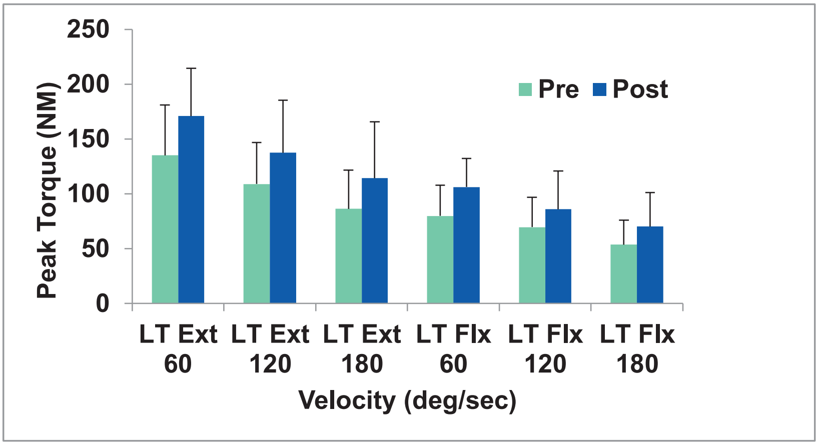

Figure 2: Pre and post season peak torques for left leg of all athletes.

DISCUSSION: The purpose of this study was to examine bilateral dynamic strength differences of the knee flexors and extensors between the dominant and non-dominant PL in NCAA Division III collegiate players. Rahnama, et al. (2005) tested the knee flexors and extensors of dominant and non-dominant kicking leg. Although they found no significant differences between knee extensors, researchers did find that the knee flexors of the preferred kicking leg were significantly weaker than the knee flexors of the non-preferred kicking leg at the velocity of 120 deg/sec. This suggested that the knee flexors of the plant leg were stronger than the knee flexors of the kicking leg. Rahnama, et al. stressed the importance of minimizing strength differences by reporting that 68% of the subjects showed significant musculoskeletal abnormalities or deficiencies, and concluded that the muscular imbalance can be regarded as an injury risk factor. In addition, Mognoni, Narici, Sirtori, and Lorenzelli (1994), were initially testing the relationship of knee extensor and hip flexor strength with ball velocity. Interestingly, their data suggested that the peak isokinetic torque of the knee extensors was higher in the non-dominant limb when compared to the dominant. Researchers imply that this could be a result of the extensor muscles of the non-dominant leg supporting the “weight of the body and the reaction of the torque developed by the opposite limb” (p. 360).

This current study did not find significant differences between the dominant and non-dominant leg in either right or left dominant subjects. The results of this study suggest that

there are no significant strength differences between the dominant PL and non-dominant PL as reported in previous research (Mognoni, et al., 1994; Rahnama, et al. 2005). Interestingly though, preseason and postseason peak torques were statistically significant when comparing right leg to right leg and left leg to left leg, except when comparing right leg flexors. In every case, the post season peak torque was greater than that of the pre-season peak torque. This may be a result in the difference in a subject's training level or an increase in more soccer specific, drills and practices in season and less fitness or weight training as experienced in the preseason.
Although the values were not calculated, it is easy to observe strength differences between the knee extensors and flexors (Figures 1-2). Several authors have concluded that there are significant strength differences between these muscle groups (Kellis, Katis, and Gissi, 2004; Zakas, 2006), and some even go as far as to attribute it to catastrophic injuries. The implications of the future research could change training protocols among soccer players and coaches. There are many factors that accompany performance differences between dominant and non-dominant plant leg. These include kinetics and kinematics of the plant leg (Orloff, et al., 2008), shear forces of the plant leg (Kellis, et al., 2004) and joint torques of the plant leg (Clagg, Warnock, and Thomas, 2009).

CONCLUSION: There were no significant strength differences between dominant and non-dominant plant leg when examining knee flexors and extensors. But the significantly different peak torques between pre and postseason may prompt coaches to add more soccer specific drills within preseason training. Future research should investigate kinetics and kinematics of the plant leg, shear forces of the plant leg, and joint torques of the plant leg, and include bilateral strength tests, to determine dominant and non-dominant asymmetries.

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