Journal of Science and Medicine in Sport 19 (2016) 518–523

Contents lists available at ScienceDirect

Journal of Science and Medicine in Sport

journal homepage: www.elsevier.com/locate/jsams

Original research

Predictors and effects of patellofemoral pain following hamstring-tendon ACL reconstruction

Adam G. Culvenor[a,b], Natalie J. Collins[a,c], Bill Vicenzino[a], Jill L. Cook[d], Timothy S. Whitehead[e], Hayden G. Morris[f], Kay M. Crossley[a,b,*]

[a] The University of Queensland, School of Health and Rehabilitation Sciences, Division of Physiotherapy, Australia
[b] La Trobe University, Department of Physiotherapy, School of Allied Health, College of Science, Health and Engineering, Australia
[c] The University of Melbourne, Department of Mechanical Engineering, Australia
[d] Monash University, Department of Physiotherapy, School of Primary Health Care, Australia
[e] Epworth Healthcare, Australia
[f] The University of Melbourne, Department of Physiotherapy, Melbourne School of Health Sciences, Australia

ARTICLE INFO

Article history:
Received 27 March 2015
Received in revised form 5 June 2015
Accepted 2 July 2015
Available online 10 July 2015

Keywords:
Anterior knee pain
Quality of life
Rehabilitation
Kinesiophobia
Return to sport

ABSTRACT

Objectives: Patellofemoral pain is a frequent and troublesome complication following anterior cruciate ligament reconstruction (ACLR), irrespective of graft source. Yet, little is known about the factors associated with patellofemoral pain following hamstring-tendon ACLR.
Design: Retrospective analysis of potential patellofemoral pain predictors, and cross-sectional analysis of possible patellofemoral pain consequences.
Methods: Potential predictors (pre-injury patellofemoral pain and activity level, concomitant patellofemoral cartilage damage and meniscectomy, age, sex, and surgical delay) and consequences (hopping performance, quality of life, kinesiophobia, and return to sport rates and attitudes) of patellofemoral pain 12 months following hamstring-tendon ACLR were assessed in 110 participants using univariate and multivariate analyses.
Results: Thirty-three participants (30%) had patellofemoral pain at 12 months post-ACLR. Older age at the time of ACLR was the only predictor of post-operative patellofemoral pain. Following ACLR, those with patellofemoral pain had a higher body mass index, and worse physical performance, quality of life, kinesiophobia and return to sport attitudes. Patellofemoral pain has a significant burden on individuals 12 months following hamstring-tendon ACLR.
Conclusions: Clinicians need to be cognisant of patellofemoral pain, particularly in older individuals and those with a higher body mass index. The importance of considering psychological factors that are not typically addressed during ACLR rehabilitation, such as kinesiophobia, quality of life and return to sport attitudes is emphasised.

1. Introduction

Patellofemoral pain (PFP) is a well-established complication that can compromise outcome following anterior cruciate ligament reconstruction (ACLR).[1–3] Post-operative PFP affects up to 50% of knees more than two years following a bone-patella tendon-bone (BPTB) autograft ACLR.[4] Although the commonly utilised hamstring-tendon autograft results in lower rates of PFP according to previous meta-analyses,[4,5] PFP remains problematic in up to one-third of people after hamstring-tendon harvest.[4] Indeed, some systematic reviews report no difference in PFP rates between autograft type.[6,7] Hence, factors other than donor site morbidity are likely to drive the development of PFP.

Patellofemoral pain following BPTB autograft has been associated with lack of knee extension[1] and flexion[8] range of movement (ROM), and increased joint laxity.[2] Whether these factors are related to PFP following hamstring-tendon autograft remains unknown. Only one study has investigated post-operative factors in people with PFP following hamstring-tendon harvest, finding an association with increased blood flow in the infrapatellar fat pad at six months post-ACLR.[9] Other structural features, such as concurrent patellofemoral cartilage and meniscal lesions, as well as pre-existing PFP, pre-injury activity level, older age or surgical delay may predict post-operative PFP, particularly as they are

* Corresponding author.
E-mail address: k.crossley@latrobe.edu.au (K.M. Crossley).

http://dx.doi.org/10.1016/j.jsams.2015.07.008
1440-2440/

risk factors for radiographic patellofemoral OA.[10–12] Knowledge of pre-operative risk factors could identify targets for interventions to mitigate the risk of PFP following ACLR.

Psychological factors, such as health-related quality-of-life (QoL), kinesiophobia (fear of movement) and attitudes towards sports participation, are increasingly recognised as important contributors to recovery following ACLR[13] and PFP.[14] The clinical significance of PFP following ACLR on these important patient-reported outcomes has received little research attention. Similarly, the impact of PFP on physical performance (i.e. hopping ability), which is often used to define success of ACLR, is not well known. Establishing whether those with PFP following ACLR have lower QoL, higher kinesiophobia, worse return-to-sport attitudes and rates, or lower physical performance at a time when patients are often discharged from structured rehabilitation, may reveal the need for more focussed interventions to minimise the burden of PFP.

In a cohort of individuals 12-months following a hamstring-tendon ACLR, this study aimed to: (i) evaluate if concurrent structural pathology, pre-injury PFP or activity level, or demographic characteristics were predictive of PFP; and (ii) determine if clinical impairments, physical performance and patient-reported outcomes were worse in individuals with PFP than those without.

