

Radiographic Incidence of Post-Traumatic Osteoarthritis Following ACL Injuries: A Computer Vision Analysis of Kellgren-Lawrence Grade and Minimum Joint Space Width

Yining Lu, Linjun Yang, Michael C Dean, Cody Wyles, Aaron John Krych

INTRODUCTION: The incidence of posttraumatic osteoarthritis (PTOA) at a minimum of 90 months following anterior cruciate ligament (ACL) injury is not well-defined; furthermore, robust comparisons of the incidence between nonoperative management and reconstruction remain sparse. We hypothesized that the incidence of clinical radiographic PTOA following ACL injury will be significantly higher in patients treated nonoperatively compared to those undergoing ACLR.

METHODS: A longitudinal population-based geographic database identified patients who sustained an ACL injury between 1990 and 2016 with a minimum of 7.5 years radiographic follow-up. Patients were included if they underwent reconstruction (ACLR) or a documented sequence of nonoperative management, had no history of ipsilateral or contralateral knee surgery, and had a weight-bearing anteroposterior radiograph of the bilateral knees at final follow-up. Patients who underwent revision ACLR or concomitant ligamentous reconstruction were excluded. Two computer vision algorithms were used to evaluate the bilateral knee radiographs to (1) provide a Kellgren-Lawrence (KL) grading, (2) measure the medial and lateral minimum joint space width (mJSW), and (3) identify the presence ipsilateral/contralateral unicompartmental or total knee arthroplasty (UKA/TKA). Readings from the contralateral uninjured knee were used as an internal control to calibrate the true degree of radiographic PTOA. Two-sided nonparametric comparisons of the incidence of PTOA and mean mJSW between patients undergoing nonoperative management and ACLR were performed.

RESULTS: A total of 408 patients were included, of which 285 (69.9%) underwent ACLR (Age: 26, [IQR: 16], 44.9% Female, BMI 27.2 [IQR: 6.2]) and 123 underwent nonoperative management (Age: 39, [IQR: 11], 50.4% Female, BMI 28.6 [IQR: 6.2]). The incidence of radiographic PTOA based on mJSW (≥ 1 mm difference in mJSW between injured knee, or progression to UKA/TKA in the injured knee, compared to the contralateral uninjured knee as an internal control) was 25.3% in the ACLR cohort compared to 39.0% in the nonoperative treated cohort ($p < 0.001$); whereas the incidence based on KL grade (difference ≥ 1 compared to the contralateral uninjured knee) was 8.4% in the ACLR cohort compared to 27.6% in the nonoperative treated cohort. The mean mJSW of the injured knee was significantly greater in the ACLR cohort (6.2, IQR: 1.2) compared to the nonoperative cohort (5.5, IQR: 1.5, $p < 0.001$); additionally, the mJSW of the contralateral uninjured knee was also significantly higher in the ACLR cohort (7.1, IQR: 1.4 vs 6.3, IQR 1.3, $p < 0.001$).

DISCUSSION AND CONCLUSION: Compared to patients undergoing ACLR, patients treated nonoperatively demonstrated significantly decreased mJSW in both the injured and the uninjured contralateral knee at 7.5 years follow-up. The incidence of clinical radiographic PTOA after ACL injury based on differences of ≥ 1 mm mJSW compared to the contralateral uninjured knee was 25.3% in the ACLR cohort and 39.0% in the nonoperative cohort.

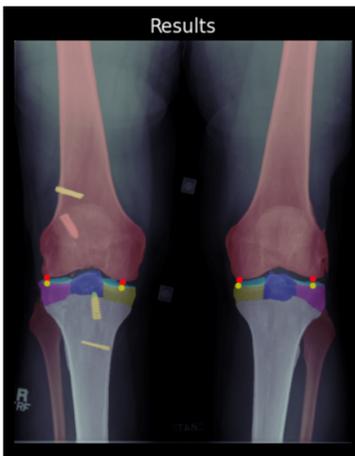


Figure 1: Segmentation map of weightbearing AP knee radiographs demonstrating the measured minimum joint space