The Reliability of Three Isokinetic Knee-extension Angle-specific Torques

By: Brent L. Arnold, MS, ATC , David H. Perrin, PhD, ATC, and Evan V. Hellwig, PhD, ATC, PT*

Arnold, B.A., Perrin, D.H., & Hellwig, E.V. (1993). The reliability of three isokinetic knee extension angle specific torques. Journal of Athletic Training, 28: 227-229.

*****Note: Figures may be missing for this format of the document**
*****Note: Footnotes and endnotes indicated with brackets**

Abstract:

To determine the reliability of concentric quadriceps muscle torque at 30°, 60 °, and 75 ° of knee extension, 25 female university students were studied. Each subject was tested on the Kin-Com isokinetic dynamometer on 2 separate days, 7 days apart. The dynamometer's speed was set at 60 7s. Intraclass correlation coefficients for 30°, 60°, and 75 ° were 0.84 ($p<.01$), 0.87 ($p<.01$), and 0.83 ($p<.01$), respectively. The standard errors of the measure were 5 .92 N·m, 7 .65 ·N·m, and 7.35 N•m, respectively. Based on the instrumentation and protocol used in this study, we believe angle-specific torques have good reliability. Because of the error size, clinicians using similar methodology to determine angle-specific torques should be cautious when comparing differences between angle- specific torques of less than 12 to 16 N·m.

Article:

Several studies have reported the reliability of the Kinetic Communicator II (Kin-Com) isokinetic dynamometer (Chattecx Corp, Hixson, Tenn). Farrell et al[3] established the mechanical reliability of the Kin-Com in both static and dynamic modes. Other studies have established the reliability of concentric and eccentric peak torque (PT) values of the quad-riceps muscle group.[6,8,9] However, the reliability of torque values at a specific point in the range of motion (angle-specific torques) has not been clearly established.

Angle-specific torques are of value to the clinician because they allow assessment of muscle function at a specific point in the range of motion. This is useful when the clinician suspects or is aware of a strength deficit at a specific point in the range of motion. Several studies have examined the issue of angle-specific torques.'" Two of these studies used the Cybex II (Lumex Inc, Ronkonkoma, NY) and used coefficients of variation to suggest that angle-specific torques are of less value than peak torques in the assessment of muscle function.[4,5] However, neither of these studies examined whether angle- specific torques had any value in

* Brent L. Arnold is a doctoral student in Sports Medicine at the Curry School of Education at the University of Virginia in Charlottesville, VA 22903
David H. Perrin is an associate professor and Director of Graduate Athletic Training Education and Research at the Curry School of Education at the University of Virginia.
Evan V. Hellwig is an assistant professor of Health and Physical Education at Cedarville College in Cedarville, Ohio

assessing muscle function at a specific point in the range of motion. Furthermore, neither study examined the test to retest reliability of angle-specific torques. Bohannon and Smith [1] also examined the reliability of angle-specific torques on the Cybex II and concluded that this isokinetic measurement was reliable; however, they used intrasession reliability, not intersession reliability. Therefore, these three studies have not established angle-specific torque inter- session reliability.

More recently, Kues et al,[6] reported that angle-specific torque intersession reliability was very high at a variety of velocities and joint angles using the Kin-Com. However, they did not use the manufacturer's recording hardware and software to establish these reliabilities. Therefore, it is unclear whether clinicians can expect reliable angle-specific torques using the Kin- Corn's standard instrumentation. This study determined concentric knee inter-session test/retest reliability at knee joint angles of 30°, 60°, and 75°, using standard Kin-Com instrumentation.

METHODOLOGY

Twenty-five healthy university graduate and undergraduate female students participated in the study (age=21.0±1.5 yr, ht=166.6±5.7 cm, wt=59.8±5.0 kg). None of the subjects had a prior history of injury to the tested knee, nor experience on the dynamometer within 6 months prior to the study. We obtained informed consent from all subjects.

The measuring instrument was the Kinetic Communicator II, with version 2.4 software. We used the manufacturer's standard lever arm and pad attachments for knee joint testing. Data were collected on the right quadriceps with subjects in the seated position on two occasions, 7 days apart. We averaged three maximal repetitions for each subject on each day. Using a goniometer, we set knee extension at 0°. This was then entered as the zero joint angle. Each repetition started at 90° of knee flexion and stopped at 0° of knee flexion. The speed of the dynamometer was set at 60°/s. The minimal force needed to initiate dynamometer motion (preload) was set at 25 N and the minimal force needed to maintain dynamometer motion was set at 20 N. Gravity correction was performed with the knee at 0° of extension.

