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COMPARISON BETWEEN PLYOMETRIC AND ISOKINETIC TRAINING DURING THREE WEEKS ON ISOKINETIC STRENGTH IN SPORT SCIENCES STUDENTS

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The purpose of the present study was to compare the effects of 3 weeks of isokinetic training vs plyometric training of the knee flexors and extensors on isokinetic strength. Twenty four students volunteered to participate, divided into 3 groups: one group performed the isokinetic exercises; a second group performed consecutive jumps, and a third was a control group. The knee extensor and flexor muscle peak torque, total work and average power of each leg were concentrically measured at $300º·s^{-1}$ using a Biodex System 3 isokinetic dynamometer. The results indicated that the concentric isokinetic training resulted in increase peak torque. ANOVA analysis between the three groups revealed statistical differences for peak torque ($p<0.05$) and average power ($p<0.05$) knee extension right leg and peak torque knee extension left leg ($p<0.05$).

KEY WORDS: training, isokinetic, plyometric, comparison.

INTRODUCTION: Performance in many sporting events is related to the ability to produce large amounts of force at fast angular velocities (Prevost et al, 1999). The isokinetic training studies have all demonstrated significant improvements in torque production at high and slow training velocities (Prevost et al, 1999; Evetovich et al, 2001; Ingebrigtsen et al, 2009). Isokinetic movements have widespread use in performance testing, rehabilitation, and for athletic training. isokinetic resistance training has been shown to produce many beneficial adaptations in muscle strength, power, enzyme activities, and fiber composition. The strength gain to the trained contraction velocity, has especially received considerable scientific and practical attention (Brown & Whitehurst, 2003). However, the effect of high-velocity isokinetic training versus plyometric training has not been thoroughly investigated. On the other hand, the plyometric exercise causes higher muscle tension compared to conventional resistance training (Asmussen & Bonde-Petersen, 1974; Ingebrigtsen et al, 2009). For this reason, plyometric exercises are widely recommended for power enhancement in explosive activities (e.g. jump or sprint). Relevant studies with jumping training reported that plyometric training increased vertical jumping performance both for elite athletes and physically active people (e.g. sport sciences students). The purpose of the present study was to compare the effects of 3 weeks of isokinetic training vs plyometric training of the knee flexors and extensors on isokinetic strength.

METHODS: Twenty-four male students volunteered to participate in this study and were randomly assigned to 1 of 3 groups:
Group 1: Isokinetic training (n = 7; age 20.1 ± 2.7 years old; height 174.1±4.2 cm; body mass 66.5 ± 5.5kg).
Group 2: Plyometric training (n = 9; age 18.1 ± 0.3 years old; height 170.9±7.3 cm; body mass 60.6±7.6kg;).
Group 3: Control (n = 8; age 18.7 ± 1.2 years old; height 167.7±7.9 cm; body mass 57.0±12.5kg;).
The study was approved by the University of Castilla La Mancha, the potential risks were explained, and all subjects gave written informed consent to participate in the study. All subjects were sport science and physical education students and practice different sports.
None of the subjects had previously performed specific strength training when this study started, and all of them were free of musculoskeletal disease. All subjects were instructed not to perform excessive physical activity before the testing sessions but to continue with their normal routines. The independent variable was the training performed. Both (isokinetic and plyometric were carried out during three weeks, subjects performed six sessions).

