Validity of Data Extraction Techniques on the Kinetic Communicator (KinCom) Isokinetic Device

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

Abstract:

The purpose of this study was to examine the validity of the average and peak torque values of the knee extensor and flexor musculature obtained through the data extraction technique. Twenty women (age = 20.2 ± 1.01 yr; height = 169.0 ± 6.8 cm; weight = 60.8 ± 5.5 kg) were assessed for isokinetic peak and average torque of the knee musculature at a velocity of 90 deg/sec. Subjects were randomly assessed through a range of motion of 5-90 deg and 25-70 deg. Peak and average torque values within a range of motion of 25-70 deg were extracted from the tested range of motion of 5-90 deg. Correlational analyses between the tested and extracted variables revealed relationships ranging from r = 0.79 to 0.95. Paired t tests found no significant differences ($p < 0.006$). These findings suggest that the data extraction techniques are valid.

Article:

INTRODUCTION

Hislop and Perrine[1] first introduced isokinetic dynamometry to the scientific community in 1967. Several mechanical properties of muscle, including torque, total work, and average power, have been used as the traditional isokinetic measurements. [4,6] Isokinetic assessment has also historically occurred through a full range of motion. However, the newer generations of isokinetic dynamometers have developed several additional evaluation options and data analysis parameters.

The KinCom software package (Chattecx Corp., Chattanooga, TN) allows the clinician to extract data from a smaller range of motion within the total tested range of motion for data analysis purposes. Data extraction can be accomplished by moving the range of motion cursors after data collection to delineate a smaller range of motion.

Two common uses of the data extraction technique have recently been illustrated in the literature. The first use was to test a healthy population through a full range of motion and extract data through a shorter range of motion to infer to an injured population. Ng and Kramer5 reported peak and average torque values of the shoulder internal and external rotator muscle groups. The researchers assessed the shoulder rotators through a range of 135 deg at a test velocity of 60 deg/sec. However, they reported torque values through a 60-deg range of motion. The stated purpose of this data extraction technique was to infer data of injured patients with restricted ranges of motion.

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The second recently observed use of the data extraction technique is to eliminate the first and last 10 deg from the tested range of motion. The stated purpose of this technique is to eliminate from analysis any torque production during acceleration to the preset velocity and to eliminate any potential impact artifact from the torque curve analysis.[2,3,5]

Although use of the data extraction technique in isokinetic research is becoming more frequent, the validity of extracted data has not been determined. Therefore, the purpose of this study was to determine the validity of the data extraction capability of the KinCom software package.

METHODS

Subjects

Twenty women (age = 20.2 ± 1.01 yr; height = 169.0 ± 6.8 cm; weight = 60.8 ± 5.5 kg) participated in the study on 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 right knee.

Test Protocol

Subjects were assessed for isokinetic concentric and eccentric average and peak torque (Nm) of the right side knee extensor and flexor musculature on a Kinetic Communicator (KinCom) isokinetic dynamometer at a velocity of 90 deg/sec. Subjects were randomly assessed through 5-90 deg ROM and 25-70 deg ROM. A preload of 75 N was used, all data were gravity corrected, and the KinCom was calibrated before each test session.

Knee Extensor Assessment

Torque/force output 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 deg of flexion. Subjects were secured with velcro straps at the distal thigh and across the waist. The distal pad was placed slightly proximal to the malleoli. The axis of the dynamometer was aligned with the axis of rotation of the knee.

Knee Flexor Assessment

Torque/force output of the knee flexor muscle groups 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.

Warm-up Procedures

All subjects participated in stretching exercises for the quadriceps and hamstring muscle groups both before and after the testing session. All subjects participated in a warm-up session before both isokinetic test sessions. The warm-up consisted of three to five submaximal and one maximal concentric and eccentric contractions for both the knee extensor and flexor muscle groups. Assessment procedures followed a 1-min rest period.

Data Collection

After a 1-min rest period, subjects performed several maximal concentric and eccentric contractions of the knee extensor muscle group. The data management capabilities of the KinCom's computer software allowed the researcher to examine the torque curves produced by each subject as the contractions were executed. Therefore, as torque curves were produced and examined, three reproducible torque curves were selected and used for subsequent data analysis. Subjects performed the number of contractions needed to obtain the three reproducible torque curves. 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.

Data Extraction

After data collection, the KinCom software package has many options for data reduction. The system will calculate gravity-corrected average and peak torque values from the gravity correction value and from the torque produced by the subjects. Average torque values are produced immediately when extracting data. By moving a cursor across the torque curve, the peak torque values were located and used for further analysis.

Similarly, the software package allows the range of motion cursors to be moved, such that a shorter range of motion may be analyzed from within a tested, larger range of motion. Using the same techniques as previously mentioned, peak and average torque values from a range of 25-70 deg range of motion were extracted from within the tested 5-90 deg range of motion, and used for subsequent data analysis.

