The Influence of Tibial Length on Radiographic Posterior Tibial Slope Measurement: How Much Tibia Do We Need?

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INTRODUCTION:

The posterior tibial slope (PTS) is a morphological characteristic that has been identified as a biomechanical risk factor for cruciate ligament injury. Prior studies have investigated the reliability of using partial length radiographs of the tibia to determine the PTS. Given the clinical significance of PTS with respect to ligament reconstruction, it is crucial to understand how proximal tibial length may affect assessment of PTS. The purpose of this study was to determine whether significant differences exist when comparing PTS measured using increasing lengths of the tibia to determine the anatomical axis.

METHODS:

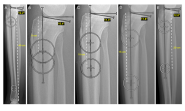
Patients with full-length weightbearing tibial radiographs were retrospectively identified from 2014 to 2022 at a single institution. Patients were excluded if there was any previous history of lower extremity fracture or osteotomy. The anatomical axis of the tibia was determined using the full length of tibial radiographs, and the “reference PTS” was measured using this axis. Using the same radiograph, the PTS was measured using four different anatomical axes at standardized tibial lengths. While the center of the proximal circle remained constant at 5-cm below the tibial plateau, the center of the distal circle was drawn at four points: a) overlapping circles; b) 10-cm distal to the tibial plateau; c) 15-cm distal to the tibial plateau; d) half the length of the tibia, measured from the tibial plateau to the tibial plafond. All measurements were performed by two readers. Interclass correlation coefficient (ICC) estimates were calculated to assess inter-rater reliability based on a single-rater, absolute agreement, two-way mixed effects model. PTS measurements performed at each axis were compared to the reference PTS using paired two-tailed t-tests. Bivariate correlation and frequency distribution analysis (measurements >2-degrees from reference PTS) were performed between the reference PTS and PTS measured at each of the four other lengths.

RESULTS:

A total of 154 patients (39.8±17.4 years old, 44.2% male) were included in the final analysis. Measurements at each of the four tibial lengths were all significantly different from the reference PTS ($p<0.001$). The correlation strength improved with increasing tibial length (overlapping: R=0.681, 10-cm: R=0.821, 15-cm: R=0.937, and half-tibia: R=0.963). The number of PTS measurements >2-degree absolute difference from the reference PTS decreased with increasing tibial length (overlapping: 40.3%, 10-cm: 24.0%, 15-cm: 26.0%, and half-tibia: 18.8%).

DISCUSSION AND CONCLUSION:

Both inter-rater reliability and correlation strength improved markedly with increasing tibial length used to determine the anatomical axis. Furthermore, the number of outlying PTS measurements (>2-degrees from the reference PTS) decreased precipitously with increasing tibial length. Accuracy and precision of PTS measurements improved with increasing length of tibia used to determine the anatomical axis. These results demonstrate that when measuring the PTS, it is important to consider the length of the tibia utilized when determining the anatomical axis, to ensure accurate comparison to reported values in the literature.



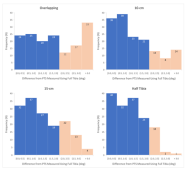


TABLE 1
Interclass Correlation Coefficient of Posterior Tibial Slope Measurements at Increasing Tibial Lengths

	ICC	95% CI	p-value
Overlapping	0.502	0.371 - 0.610	<.001
10-cm	0.710	0.622 - 0.780	<.001
15-cm	0.926	0.899 - 0.945	<.001
Half tibia	0.929	0.903 - 0.948	<.001
Full tibia	0.955	0.911 - 0.952	<.001

Abbreviations: ICC intraclass correlation coefficient, CI confidence interval.

TABLE 2
Paired Two-Sample T-Test Analysis of Posterior Tibial Slope Measurements

	Full-length	Overlapping	10-cm	15-cm
	p-values			
Overlapping	<.001			
10-cm	<.001	0.915		
15-cm	<.001	0.131	0.025	
Half tibia	<.001	0.478	0.339	<.001

TABLE 4
Pearson Correlations with Anatomical Axis Measurements

	Pearson coefficient	95% CI	Correlation Strength	p-value
Overlapping	0.681	0.586 - 0.758	Moderate	<.001
10-cm	0.821	0.762 - 0.867	Strong	<.001
15-cm	0.937	0.914 - 0.954	Very Strong	<.001
Half tibia	0.963	0.949 - 0.973	Very Strong	<.001