

BILATERAL COMPARISON OF KNEE EXTENSOR MECHANISM AND PATELLAR TENDON LENGTH IN YOUNG ADULTS WITH HEALTHY KNEES

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INTRODUCTION

To examine the effect of injuries and surgical interventions on knee biomechanics, the non-injured knees of the patients were commonly used as controls for comparison purposes in previous studies. For example, using radiography and MRI techniques, respectively, Breitfuss et al. (1996) and Meisterling et al. (1993) explored possible changes in patellar tendon length due to anterior cruciate ligament (ACL) reconstruction by comparing the data collected from the operated knee with the non-operated knee of the same subject. These authors assumed that there were minimum bilateral differences in knee geometry before the ACL injury. However, the validity of such an assumption has not been examined. Therefore, the purpose of this study was to investigate whether significant bilateral differences in knee extensor mechanism and patellar tendon length existed in individuals with healthy knees.

METHODS

Sagittal knee radiographs of both knees at 4 different knee flexion angles (40° to 85° at intervals of 15°) were obtained from 6 males and 6 females (age 22.4 ± 1.9 yrs, height 172 ± 10 cm, weight 782 ± 121 N) who had no history of major knee injuries or surgery. To load the knee joint, the subject sat on a stool located next to an x-ray film and performed isometric knee extensions with maximal effort when the radiographs were taken. To provide the resistance to knee

extension, a steel cable with one end connected to an ankle strap and the other end fastened to an angle iron fixed to the bottom of the stool was used (Figure 1). A metal pin with a length of 10.15 cm was placed on the anterior surface of the patella tendon for spatial reference.

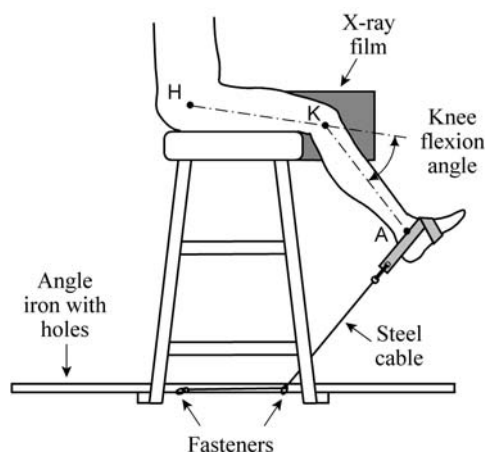


Figure 1: Schematic showing the stool used for radiographic data collection.

Each radiograph was analyzed by 3 analysts independently using the same procedures/instructions. The detail procedures and its reliability were reported in Chow et al. (2006). In essence, each analyst identified different landmarks on a radiograph for the determination of the lines of action of the patellar tendon, quadriceps tendon, and patellofemoral joint contact forces and the patellofemoral and tibiofemoral contact points. The effective moment arm of the quadriceps was computed as the product of the moment arm of the patellar tendon force about the tibiofemoral contact and the mechanical

advantage of the patellar mechanism (the ratio of the moment arms of the patellar tendon and quadriceps tendon force acting on the patellofemoral joint) (Grood et al., 1984).

The proximal attachment of the patellar tendon is the midpoint between the most inferior point of the anterior surface of the patella and the most inferior aspect of the patella. The distal attachment of the patellar tendon is the midpoint between the deepest superior tibial indentation and the farthest tibial protrusion. The patellar tendon length is the shortest distance between the proximal and distal attachments. The average values over 3 analysts were used in subsequent statistical analyses. In addition to descriptive statistics, bilateral differences were examined using t-tests with repeated measures. To adjust for multiple tests, the alpha level was set at 0.00625 (0.05/8).

RESULTS AND DISCUSSION

No significant bilateral differences were found in any of the effective moment arm and patellar tendon length measures. The relatively large SD values indicate large individual differences in knee geometry (Table 1).

The effective moment arm values are within the range of values reported in the literature (Chow et al., 1999). The results also agree with previous findings that the effective

moment arm decreases with increasing knee flexion for knee flexion angles greater than 40°.

Though not statistically significant, the average patellar tendon length of the right knee is greater than the left side in all knee flexion angles included in this study. Future studies should investigate whether such trend is just a coincidence.

SUMMARY/CONCLUSIONS

The lack of significant bilateral differences suggests that the non-operated healthy knee can serve as the control for examining the effect of injuries and surgical interventions on knee biomechanics if measures before injuries and surgeries are not available.

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Table 1: Mean (SD) effective moment arm and patellar tendon length values.

Knee flexion angle (°)	Effective moment arm (cm)			Patellar tendon length (cm)		
	Left	Right	p-value	Left	Right	p-value
40	4.38 (0.36)	4.23 (0.30)	0.113	5.32 (0.66)	5.47 (0.50)	0.229
55	3.88 (0.46)	4.01 (0.36)	0.193	5.25 (0.68)	5.46 (0.46)	0.127
70	3.24 (0.40)	3.26 (0.46)	0.784	5.28 (0.64)	5.54 (0.38)	0.051
85	2.63 (0.28)	2.69 (0.45)	0.587	5.29 (0.64)	5.43 (0.49)	0.265