Statistical Analysis

To determine the validity of the KinCom computer software's data extraction capability, correlational analyses (Pearson product moment correlation) were used to determine the relationship between the tested versus extracted concentric and eccentric average and peak torque values of the knee extensors and flexors. Additionally, eight paired *t* tests were computed to determine if significant differences existed between the tested and extracted average and peak torque values produced by the knee extensor and flexor muscle groups. A Bonferroni correction (0.05 / 8) was used to adjust for the possibility of an inflated alpha level. The adjusted level of significance was set at $p < 0.006$.

RESULTS

Average and peak tested and extracted torque values are presented in Table 1. Pearson correlation coeffi-

Table 1 Average and peak tested and extracted torque (Nm) values, correlation coefficients, and *t* test values.

Measure	mean ± SD	*r*	*t* test
Average torque			
Concentric extension			
Tested	79.0 ± 13.0	0.85	2.69 (p = 0.01)
Extracted	85.0 ± 20.0		
Eccentric extension			
Tested	97.7 ± 23.4	0.79	0.09 (p = 0.93)
Extracted	95.4 ± 30.5		
Concentric flexion			
Tested	44.2 ± 8.9	0.93	2.23 (p = 0.04)
Extracted	46.9 ± 9.3		
Eccentric flexion			
Tested	57.3 ± 14.0	0.95	2.24 (p = 0.04)
Extracted	60.6 ± 18.0		
Peak torque			
Concentric extension			
Tested	98.1 ± 16.7	0.81	1.92 (p = 0.07)
Extracted	105.6 ± 28.1		
Eccentric extension			
Tested	125.7 ± 34.7	0.82	1.80 (p = 0.09)
Extracted	115.9 ± 42.5		
Concentric flexion			
Tested	55.6 ± 12.0	0.88	3.03 (p = 0.007)
Extracted	51.8 ± 10.9		
Eccentric flexion			
Tested	66.9 ± 15.7	0.93	0.42 (p = 0.69)
Extracted	67.6 ± 19.0		

cients ranged from 0.79 to 0.95 between the tested and extracted variables and paired *t* tests showed no significant differences between the tested and extracted torque measures (Table 1).

DISCUSSION

The KinCom software package allows the researcher to extract data from a smaller range of motion within the total tested range of motion for the purpose of data analysis. The results of the present study indicate that this is a valid procedure. Pearson product moment correlation coefficients showed moderate to high relationships between the tested and extracted measures. In further support of the validity of the procedure, the differences between the tested and extracted values were nominal and not statistically significant, ranging from 1 to 8%.

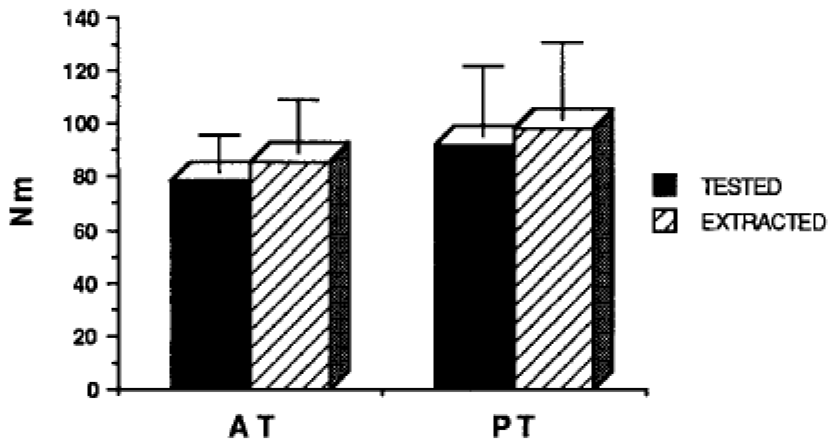

Figure 1 Concentric knee extension.

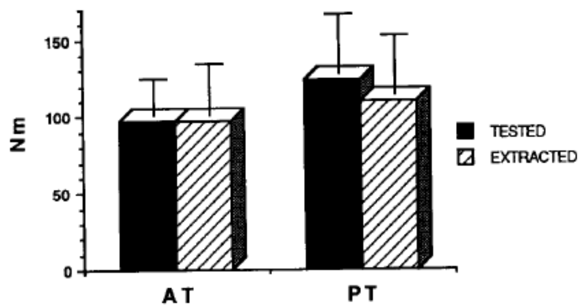

Figure 2 Eccentric knee extension.