Isokinetic training: Subjects performed six sets of ten maximal concentric consecutive repetitions of extension and flexion movement of the knee at 300 º · s^{-1}, in both legs. They always started with the dominant leg. One minute of rest was allowed between sets.
Plyometric training: Subjects performed six to ten sets of ten consecutive jumps (two legged hops). Progressively we increased the height and the length of the jumps throughout the plyometric training program.
The control group was sport sciences students and none of them was actively engaged in any type of systematic physical training.
The dependent variables were the variables in isokinetic test (Peak torque (N·m), Total Work (J) and Average Power (W)) measured in dominant and non dominant leg, and in extension and flexión movement at 300 º · s^{-1}.
Subjects performed a standardised warm-up at the start of the session, consisting of 5 minutes of cycling at low intensity followed by 3 minutes of rest. The participants were instructed to “cycle at a comfortable speed” which was observed to be a consistent pace.
The knee extensor and flexor muscle peak torque, total work and average power of each leg were concentrically measured at 300º·s^{-1} (5 repetitions each) using a Biodex System 3 isokinetic dynamometer (Biodex Corporation, Shirley, NY) according to standard procedures (Zakas et al., 2005).
The subject was strapped into the chair, using the lateral femoral condyle as an anatomical reference for the axis of rotation. The length of the lever arm was individually determined, and the resistance pad was placed proximal to the medial malleolus. Gravity correction was applied after direct measurements of the mass of the lower limb lever arm system at 30º knee extension. Range of motion varied from 90º knee flexion to 0º extension (considering 0º as full extension). The values of the peak torques over 5 consecutive contractions for each muscle group tested were used for the data analysis. One minute of rest was allowed between assessments using the protocol described by Bradic et al. All subjects indicated that their right leg was dominant (the one they would use to kick a ball). Subjects were instructed to hold their arms across the chest to isolate extension movements in knee joint (Genuario & Dolgener, 1980).
The statistics program SPSS 19.0 for Windows (SPSS Inc., Chicago, IL) was used to compute means ± standard deviation (SD) and other statistical parameters. A repeated-measures analysis of variance was initially performed to identify significant group differences to compare differences in peak torque, total work and average power over time. A Bonferroni post hoc test was used to compare plyometric, isokinetics and control group. The criterion for statistical significance was set at an alpha level of 0.05 for all comparisons.

RESULTS: The results are shown in Tables 1 and 2. They illustrate that Peak torque knee flexion in both legs and total work knee extension and flexion in both legs had a decrease in postest. Besides, average power Knee extension left leg and average power knee flexion in both legs showed a decreased in postest. ANOVA analysis between the three groups revealed no statistical differences for postest or for the group, except for peak torque ($p<0.05$) and average power ($p<0.05$) knee extension right leg and peak torque knee extension left leg ($p<0.05$).

DISCUSSION: The purpose of the present study was to compare the effects of 3 weeks of isokinetic training vs plyometric training of the knee flexors and extensors on isokinetic strength. To the best of our knowledge, no other study has examined this issue. The results of the present study indicated that the concentric isokinetic training resulted in increase peak torque knee extension right and left leg in the isokinetic group but not in plyometric and control group, it could be due that neural adaptations predominate in short-term isokinetic training as shown Prevost et al, (1999). Furthermore, none of the plyometric protocols resulted in changes in isokinetic strength. This investigation relies heavily on the theory underlying specificity of training. The findings of this study highlight the importance of the principle of contraction specificity during isokinetic training (Evetovich et al, 2001; Ingebrigtsen et al. 2009) This is based on research supporting the concept that resistance

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training effects are most robust when performed at the velocity in which the actual activity occurs (Brown & Whitehurst, 2003). In addition, it can be concluded that it is not necessary to train with a plyometric exercise to improve high speed isokinetic strength. An unexpected finding of this study was that total work and average power decreased for the plyometric group but also for the isokinetic group. The lack of enhancements found in this study is in contrast to the results of Prevost et al, (1999), Evetovich et al. (2001), or Morris et al (2001). This may suggest that stronger athletes experience greater isokinetic strength, whereas the opposite occurred in the sample of sport science students. On the other hand, these results could be due to the limited number of training sessions and/or total volume of training that was performed.

Table 1
Absolute (N·m) isokinetic peak torques, total work (J) and average power (W) at 300·s^{-1} in right leg of sport sciences students.

	Isokinetic group		Plyometric group		Control group	
	Pre test	Post test	Pre test	Post test	Pre test	Post test
Peak torque Knee Extension (N·M)	117.81 ±26.90	142.67 ±18.60	105.11 ±32.90	99.20 ±27.76	100.41 ±28.57	106.50 ±16.34
Peak torque Knee Flexion (N·M)	91.97 ±17.68	87.23 ±15.73	67.82 ±19.17	58.75 ±19.49	78.30 ±17.45	73.58 ±20.74
Total Work Knee Extension (J)	471.04 ±87.59	435.77 ±69.07	429.09 ±102.73	302.81 ±111.67	444.08 ±95.62	329.26 ±64.76
Total Work Knee Flexion (J)	320.34 ±78.57	260.40 ±65.15	223.48 ±57.69	170.06 ±73.77	315.17 ±83.79	226.50 ±74.81
Average Power Knee Extension (W)	264.31 ±56.29	275.81 ±43.48	227.07 ±57.11	178.23 ±65.61	244.20 ±71.26	194.99 ±39.83
Average Power Knee Flexion (W)	159.90 ±36.37	156.84 ±36.95	110.94 ±32.10	89.84 ±38.75	158.46 ±64.21	122.57 ±44.30

