

Evaluating the Relationship Between Posterior Tibial Slope and Meniscal Thickness in Native Knees

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Background: Posterior tibial slope (PTS) is a critical determinant of sagittal knee biomechanics, influencing tibiofemoral kinematics and cruciate ligament forces. While PTS is traditionally measured using osseous landmarks, the functional articulating surface is shaped by cartilage and meniscal geometry. The relationship between native meniscal thickness and PTS remains poorly understood. This study evaluated the association between PTS and regional meniscal thickness in native, non-pathologic knees.

Methods: A retrospective study was performed on adult patients with MRI and corresponding lateral radiographs of native, non-pathologic knees. Medial and lateral meniscal thickness at the anterior horn, midbody, and posterior horn were measured on MRI using digital calipers. Posterior tibial slope was measured on standardized lateral radiographs. Linear regression models were used to assess the relationship between PTS and meniscal thickness across all regions. Subgroup analyses were conducted based on sex, race, body mass index (BMI), and height.

Results: A total of 108 knees met inclusion criteria. Mean PTS was $7.2^\circ \pm 1.5^\circ$, and mean meniscal thickness ranged from 4.8 to 6.6 mm across regions. No statistically significant associations were identified between PTS and meniscal thickness in any region (all $p > 0.05$), with uniformly low R^2 values indicating minimal explanatory power. Subgroup analyses revealed no significant associations by sex, race, or BMI. However, patients taller than 69 inches demonstrated a significant positive association between PTS and overall meniscal thickness ($\beta = 0.218 \text{ mm}/^\circ$, $p = 0.007$).

Conclusion: PTS does not predict regional meniscal thickness in native knees, suggesting osseous alignment and meniscal morphology function independently in knee biomechanics. Height may act as a moderating factor, indicating a potential developmental or biomechanical interaction. These findings underscore the importance of incorporating soft tissue anatomy alongside bony parameters in surgical planning for procedures such as total knee and unicompartmental arthroplasty.

Table 1: Linear and Mixed Effects Regression Results Examining the Association Between Posterior Tibial Slope and Meniscal Thickness

Summary of Statistical Results: Posterior Tibial Slope vs Meniscal Thickness			
<i>Linear and Mixed-Effects Regression Models (n = 108 knees)</i>			
Analysis	β (mm per 1° PTS)	p-value	R^2
Overall mixed model	-0.018	0.820	—
Model comparison (LRT)	—	<0.001	—
Lateral anterior horn	-0.099	0.140	0.020
Lateral midbody	-0.016	0.840	0.000
Lateral posterior horn	-0.011	0.870	0.000
Medial anterior horn	-0.027	0.680	0.002
Medial midbody	0.054	0.410	0.006
Medial posterior horn	0.028	0.690	0.002
Height ≤ 69 in	-0.011	0.680	0.233
Height > 69 in	0.218	0.007	0.263
Female	-0.048	0.152	0.233
Male	0.001	0.987	0.223
Normal BMI	0.024	0.681	0.348
Overweight BMI	-0.059	0.237	0.178
Obese BMI	0.041	0.333	0.204
White	0.015	0.715	0.195
Black / African American	-0.106	0.176	0.313
Other	-0.053	0.218	0.250

Figure 1: Scatterplots demonstrating the relationship between posterior tibial slope (PTS) and meniscal thickness across medial meniscal regions.

