THE RELATIONSHIP BETWEEN STATIC AND DYNAMIC QUADRICEPS ANGLES

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As women have become more involved as participants in sport and recreational activities there has been an unfortunate increase in the frequency of injury to the lower extremity. Often, these injuries occur at the knee (Clarke & Buckley, 1980; Clement, Taunton, Smart & McNicol, 1982; Hunter 1984).

The most effective angle of pull for the quadriceps muscles (q-angle) is 10 degrees valgus (Pevsner, Johnson & Blazina, 1979). Women typically tend to have greater q-angles than men (Schuster, 1978). with an average for women of 17 degrees and for men of 14 degrees (Anglietti, Insall & Cerulli, 1983; Percy & Strother, 1985). Some investigators attribute these differences to the fact that women anatomically have a wider pelvis (Schuster, 1978: Hunter, 1984). Other researchers indicated that pelvic differences did not account for greater q-angles (Horton & Hall, 1989; Atwater, 1990).

Excessive q-angle is an anatomical factor that may predispose the individual to lower extremity injury (James, Bates & Ostemig, 1978; Jernick & Heifitz, 1979; Beck & Wildermuth, 1985; Brody, 1980). It is generally agreed that q-angles of 15-20 degrees are excessive (Davies & Larson, 1978; Anglietti et al., 1983). Overuse injuries related to excessive q-angle are chondromalacia of the patella and lateral subluxation of the patella (Anglietti et al., 1983: Horton & Hall, 1990). However, Fox (1975) stated that q-angle itself is not the sole cause of injury.

Q-angle is measured as the acute angle formed by a line from the anterior superior iliac spine (ASIS) of the pelvis and the center of the patella, and the line formed by the center of the patella and the tibial tubercle (Insall, Falvo & Wise, 1976). Q-angles have traditionally been measured statically. The purpose of this study was to measure q-angle both statically and dynamically during walking to determine the relationship between the static and dynamic measures.

METHODOLOGY

Ten healthy women, ages 19-35, volunteered for the study. Before participation, each subject gave consent in accordance with University policy. The mean mass for the sample was 61.45 kg (SD = 6.65). All subjects reported no previous history of lower extremity injury.

Data were collected during a single session of approximately 20 minutes. Initially, one centimeter reference markers were placed on each subject to facilitate digitizing the

video image. Markers were placed on the **ASIS,** center of the patella and **tibial** tubercle of the right leg when the each subject was standing. **These** markers were used to determine q-angles in **walking** in **the** frontal plane. **Anthropometric** data measured consisted of hip width and leg length. Hip width was measured with calipers from one **ASIS** to the other. Leg length was measured from the greater **trochanter** to the floor. Before **data** collection. each subject was familiarized with the equipment and testing environment. A **warm** up period was provided to allow the subject to get used to the walking pace. Treadmill speed was calibrated and set to a 1.5 **m/s pace** (3.35 mph). All subjects were barefoot during the testing.

One **Panasonic AG450** video camera was positioned 8 m in front of the treadmill to film each subject. The camera speed was 30 Hz with a shutter of **1/1000.** To increase image size the subject was filmed only from the waist down. Five consecutive footfalls of the right leg were filmed for each subject The treadmill was then shut off and static q-angles were filmed. Each subject was **recorded** in their chosen stance and in a calibrated stance as per Clarke, Frederick and **Hamill** (1983). The calibrated stance consisted of the heels 4 cm apart and feet abducted 7 degrees.

The X-Y coordinate points of the **ASIS,** center of the patella and tibial tubercle were digitized and angles were generated using the PEAK Performance Technology Motion Measurement System. Digitizing began 10 fields prior to foot strike and terminated 5 fields after toe off. All raw **data** points were smoothed with a digital filter at a 6 Hz cutoff. Dynamic q-angle was averaged over the 5 trials for each subject at foot strike and midstance.

RESULTS AND DISCUSSION

Table 1 presents the **sample** means. standard deviations and ranges for leg length, hip width. static q-angle wilh a chosen stance (SQ CHOSEN), static q-angle wilh a calibrated stance (SQ CAL), dynamic q-angle at foot strike (DQ FS) and dynamic q-angle at midstance (DQ MS).

Table 1: Descriptive Statistics for the Sample

	Mean	(SD)	Range
Leg length (c)	85.72	(3.51)	81.91 - 91.12
Hip width (cm)	22.86	(2.15)	22.86 - 29.85
SQ CHOSEN (degrees)	16.63	(6.07)	3.90 - 25.80
SQ CAL (degrees)	14.57	(8.06)	3.70 - 32.30
DQ FS (degrees)	13.64	(4.01)	6.46 - 19.06
DQ MS (degrees)	14.07	(3.84)	8.86 - 19.62

Pearson product moment correlations ($\mathbf{r}$) were calculated between the variables (see Table 2). A moderate relationship ($\mathbf{r} = .65$) was found between SQ CHOSEN and SQ CAL. Little relationship ($\mathbf{r} = .27$ and $\mathbf{r} = .26$) was found between both static measures (SQ CHOSEN and SQ CAL) and dynamic q-angle at foot strike (DQ FS). Little relationship ($\mathbf{r} = .42$ and $\mathbf{r} = .22$) was also found between both static q-angles (SQ CHOSEN and SQ CAL) and dynamic q-angle at midstance (DQ MS). These results indicate that there may be problems with static measurements. Static measurements showed little relationship to dynamic measurements in this study. This agrees with the Woodall and Welsh (1990) statement that q-angles vary during movement and at rest They cautioned that normal static q-angles may become pathological during movement. However, the present investigation suggests that greater q-angles were found in static and lesser in dynamic. The two dynamic q-angle measures (DQ FS and DQ MS) showed a high correlation of $\mathbf{r} = .84$. Hip width showed little relationship to all q-angle measures both static and dynamic. This agrees with the statements made by Horton and Hall (1989) and Atwater (1990) that hip width was not related to q-angle. Leg length was more highly correlated with the q-angle variables than was hip width.

Table 2: Correlation Matrix for the Sample

	Leg Length	Hip width	SQCHOSEN	SQ CAL	DQFS	DQ MS
Leg length	1.00					
Hip width	0.18	1.00				
SQ CHOSEN	0.54	0.15	1.00			
SQ CAL	0.45	-0.12	0.65	1.00		
DQ FS	0.49	0.25	0.27	0.26	1.00	
DQ MS	0.41	0.39	0.42	0.22	0.84	1.00

CONCLUSIONS

The results of this study indicate that there may be problems with static measurements. Static q-angle measurements in this study showed little relationship to dynamic q-angle measurements.

Little relationship was found between hip width and all q-angle variables. However, leg length showed a slightly better relationship to static and dynamic q-angle measurements.

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