Relationship between Isokinetic Average Force, Average Torque, Peak Force, and Peak Torque of the Knee Extensor and Flexor Musculature

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Tis, L.L., & Perrin, D.H. (1994). Relationship between isokinetic average force, average torque, peak force, and peak torque of the knee extensor and flexor musculature. Isokinetics and Exercise Science, 4, 150-152.

*****Note: Figures may be missing from this format of the document**

Abstract:

The purpose of this study was to determine the relationship between average force, average torque, peak force, and peak torque produced by the knee musculature. Twenty women were assessed for isokinetic concentric and eccentric knee extensor and flexor muscular strength at a velocity of 90 deg/sec. Correlational analyses showed relationships ranging from r = 0.89 to r = 0.94 for concentric extension, r = 0.92 to r = 0.99 for eccentric extension, r = 0.81 to r = 0.95 for concentric flexion, and r 0.90 to r = 0.96 for eccentric flexion. The strong relationship between the tested variables suggests that any of these variables are appropriate when reporting isokinetic strength data. However, because average values are dependent on the preload and range of motion through which a joint is assessed, it is imperative that these variables remain consistent between and among subjects. If this is not possible, the use of peak measures is recommended.

Article:

INTRODUCTION

Hislop and Perrine[2] introduced the concept of isokinetics in 1967 and with it the ability to rapidly quantify human muscular performance of a moving limb. Traditionally, isokinetic strength has been reported as peak torque.[2,5,13] However, technological advances and new isokinetic systems have made possible the quantification of isokinetic strength as average force, average torque, peak force, or peak torque. The Kinetic Communicator (KinCom; Chattecx Corp., Chattanooga, TN) is one such device. The load cell of the KinCom is located at the distal pad attachment and thus measures force (N) from the point of application as produced by a specific muscle group. The software enables the entry of the distance of the load cell from the axis of rotation, allowing for the conversion of force to torque values (Nm). After data collection, the software has the capacity to report the data in terms of average force (N), average torque (Nm), peak force (N), and/or peak torque (Nm).

Although isokinetic strength has typically been reported as peak torque,[2,5] there are several examples where data have been reported in terms of average force[6,7,10] and average torque[9,12;] data also can be reported in terms of peak force. However, the use of these measures interchangeably has only been established for the shoulder rotator musculature.[8] Therefore, the purpose of this study was

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to determine the relationship between isokinetic average force, average torque, peak force, and peak torque of the knee extensor and flexor musculature.

METHODS

Twenty women (age 20.2 ± 1.01 years, height 169.0 6.8 cm, weight 60.8 5.5 kg) participated in the study upon giving their informed consent in accordance with institutional human investigation committee guidelines. Subjects were excluded from the study if they reported any history of injury sustained to the dominant knee.

Subjects were assessed for isokinetic concentric and eccentric average and peak force (N) and torque (Nm) of the dominant knee extensor and flexor musculature on a KinCom isokinetic dynamometer at a velocity 90 deg/ sec. Subjects were assessed through a range of motion of 5 to 90 degrees. A preload of 75 N was used, and all data were gravity corrected.

Strength of the knee extensor muscle group was assessed in an upright, seated position using the KinCom back rest attachment. The hip was positioned in approximately 80 degrees of flexion, and subjects were stabilized at the distal thigh and across the waist. The axis of the dynamometer was aligned with the axis of rotation of the knee, and the distal pad was placed slightly proximal to the malleoli.

Strength of the knee flexor muscle group was assessed in a prone position. Subjects were secured at the pelvis and distal thigh with Velcro straps. The distal pad was placed slightly proximal to the malleoli, and the axis of the dynamometer was aligned with the axis of rotation of the knee.

Before testing, subjects participated in familiarization procedures that included stretching exercises for the quadriceps and hamstring muscle groups and three to five submaximal and one maximal concentric and eccentric contractions for both the knee extensor and flexor muscle groups. After a 1-minute rest period, subjects performed several maximal concentric and eccentric contractions of the knee extensor muscle group. Three reproducible torque curves were selected using the overlay technique. After assessment of knee extensor strength, subjects were positioned for assessment of knee flexor strength. Data collection procedures were identical for the knee flexor muscle group.

Average force and torque values were obtained from the entire isokinetic strength curve. Peak force and torque values were obtained from the highest point of the strength curve. Correlational matrices were then produced to determine the relationship between average force, average torque, peak force, and peak torque.

RESULTS

The correlation coefficients for concentric and eccentric average force, average torque, peak force, and peak torque of the knee flexor and extensor musculature are presented in Tables 1-4. The relationship between the concentric knee extensor variables ranged from r = 0.82 to r = 0.94. The relationship between the eccentric knee exten-

Table 1 Correlations between concentric knee extensor average force (AF), average torque (AT), peak force (PF), and peak torque (PT).

	PF	AT	PT
AF	0.94	0.89	0.82
PF		0.88	0.91
AT			0.94

Table 2 Correlations between eccentric knee extensor average force (AF), average torque (AT), peak force (PF), and peak torque (PT).

	PF	AT	PT
AF	0.98	0.93	0.91
PF		0.93	0.94
AT			0.99

Table 3 Correlations between concentric knee flexor average force (AF), average torque (AT), peak force (PF), and peak torque (PT).

	PF	AT	PT
AF	0.91	0.81	0.72
PF		0.86	0.85
AT			0.95

Table 4 Correlations between eccentric knee flexor average force (AF), average torque (AT), peak force (PF), and peak torque (PT).

	PF	AT	PT
AF	0.95	0.91	0.86
PF		0.86	0.90
AT			0.96

sor variables ranged from r 0.91 to r = 0.99. The relationship between the concentric knee flexor variables ranged from r = 0.72 to r = 0.95. The relationship between the eccentric knee flexor variables ranged from r = 0.86 to r = 0.96.

Discussion

The results of this study indicate that a strong relationship exists between isokinetic average force, average torque, peak force, and peak torque of the knee extensor and flexor musculature. As such, these values may be used interchangeably when reporting isokinetic strength. These findings are also in agreement with the findings of Perrin *et al.*,[8] who reported similar relationships for the shoulder rotator musculature. Although these data support interchangeable use of average and peak values, it should also be noted that testing procedures for these data were consistent with regard to positioning, gravity compensation, range of motion, and preload.

Research has shown that factors such as positioning[12,13] and gravity compensation[6] will affect the isokinetic strength values obtained when assessing the knee. Therefore, consistency is necessary with regard to these factors. The interchangeable use of isokinetic average and peak values may be confounded when consistent assessment procedures are not used.

Similarly, isokinetic features such as range of motion[11] and preload[1,3,4,11] are required to obtain accurate isokinetic measures. Both range of motion and preload will affect the average values obtained

during an isokinetic test[1,3,4,11] Average values obtained through a shorter arc will tend to be greater than those obtained through a greater arc.[11] An increasing preload will also increase the average values obtained for the knee musculature.[1,3,4,11] Therefore, inconsistent use of range of motion and preload features will confound the interchangeable use of average and peak measures.

In conclusion, a strong relationship exists between average force, average torque, peak force, and peak torque. These relationships support the use of any of these variables when reporting isokinetic data. Similarly, these relationships also support the interchangeable use of these variables. However, when using peak and average measures interchangeably, consistent use of isokinetic fea tures, such as preload and range of motion, is necessary. Because of the sensitivity of average measures, the use of peak force or torque is recommended when consistency both between and among subjects is not possible.

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