Preliminary Analysis of PCL Volume Variation in ACL-injured Pediatric Knees: Insights into Maturity and Injury Implications

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Summary

This preliminary study examined the relationship between posterior cruciate ligament (PCL) volume, activity level, and skeletal and sexual maturity in adolescents. No significant effects of age, Tanner stage, or Tegner score on PCL volume were identified. High inter-individual variability may indicate that factors beyond skeletal and sexual maturity or activity level influence PCL morphology in this population.

Introduction

The PCL is critical for knee joint stability and its volumetric growth during adolescence may provide insights into maturation and injury implications [1]. While PCL volume typically increases with sexual and skeletal maturity, ACL injuries can disrupt this process, potentially altering PCL morphology [2, 3]. This study examined the relationship between the PCL volume and Tanner stage, Tegner score, and age, with the hypothesis that PCL volume increases with maturity.

Methods

MRI scans from 30 pediatric ACL-injured females (15.35 ± 1.28 yrs.; 165.3 ± 5.86 cm; 65.03 ± 10.80 kg) were segmented by a single rater. PCL volume was calculated using Elucis software (RealizeMedical, 2021), while age, Tegner score (0-9; n=30 with 18 participants scoring ≤3 and 12 scoring >3), and Tanner stage (2-5; n=30 with 1 participant in stages 1 and 2, 16 at stage 4, and 15 at stage 5) were extracted from clinical records. Pearson correlation analysis examined relationships between PCL volume, Tegner score, and age. A sample size of 65 was indicated for a two-tailed analysis ($\propto$ error probability = 0.05, power = 0.8). Independent t-test compared PCL volume between Tanner stage 4 vs. 5, with a required sample size of 64, as only 2 participants had a Tanner stage <4. G*Power (ver. 3.1.9.2, Germany) was used for all sample size calculations. The present study analyzed data from 30 participants as a preliminary investigation.

Results and Discussion

No significant correlation was found between Tegner score and PCL volume ($r = -0.17$, $p = 0.363$) or age and PCL volume ($r = -0.06$, $p = 0.748$). Independent t-test revealed no significant difference in PCL volume between Tanner stage 4 and 5 ($t = -1.17$, $p = 0.254$).

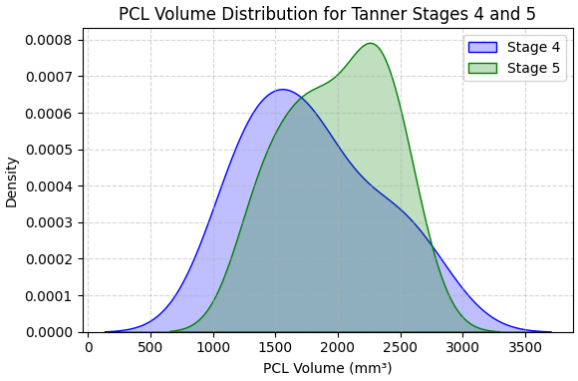

Figure 1: Distribution of PCL volume (mm^3) between Tanner stages 4 and 5 shows high inter-individual variability

While wide variability between individuals was observed, the lack of significant results suggests that age, Tanner stage, and Tegner score, may not influence the PCL volume in this cohort. High inter-individual variability may obscure any potential relationships [Figure 1]. Previous research has shown PCL structural adaptations occur post-ACL injury, with smaller PCL volumes observed in ACL-ruptured patients compared to healthy individuals [3, 4]. This injury related factor may confound the expected relationships with age, Tegner score, Tanner stage. Further investigation would need a larger sample size and a healthy cohort for comparison.

Conclusions

These findings show no significant relationships between PCL volume and Tanner stage or activity level in ACL-injured adolescent females. The high inter-individual variability suggests other factors, like injury duration or neuromuscular control changes, may more prominently influence PCL morphology.

References

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