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Brief Report

Anterior knee pain following anterior cruciate ligament reconstruction does not increase the risk of patellofemoral osteoarthritis at 15- and 20-year follow-ups

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SUMMARY

Objective: To prospectively evaluate the relationship between the presence or persistence of anterior knee pain (AKP) during the first 2-years following anterior cruciate ligament reconstruction (ACLR) and patellofemoral osteoarthritis (PFOA) at 15- and 20-years.
Design: This study was ancillary to a long-term prospective cohort study of 221 participants following bone-patellar-tendon-bone ACLR. AKP was assessed at 1- and 2-years post-ACLR using part of the Cincinnati knee score with an additional pain location question (persistence defined as presence at both follow-ups). Radiographic PFOA (definite patellofemoral osteophyte) and symptomatic PFOA (patellofemoral osteophyte, with knee pain during past 4 weeks) was assessed at 15- and 20-years follow-up. We used generalized linear models with Poisson regression to assess the relationship between AKP and PFOA.
Results: Of the 181 participants (82%) who were assessed at 15-years post-ACLR (age 39 ± 9 years; 42% female), 36 (24%) and 33 (22%) had AKP at 1- and 2-years, respectively, while 14 (8%) reported persistent AKP. Radiographic and symptomatic PFOA was observed at 15-years in 130 (72%) and 70 (39%) participants, respectively, and at 20-years in 115 (80%) and 60 (42%) participants, respectively. Neither the presence nor persistence of AKP at 1- and/or 2-years post-ACLR was associated with significantly higher risk of radiographic or symptomatic PFOA at 15- or 20-years (risk ratios <2.1).
Conclusions: Although AKP and PFOA were prevalent, AKP does not appear to be associated with long-term PFOA following ACLR.

The patellofemoral joint is increasingly recognized as a key contributor to knee osteoarthritis (OA) and is strongly associated with pain[1]. There is speculation that a history of anterior knee pain (AKP) (i.e., patellofemoral pain) may be an indicator of early patellofemoral degeneration and that such symptoms precede the development of patellofemoral OA (PFOA)[2,3]. Individuals undergoing arthroplasty for isolated PFOA were more than twice as likely to retrospectively report having had AKP during adolescence than patients undergoing arthroplasty for tibiofemoral OA (TFOA)[3]. However, no studies have prospectively evaluated individuals with AKP through to PFOA development (or non-development).

AKP and PFOA are particularly common and troublesome complications in young adults after anterior cruciate ligament reconstruction (ACLR), irrespective of graft type[4,5]. AKP occurs in 30–50%

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of patients 1–2 years following ACLR[4,6], while approximately half of all patients suffer from radiographic PFOA ≥10-years post-ACLR[5]. If AKP is prospectively found to increase the risk of longer-term PFOA, management strategies aimed to reduce the PFOA risk may be targeted at those with AKP. Therefore, the aim of the current study was to determine whether the presence or persistence of AKP at 1- and 2-years post-ACLR was associated with increased risk of radiographic and/or symptomatic PFOA at 15- or 20-years post-ACLR. Based on previous retrospective data, we hypothesized that the presence and persistence of AKP at 1- and 2-years post-ACLR would be associated with increased risk of radiographic and symptomatic PFOA at 15- and 20-years.

Methods

Participants

This study was ancillary to a prospective evaluation of knee function and OA post-ACLR in Norway. 221 subjects who underwent ACLR with a bone-patellar-tendon-bone autograft[7] were consecutively recruited between 1990 and 1997 and have been prospectively followed at 6-months, 1-year, 2-years, 15-years, and 20-years post-ACLR. Initial inclusion criteria were: aged 14–50-years at time of surgery, and no other major ligament/bone injuries in either lower-extremity in the year prior to ACLR.

Meniscal injuries requiring treatment underwent partial resection or suturing as indicated arthroscopically. Chondral lesions were shaved and loose edges removed according to surgical assessment. All participants completed similar postoperative rehabilitation, including early weight-bearing, with an emphasis on neuromuscular and strength training to re-establish knee function[7].

Two-years symptomatic and functional outcomes have been published on 155 participants[7,8], and 15- and 20-year postoperative results for knee symptoms, function and OA have recently been published on 181 and 144 participants, respectively[9,10]. The Regional Ethical Committee approved the study, and all subjects signed informed consent.