We stabilized subjects with straps at the hip, thigh, and tibia. We aligned the dynamometer's axis of rotation with the lateral epicondyle of the femur and placed the tibial pad just above the malleolus.

Before data collection on day 1, we asked subjects to perform three sub-maximal warm-up contractions followed by one maximal warm-up contraction. During the assessment process, subjects placed their arms across their chests and were instructed to kick out with maximal effort before each repetition.

We extracted data using the average torque curve by moving the value marker to the 30°, 60°, and 75° joint angles and recording the torque values at each of these points along the torque curve (Fig 1). We analyzed the data using a one-way repeated measures analysis of variance (ANOVA) and calculated intraclass correlation coefficients (ICCs) using the Shrout and Fleiss[7] ICC formula (2,k). We calculated standard errors of the measure by multiplying the standard deviation of the angle-specific torque scores of each angle by the square root of 1-R.

Table 1.—Test/Retest Mean and Standard Error of the Mean (SE)

	Test		Retest	
Angle	**Mean**	**SE**	**Mean**	**SE**
30°	77.96	3.15	81.72	2.97
60°	125.48	4.42	128.72	4.40
75°	116.04	3.82	117.56	3.59

RESULTS

The mean scores and the standard error of the means for all three positions are presented in Table 1. The test/retest ICC for 30° was R=0.84 (p<.01). For 60° and 75°, the ICC was R=0.87 (p<.01) and R=0.83 (p<.01), respectively. The standard errors of the measure were 5.92 N•m, 7.65 N•m, and 7.35 N•m at 30°, 60°, and 75°, respectively.

DISCUSSION

The major finding of our study was that the angle-specific torques at all three joint positions had good reliability. This is supported by ICC values ranging from 0.83 to 0.87 and by relatively small standard errors of measurement. Standard errors of measurement are useful in determining whether the difference between a test and a retest is due to true change or error. For example, if an angle-specific torque at 60° on day 1 is 110 N•rn and on day 2 is 120 N•m, a clinician can be reasonably certain that the difference is due to error and not true change because the 120 N•m is not greater than two standard errors from 110 N•m, ie, 110±15.3 N•m. It has been suggested that "a relatively high ICC may not reflect an acceptable measurement if the SEM suggests that the precision of the measurement is not acceptable for the intended purpose."[2] These results differ from the conclusions of Kannus and Kaplan[4] and Kannus and Yasuda,[5] whose studies only reported coefficients of variation and not test-retest reliability. One possible explanation is that both of the above studies used single best values for angle-specific torques instead of the mean of three repetitions.

The ICC values for our study are considerably lower than those of Kues et al,[6] possibly due to differences in test protocol, data acquisition, and data analysis. The two main differences between protocol are: first, their subjects had 2 complete days of practice before beginning testing. Additionally, during each of the practice sessions, each subject performed six repetitions under eight different isokinetic conditions. This total of 96 repetitions on the dynamometer prior to testing compares to four practice repetitions in our study. Thus, their subjects had substantially more experience with the dynamometer than ours did. Second, there was a difference in the number of days between the test and retest sessions. Kues et al had a maximum of 4 days between tests, whereas we provided a minimum of 7 days between test sessions. This may have resulted in our subjects having a greater decrease in familiarity with the dynamometer on the second day than theirs did, thus producing lower correlation coefficients in our investigation.

