Measurement of the Quadriceps Angle

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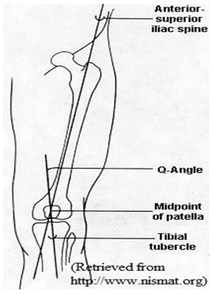
Introduction

Measurement of the patellar center (PC) is important for physical therapists as it is used in determining clinical measurements designed to screen for and predict risk of pathology at the knee, specifically Patellar Femoral Pain Syndrome (PFPS) and Anterior Cruciate Ligament (ACL) Tears (Smith, Hunt & Donnel, 2008). These clinical measurements include the Quadriceps Angle (Q-angle) which is an angle that is formed in the frontal plane by a line from the Anterior Superior Iliac Spine (ASIS) to the PC and a line from the tibial tuberosity through the PC (see figure below). Palpation by an experienced clinician is the most common method of assessing the Q-angle, and this requires determination the PC (Smith, Hunt & Donell, 2008). A systematic review of the methods used in the majority of available studies has shown low reliability in this measurement (Smith, Hunt & Donnel, 2008). Therefore, a device that could provide an accurate and reliable alternative to standard manual palpation would help to reduce some of these errors thus providing more accurate and repeatable diagnoses.

Objective

The current study was designed to evaluate the validity and reliability of finding the quadriceps angle (Q-angle) utilizing manual palpation versus a specialized tool.



Methods and Materials

- Two groups of examiners were used to measure the Q-angle on both a male and female subject.
- A standard radiograph taken of the right lower extremity of both of these measurement subjects.
- 41 volunteered to measure these subjects: 37 were physical therapy students (25 were1st year, 12 were 2nd year) and 4 were licensed physical therapists.
- The subject being measured was placed in supine position with both knees in full extension. Both hips were positioned in neutral internal/external rotation.
- Each participant measured both male and female subjects with their assigned method (device or standard palpation).
- Dry erase marker was used by participants to pinpoint the patellar center using either the device or standard method. A long arm goniometer was used to line up that axis point with the tibial tuberosity and ASIS. The average of 3 trials was recorded by the researcher.

Results

Device vs. Palpation: Male Subject

Table 3-A. Group Statistics (Male)

	Group	N	Mean	Std. Deviation	Std. Error Mean
Male	Palpation	21	14.5167	2.96039	.64601
	Device	20	14.5830	3.25010	.72675

Table 3-B. Independent Samples Test (Male)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Male	Equal variances assumed	.167	.685	-.068	39	.946	-.06633	.97010	-2.02854	1.89588

- **No statistical Difference vs. Mean (p = .94)** between measurements
- by device and palpation method for measurement scores of male subject.

Device vs. Palpation: Female Subject

Table 4-A. Group Statistics (Female)

	Group	N	Mean	Std. Deviation	Std. Error Mean
Female	Palpation	21	17.9129	3.00272	.65525
	Device	20	19.1005	3.95543	.88446

Table 4-B. Independent Samples Test (Female)

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	2.004	.165	-1.086	39	.284	-1.18764	1.09336	-3.39917	1.02388

- Mean scores higher with device. However, **no statistical Difference (p = .28).**

Measured vs. X-ray Value

- The tables below present information for the variable called "difference" that was computed by taking the difference between the measured value and the reference (X-ray) score. The data points for the male and female subjects were combined in one series. **The mean of difference values of palpation and device show that the mean for device is higher. The standard deviation and standard error mean for device method is much higher than palpation, which conveys that there is more variability in the scores obtained by device method (Table 5-A).**

Table 5-A. Overall Group Statistics

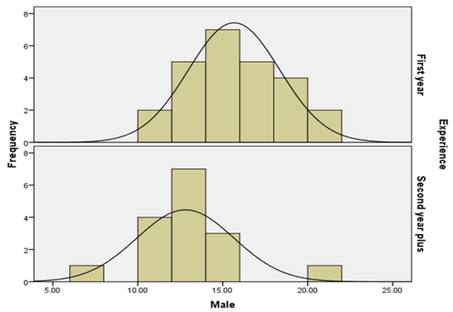
	Group	N	Mean	Std. Deviation	Std. Error Mean
Difference	Palpation	42	1.2148	2.96085	.45687
	Device	40	1.8418	3.58287	.56650

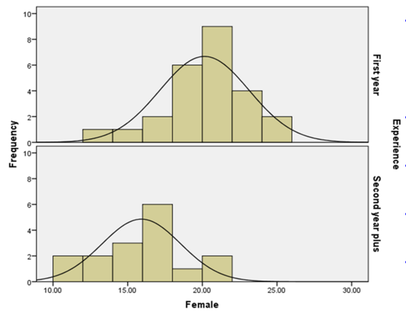
Table 5-B. Group Statistics (1=Palpation; 2=Device)