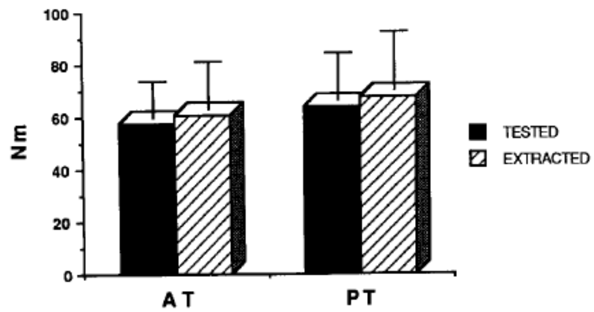

Figure 4 Eccentric knee flexion.

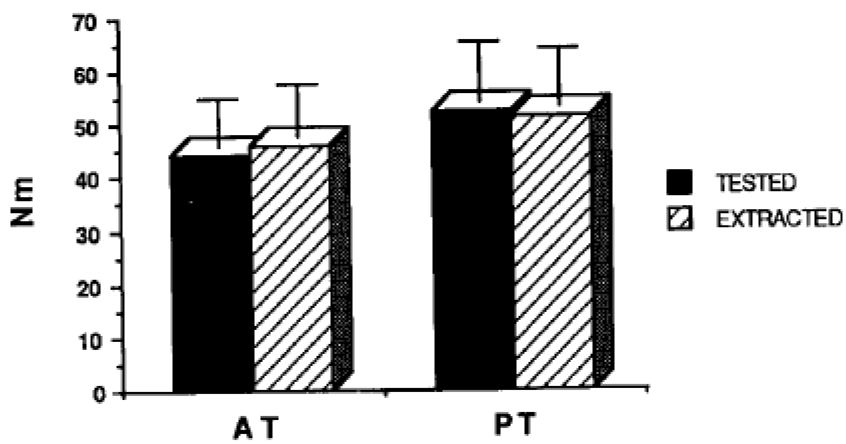

Figure 3 Concentric knee flexion.

Closer examination of the data showed some interesting patterns in the relationships between the tested and extracted torque values. Most of the comparisons demonstrate that the extracted average and peak torque values were greater than the tested values, with the exception of eccentric extension *(Figures 1-4)*. This finding may be related to the type of torque curves produced by the knee extensor and flexor musculature. The eccentric extensor torque curve was an ascending curve at 90 deg/sec and extraction removed the highest points in the curve, which lowered the average torque value. However, the other curves were either parabolic (concentric extension) or relatively flat (flexion), with the lowest points in the curve existing at the ends. As such, extraction eliminated the low points and thus increased the average torque value.

Although these differences were not significant in the present study, the findings are limited because the relationships will vary depending on the muscle group assessed, the velocity of assessment, the subject population used, and the portion of a total curve that will be extracted. For example, assessment of the knee extensor musculature at a lower velocity, or in a population of athletic males, may generate torque curves that are more parabolic in nature. Extracting from the center of the curve may hypothetically significantly increase the torque values in comparison with actual tested values.

Another interesting observation in the present study was that the extracted peak torque values were not exactly the same as the tested values, indicating that, depending on the amount of curve that is extracted, the point at which peak torque occurs may be eliminated. Again, the degree that peak torque was affected in the present study was minimal. However, this finding is specific to the muscle groups assessed, the subject population, test velocity, and the amount of curve extracted.

Although at the present time limited use of the data extraction techniques are found in the literature, the potential for further use exists. One demonstrated application is to infer data of an injured population with restricted range of motion. Ng and Kramer[5] reported peak and average torque values of the shoulder internal and external rotator muscle groups. The researchers assessed the shoulder rotators through a range of 135 deg at a test velocity of 60 deg/sec. However, they reported average and peak torque values through 60 deg range of motion. Their observation that peak torque did not occur within the extracted range of motion adds credence to the findings of the present study in that peak torques may not be exact if the point at which peak torque occurs is not included in the extracted portion of the curve.

A second recently observed use of the data extraction technique was to eliminate the first and last 10 deg from the tested range of motion. The stated purpose of this technique is to eliminate from analysis any torque production during acceleration to the preset velocity and to eliminate any potential impact artifact from the torque curve analysis.[2,3,5] With respect to the KinCom isokinetic device, this may be an unnecessary procedure because the software controls the time to accelerate to the preset velocity through what it terms acceleration turn points. Through selection of either a low, medium, or high acceleration turn point, the preset velocity is reached at varying time frames. Similarly, preload should control for impact artifact by standardizing the amount of force a subject must produce before lever arm movement can be initiated. Although this may not be a necessary use of the data extraction procedure, the torque values are valid based on the findings of this study.

In conclusion, the findings of this investigation suggest that the data extraction technique is a valid procedure. Further research is needed to examine the relationship between tested and extracted torque values for other muscle groups, additional subject populations, and additional test velocities. Additionally, further research should also examine the relationship between tested and extracted values when extracting through different portions of a torque curve as well as differing amounts of a torque curve.

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