Table 2
Absolute (N·m) isokinetic peak torques, total work (J) and average power (W) at 300·s^{-1} in left leg of sport sciences students.

	Isokinetic group		Plyometric group		Control group	
	Pre test	Post test	Pre test	Post test	Pre test	Post test
Peak torque Knee Extension (N·M)	118.56 ±22.65	136.53 ±15.19	98.96 ±24.55	96.46 ±24.29	103.74 ±21.29	102.95 ±15.73
Peak torque Knee Flexion (N·M)	89.79 ±20.60	80.10 ±12.61	67.90 ±13.17	58.19 ±14.68	77.00 ±23.62	65.31 ±19.58
Total Work Knee Extension (J)	464.20 ±91.69	401.71 ±48.75	435.20 ±107.56	312.52 ±83.99	438.61 ±115.15	329.60 ±58.83
Total Work Knee Flexion (J)	297.37 ±95.93	229.63 ±43.09	236.50 ±44.29	185.93 ±56.98	292.64 ±94.58	207.06 ±74.84
Average Power Knee Extension (W)	273.33 ±49.86	248.69 ±26.79	229.57 ±62.36	171.46 ±56.39	244.17 ±75.28	186.16 ±30.33
Average Power Knee Flexion (W)	150.09 ±48.07	138.01 ±29.35	113.92 ±31.76	93.80 ±33.80	147.64 ±57.59	104.60 ±34.43

CONCLUSION: Short-term isokinetic training does seem to improve the strength of knee extensor due that neural predominate in short-term isokinetic training. The ability to produce greater peak torque in the knee seems to be linked to the ability to train at the same velocity.

The lack of enhancements found in total work and average power could be due to the participant (physically active people) or the limited number of training sessions (two days per week).

REFERENCES:

Asmussen, E. & Bonde-Petersen, F.(1974) Apparent efficiency and storage of elastic energy in human muscles during exercise. *Acta Physiol. Scand.* 92:537–545.

Brown, L.E.& Whitehurst, M. (2003) The effect of short-term isokinetic training on force and rate of velocity development. *Journal of Strength and Conditioning Research* 17(1):88–94.

Evetovich, T.K., Housh, D.J. Housh, T.J., Johnson, G.O., Smith, D.B. & Ebersole K.T.(2001). The effect of concentric isokinetic strength training of the quadriceps femoris on electromyography and muscle strength in the trained and untrained limb. *Journal of Strength and Conditioning Research,* 15(4), 439–445.

Genuario, S.E., & Dolgener, F.A.(1980). The relationship of isokinetic torque at two speeds to the vertical jump. Research Quarterly of Exercise and Sport, 51, 593-598.

Ingebrigtsen, J, Holtermann, A, & Roeleveld, K (2009). Effects of load and contraction velocity during three-week biceps curls training on isometric and isokinetic performance. *Journal of Strength and Conditioning Research,* 23(6), 1670–1676.

Morriss, C.J., Tolfrey,K. & Coppack, R.J. (2001). Effects of short-term isokinetic training on standing long-jump performance in untrained men. *Journal of Strength and Conditioning Research,* 15(4),498–502.

Prevost, M.C., Nelson, A.G. & Maraj, B.K.V.(1999) The effect of two days of velocity-specific isokinetic training on torque production. *Journal of Strength and Conditioning Research,* 13(1), 35–39.

Zakas, A, Galazoulas, C, Doganis, G & Zakas, N. (2005) Bilateral Peak Torque of the Knee Extensor and Flexor Muscles in Elite and Amateur Male Soccer Players. Physical Training, (retrieved 2010/12/27) http://ejmas.com/pt/2005pt/ptart_zakas_0805.html

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