Assessment of AKP

Presence of AKP at the 1- and 2-year postoperative follow-ups was defined using the pain variable of the Cincinnati knee score (a patient-reported outcome assessing symptoms, function and sports activity) in addition to a question related to pain location. Specifically, AKP was considered present when participants responded less than the maximum pain-free score of 20-points on the pain variable of the Cincinnati score (i.e., participants reported at least intermittent pain during any activity or rest) when the pain was located in the anterior knee (i.e., patella). This definition has previously been used to report AKP prevalence 1- and 2-years post-ACLR[7].

Radiological examination

To assess patellofemoral abnormalities at 15- and 20-year follow-ups, bilateral standardized weight-bearing lateral and skyline radiographs were acquired with approximately 40° knee flexion in a specially designed frame. Radiographic PFOA was defined using the recently suggested Kellgren–Lawrence grade 2 cut-off modification (KL2/osteophyte) adapted for PFOA (i.e., definite osteophyte in patellofemoral compartment), as used in the 20-years follow-up of this cohort[10]. Radiographic assessment was performed by an experienced radiologist with established inter-rater reliability for Kellgren–Lawrence classification (κ 0.77)[9]. We also assessed symptomatic PFOA by asking the question: 'Have you had knee pain during the last 4-weeks?' Those who had both knee pain and a definite patellofemoral osteophyte in their ACLR knee were defined as having symptomatic PFOA (all other participants were defined as not having symptomatic PFOA and were included in the referent group for analyses). Radiographic and symptomatic tibiofemoral OA has also been evaluated at the 15- and 20-year follow-ups using posteroanterior radiographs and the same question regarding knee symptoms. TFOA prevalence and risk factors have been reported previously[9,10].

Other assessments

Body mass index (BMI) was calculated for all follow-ups (kg/m^2). Concomitant injuries assessed arthroscopically at the time of ACLR or sustained during the follow-up period were registered from the index surgical notes and by asking participants about additional injuries at 15- and 20-year follow-ups, respectively. Concomitant and additional injuries included meniscal/cartilage lesions, or MCL injuries (grade III). Participants were only classified as having isolated ACL injury if they had no concomitant or additional injuries for the entire follow-up period.

Statistical analysis

Descriptive statistics were used to describe frequencies of AKP and PFOA at each relevant follow-up. Generalized linear models with Poisson regression were used to assess whether the presence of AKP at 1- *or* 2-years post-ACLR, or persistence of AKP at both 1- *and* 2-years, was associated with an increased risk of radiographic and/or symptomatic PFOA at 15- or 20-years. Each analysis was adjusted for sex, age, BMI and combined vs isolated injury at 15- or 20-years follow-up, respectively. Risk ratios and 95% confidence intervals (CIs) were calculated. A risk ratio >1.0 represents greater risk of PFOA in the presence (or persistence) of AKP. Risk ratios with 95% CIs not crossing 1.0 were considered statistically significant. Statistical analyses were completed with SPSS-V.20.

Results

Of the 221 subjects who underwent ACLR with a bone-patellar-tendon-bone autograft, 181 (82%) and 142 (64%) participants were evaluated with radiographs at 15- and 20-year follow-ups, respectively (Table I). Reasons for loss to follow-up have been published previously[9,10]. AKP data was missing/incomplete at 1-

Table I
Demographic characteristics and prevalence of AKP and PFOA post-ACLR (n = 181 unless indicated otherwise)

	Number (%)
Age at surgery, years*	27 ± 8
Sex, female	76 (42)
BMI at 15-years, kg m^{-2}*	26.5 ± 3.7
Isolated anterior cruciate ligament injury at 15-years	69 (38)
AKP at 1-year†	36 (24)
AKP at 2-years‡	33 (20)
Persistent AKP from 1- to 2-years**	14 (10)
Radiographic PFOA at 15-years	130 (72)
Radiographic PFOA at 20- years††	115 (81)
Symptomatic PFOA at 15-years	70 (39)
Symptomatic PFOA at 20-years††	60 (42)

* Mean ± standard deviation.
† Twenty eight participants with missing AKP data at 1-year (i.e., total n = 153).
‡ Twenty participants with missing AKP data at 2-years (i.e., total n = 161).
** Thirty eight participants with missing AKP data at 1- or 2-years (i.e., total n = 143).
†† n = 142 at 20-year follow-up.