	Group	N	Mean	Std. Deviation	Std. Error Mean
Difference Female	1.00	21	.9129	3.00272	.65525
	2.00	20	2.1005	3.95543	.88446
Difference Male	1.00	21	1.5167	2.96039	.64601
	2.00	20	1.5830	3.25010	.72675

- For the female measurement (Table 5-B), the mean in difference scores (calculated by taking the difference between observed value-reference value) for the device method was higher at 2.100. This indicates that female subject when measured by device method was mostly over estimated.
- **Overall, no significant difference between method (p=.389)**

Experience Level: 1st Year Students vs. 2nd Year and above





- Due to the very small sample size of licensed PT participation and the apparent difference with experience level, a new statistic created called "2nd year plus" (PT + 2nd year) was created.
- The histogram visualizations and tables to the left show the significant difference found between these two experience levels.
- Overall the 1st year students were much less accurate regardless of the method used.
- Male Subject: T statistic is significant with a value of 3.251 and p value of 0.002.
- Female Subject: T statistic is significant with value of 4.62 at a p value of 0.00

Table 6-A. Group Statistics (Male)

	Second year plus	N	Mean	Std. Deviation	Std. Error Mean
Male	1.00	25	15.6676	2.68534	.53707
	2.00	16	12.8013	2.86127	.71532

Table 6-C. Group Statistics (Female)

	Second year plus	N	Mean	Std. Deviation	Std. Error Mean
Female	1.00	25	20.1404	2.98858	.59772
	2.00	16	15.9169	2.62868	.65717

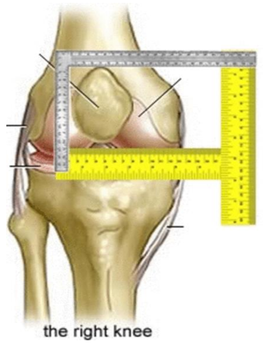
Summary of Statistical Analysis:

- Normal spread of means (device vs. Palpation)
- No statistical Difference between measurements by device and palpation method for either the male or female. Although, the female knee had greater overestimation by device.
- Although not statistically significant, the device had a greater overestimation of measurement and greater variability when compared to the X-ray measurement.
  - This was mostly due to overestimation of female knee with device.
- 1st year students were found to be significantly less accurate regardless of method and subject.

Possible Sources of Error and Future Research:

- Anatomical difference of male knee- The male subject in this study had increased tissue volume and density due to a more pronounced infrapatellar fat pad and patella alta.
- For reasons unknown, the device method overestimated the female knee. There was no apparent anatomical abnormalities present. Future research may focus on the accuracy of this device when measuring a larger sample of female subjects.
- Experience level- Both methods were affected greatly by experience level. Future studies may focus on greater licensed PT sample vs. 2nd year students and above.
- Ways to cut down on set-up time for device. The researcher observed a considerably greater amount of time needed to set-up and measure with the device.
- A longer arm goniometer may decrease the possible measurement error when lining up with the ASIS.

The Quad Rule



Current Measurement techniques: Research and Implications

- Overall, the extent to which an excessive Q-angle puts the individual at risk remains unclear. Possible reasons include:

1. Anatomical Differences can affect Q-angle measurement (Emami, et al., 2007; Powers, 2003)
   - Anteriorly tilted pelvis can result in internal rotation of the femur
   - Anteversion of the femur can cause the patella to move medially
   - Lateral rotation of the tibia can cause the patella to move laterally
2. low reliability of measurement techniques currently used in determining the Q-angle (Smith, Hunt & Donnel, 2008).

Importance of Patella Measurement:

- (Powers et al., 1999): measurement of the patellar position with palpation was greater than twice that of the MRI findings
- Due to the patella being the fulcrum for the measurement of the Q-angle it can cause large deviations in the measurement.
  - A 3mm error in finding the center of the patella could lead to an increase or decrease in the Q-angle by 3.40˚ (France & Nester, 2001).
  - If the patella is more medial or lateral, this could increase the patellofemoral pressures and cause unpredictable patterns of cartilage loading on the patellofemoral & tibiofemoral joint.

Conclusion

For an entry-level clinician with palpation experience, utilizing a measuring device to measure the Q-angle may be a viable alternative to manual palpation. However, the increased time required for measurement with the device and no significant difference noted in accuracy when compared to manual palpation, it appears to have little clinical value at this time. Future research with a larger sample is needed to determine the impact of greater experience level on the accuracy and reliability of the device. Modifications to the device could also be explored with the intention of improving its ease of use and accommodation of anatomical differences at the knee.

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