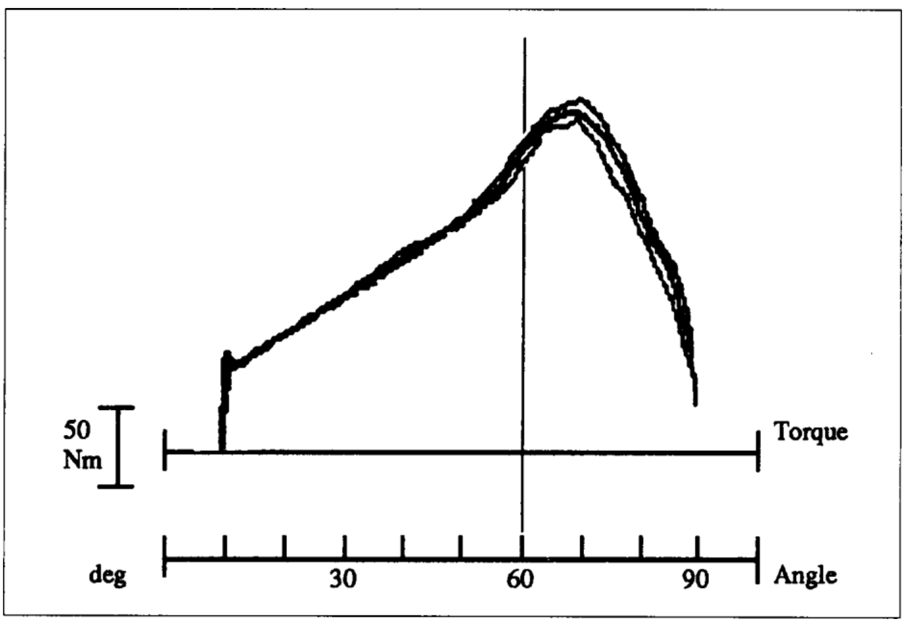

Fig 1.—Angle-specific torque derived from a knee extension torque curve at 60° of knee flexion by one of our subjects.

The high coefficients reported by Kues et al may also be related to modifications in the external equipment used for data collection. They cited a personal communication that suggested the Kin-Com's sampling rate of 100 Hz is too low and thus does not produce an accurate representation of the torque curve. To address this concern, they used external instrumentation to sample at 500 Hz. The current Kin-Com sampling rate may indeed be too low; however, this seems irrelevant since clinicians do not have the benefit of the higher sampling rate. Therefore, with respect to standard instrumentation, our study may more accurately represent the reliability of a clinician's measurements than theirs.

Another possible explanation for the lower correlations in our study was the method of deriving the angle-specifictorque values. Kues et al examined four curves from each test condition and then selected the highest angle-specific torque value of the four. We used the average value of three curves. The averaging process in our study should have stabilized the scores and thus produced a more reliable measure. It is possible that their scores were more reliable, because they more accurately represented the true scores. Addition- ally, insufficient practice in our study might have obscured the effects of averaging.

A final concern related to the protocol employed by Kues et al is the time required to test the subjects. It is likely that their protocol contributed to higher reliability of measurement. However, their protocol may not be realistic for the busy clinician involved in a variety of activities, in addition to the isokinetic assessment of any number of patients.

In summary, these results indicate that our protocol combined with the standard Kin-Com hardware and software produced angle-specific torques with good reliability and relatively small standard errors of measurement. Nevertheless, the standard errors are large enough that clinicians should be cautious in interpreting changes that are within two standard errors of the measure of each other.

REFERENCES

1. Bohannon RW, Smith MB. Intrasession reliability of angle specific knee extension torque measurements with gravity corrections. J Orthop Sports Phys Ther. 1989;11:155-157.

2. Denegar CR, Ball DW. Assessing reliability and precision of measurement: an introduction to intraclass correlation and standard error of measurement. J Sports Rehabil. 1993;2: 35-42.

3. Farrell M, Richards JG. Analysis of the reliability and validity of the kinetic communicator exercise device. Med Sci Sports Exerc. 1986;18:44-49.

4. Kannus P, Kaplan K. Angle-specific torques of thigh muscles: variability analysis in 300 healthy adults. Can .J Sport Sci. 1991;16:264-270.

5. Kannus P, Yasuda K. Value of isokinetic angle-specific torque measurements in normal and injured knees. Med Sci Sports Exerc. 1992;24:292-297.

6. Kues JM, Rothstein JM, Lamb RL. Obtaining reliable measurements of knee extensor torque produced during maximal voluntary contractions: an experimental investigation. Phys Ther. 1992;72:492-501.

7. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. Psychol Bull. 1979;86:420-428.

8. Snow CS, Blacklin K. Reliability of knee flexor peak torque measurements from a standardized test protocol on a Kin-Corn dynamometer. Arch Phys Med Rehabil. 1992;73:15-31.

9. Tredinnick TJ, Duncan PW. Reliability of measurements of concentric and eccentric loading. PhysTher. 1988;68: 656-659.