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What Drives Chronic Posterior Cruciate Ligament Failure In Cruciate-Retaining Total Knee Arthroplasty? Insights From A Large Matched Case–Control Study

Orthopaedics / Knee & Lower Leg / Joint Replacement - Secondary

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Background
Cruciate-retaining total knee arthroplasty (CR-TKA) is one of the two predominant implant designs used worldwide. Despite its widespread use, mid- to long-term flexion instability resulting from chronic posterior cruciate ligament (PCL) rupture remains a major clinical concern. Although various biomechanical and anatomical studies have proposed potential mechanisms for PCL failure, no clinical study has yet validated these risk factors. Therefore, the aim of this study was to clinically identify the risk factors associated with chronic PCL rupture.

Objectives
To identify clinical, radiographic, and intraoperative factors associated with chronic posterior cruciate ligament (PCL) rupture in cruciate-retaining total knee arthroplasty (CR-TKA), and to determine which of these parameters independently predict late flexion instability requiring revision surgery.

Study Design & Methods
The records of 1,879 patients who underwent CR-TKA between 2010 and 2023 were reviewed. Among these, 59 (%3) CR-TKAs were revised due to instability secondary to chronic PCL rupture . Of the remaining 1,820 procedures, 1,099 CR-TKAs that had no revision history and had complete final follow-up data were identified. These cases were propensity-matched to the revision cohort at a 1:2 ratio based on age, sex, follow-up duration, preoperative range of motion, preoperative and postoperative hip-knee-ankle (HKA) angles, resulting in a control cohort of 118 CR-TKAs. The two groups were compared with respect to postoperative posterior tibial slope, fibular head–tibial component distance (FH-TC), polyethylene insert thickness, and joint line elevation.

Results
Among 177 matched patients (59 cases, 118 controls), groups were comparable in baseline demographics and alignment parameters (all $p > 0.05$). Chronic PCL rupture was associated with higher posterior tibial slope (5.25° vs. 4.57°, $p = 0.029$), shorter FH–TC distance (1.7 mm vs. 2.82 mm, $p = 0.003$), and greater insert thickness (11.5 mm vs. 10.1 mm, $p < 0.001$). Multivariate analysis confirmed PTS (OR 1.22, $p = 0.029$), FH–TC distance (OR 0.83, $p = 0.028$), and insert thickness (OR 1.67, $p < 0.001$) as independent predictors, while JLE was not significant ($p = 0.432$). Insert thickness demonstrated the highest predictive value (AUC 0.72; optimal cutoff 12 mm).

Conclusions

Increased posterior tibial slope, reduced fibular head–tibial component distance, and greater polyethylene insert thickness were identified as independent risk factors for chronic posterior cruciate ligament rupture after cruciate-retaining total knee arthroplasty.

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