2. Methods

Consecutive patients who were 12–15 months post-ACLR were eligible for this study if they had a primary single-bundle ACLR with a hamstring-tendon autograft (four-strand semitendinosus/gracilis with tibial interference screw fixation), and were aged 18–50 years at surgery. Exclusion criteria were: (i) inability to read/speak English; (ii) previous injury/surgery to the ACLR knee; (iii) subsequent injury or follow-up surgery to ACLR knee; (iv) ACL injury/surgery to the contralateral knee; (v) having another condition influencing daily function; and (vi) currently pregnant or breastfeeding (due to concurrent radiology study). Eligible patients were invited to participate in the clinical assessment. Ethical approval was granted by The University of Melbourne and The University of Queensland human research ethics committees, and participants provided written informed consent prior to participation.

All reconstructions were performed arthroscopically by one of two orthopaedic surgeons (HGM, TSW) in Melbourne, Australia between July 2010 and August 2011, at a mean of 14-months (median 3-months, range 1-week to 13-years) following injury. Details of the surgical procedure and indications for concomitant meniscectomy have been published.[15] After ACLR, all patients were referred to physiotherapy for early weight-bearing, ROM and neuromuscular retraining, and a graduated return-to-sport.

The primary outcome variable was PFP, assessed with the Anterior Knee Pain Scale (AKPS), also known as the Kujala scale.[16] This valid and reliable patient-reported outcome[17] is a 13-item questionnaire designed for patients with PFP, and consists of discrete categories related to symptoms and various levels of current knee function, such as weight-bearing, running and jumping. Responses are weighted and summed to provide an overall score between 0–100, where 100 represents no disability/pain.

Potential predictors of post-operative PFP assessed included concurrent patellofemoral cartilage lesions (Outerbridge arthroscopic grade $\geq$2)[15] and meniscal tears requiring meniscectomy, as determined by the surgeon during surgery. Other potential predictors included: (i) pre-injury PFP (yes/no) assessed retrospectively with the question "*Did you have pain around your kneecap prior to knee injury?*"; (ii) pre-injury activity level assessed with the Sports Activity Classification (from level I—jumping, cutting, pivoting sports such as soccer or basketball, to level IV—sedentary);[18] (iii) time from injury to ACLR; (iv) age at ACLR; and (v) sex.

Post-operative independent variables assessed included clinical measures of knee ROM and laxity, physical performance measures of hop for distance (HFD) and one-leg rise, and patient-reported outcomes of QoL, kinesiophobia and return-to-sport. Knee ROM and laxity were assessed bilaterally by one physical therapist (AGC) with established intra- and inter-rater reliability (intraclass correlation coefficient 0.82–0.98 and 0.74–0.90, respectively). Knee extension and flexion ROM were measured using a digital inclinometer and universal goniometer, respectively (Supplementary 1). Knee laxity was assessed with the KT-1000 arthrometer at 30 pounds of pressure (MEDmetric, San Diego, CA). The mean difference between ACLR and uninjured contralateral limbs from three trials was used for analyses for each clinical test. Height and weight were recorded and body mass index (BMI) calculated.

The HFD test was conducted with hands held behind the back with the left leg always tested first after two to three practice trials (Supplementary 1).[18] A limb symmetry index (LSI), reported as a percentage (ACLR knee $\div$ contralateral knee $\times$ 100), was used for statistical analyses. The one-leg rise task, a global measure of lower-limb strength and endurance, was performed from a seated position on a standardised height plinth (knee at 90° flexion). Participants were instructed to rise on one leg as many times as possible at a controlled speed (Supplementary 1).[19] Results were dichotomised ($\geq$22 or < 22 rises), as this cut-off has been found to predict incident radiographic knee OA in middle-aged people with chronic knee pain.[19]

Health-related QoL was measured with the EuroQol5 (EQ5D),[20] which comprises five domains (mobility, self-care, usual activities, pain and anxiety/depression), as well as a visual analogue scale (VAS) for overall health status from 0 (worst) to 100 (best). Responses for the five domains were combined then dichotomised (maximum score = 'no problems', <maximum score = 'problems'). Kinesiophobia was assessed with the modified Tampa Scale for Kinesiophobia (TSK-11) which has established validity, similar to the original TSK.[21] Scores range from 11 to 44, whereby a lower score corresponds to less fear of movement. The ACL-Return-to-Sport after Injury scale (ACL-RSI) includes 12 items assessing psychological responses related to returning to sport, such as confidence, emotions, and re-injury risk.[13] Each item consists of a VAS from 0 (i.e. no confidence, very fearful) to 100 (i.e. full confidence, no fear), and the mean score of all items was calculated.

Participants' return to pre-injury sport was assessed with the question "Since surgery have you returned to a level of sporting activity that is the same or higher than before your injury? If not, why?" Dichotomised responses (yes/no) were used in further analyses. Those not participating in competitive sport prior to ACL injury and those reporting no desire to return-to-sport after ACLR for reasons other than their knee (e.g. travel, work, family) were excluded from return-to-sport analysis. The Tegner Scale was used to assess current activity level.

Cluster analysis (based on the K-means algorithm) of the AKPS was performed to classify participants into two groups (PFP and no PFP). This procedure was used in previous studies of other musculoskeletal conditions,[22] to identify homogenous groups of cases based on selected characteristics. The validity of the clusters to differentiate those with and without PFP was assessed by evaluating whether the clusters were able to differentiate participants who self-reported any pain ($\geq$mild) during squatting and ascending/descending stairs on a 5-point Likert scale (0 = no pain, 4 = extreme pain) (chi-squared test). These are recognised activities that typically aggravate patellofemoral symptoms. After the formation of clusters, potential risk factors for PFP were evaluated