The Knee 23 (2016) 121–126

Contents lists available at ScienceDirect

The Knee

Factors associated with a more rapid recovery after anterior cruciate ligament reconstruction using multivariate analysis

Job E. Scherer [a,b], Maarten H. Moen [b,c,*], Adam Weir [d], Sandor L. Schmikli [e], Rob Tamminga [f], Henk van der Hoeven [b]

[a] VU University Medical Center, Department of Orthopaedic Surgery, Amsterdam, The Netherlands
[b] Bergman Clinics, Department of Orthopedic Surgery and Sports Medicine, Naarden, The Netherlands
[c] The Sportsphysician Group, St. Lucas Andreas Hospital, Amsterdam, The Netherlands
[d] Aspetar Orthopaedic and Sports Medicine Hospital, Department of Sport Medicine, Qatar
[e] University Medical Center Utrecht, Department of Public Health and Medicine, Utrecht, The Netherlands
[f] Medicort Sports and Orthopedic Care, Utrecht/Naarden, The Netherlands

ARTICLE INFO

Article history:
Received 27 December 2014
Received in revised form 21 April 2015
Accepted 22 June 2015

Keywords:
Prognostic factors
Outcome
ACL injury
ACL reconstruction

ABSTRACT

Background: In the past, several studies investigated factors that are prognostic or associated with outcome after anterior cruciate ligament (ACL) reconstruction. A recent review showed that only limited evidence is available for most studied factors, and that insufficient analysis methods were used commonly. Therefore, the aim of this study was to add more weight to the existing evidence, about factors that are associated with a more rapid outcome after ACL reconstruction. The second aim was to use multivariate analysis to study the possible factors independently.
Methods: A cohort study was conducted with a follow-up of six months. Before surgery, patient variables were scored. Surgical variables were scored during arthroscopic ACL reconstructions with a single-bundle technique and hamstring autograft. The Lysholm score and subscales of the Knee Injury Osteoarthritis Outcome Score (KOOS) were assessed six months post surgery. A multiple analysis of variance (ANOVA) model was used to identify prognostic factors for outcome.
Results: In total, 118 patients were included. Patients, aged ≤30 years, with a subjective knee score ≥ six, with normal flexion range of motion (ROM) of the knee, with flexion and extension strength deficit of ≤20%, and those with no previous knee surgery in the same knee at baseline scored significantly higher on outcome after multivariate analysis. No significant effect of surgical factors could be found.
Conclusion: Younger age, higher subjective knee score, normal knee flexion, normal knee flexion and extension strength, and no previous knee surgery in the patients' history at baseline are associated with a more rapid recovery after ACL reconstruction.
Level of evidence: Level III, prognostic study.

1. Introduction

Anterior cruciate ligament (ACL) rupture is a common knee injury, which usually results in the loss of knee stability. The injury generally involves young patients who participate in sports. To restore knee stability, surgical ACL reconstruction is commonly performed [1,2].

A systematic review on return to sports showed that 82% of the patients returned to some form of sports after ACL reconstruction. Only 63% of the operated patients returned to their pre-injury level of sports, with only 44% of the patients returning to competitive sports [3]. In clinical practice, it is hard to predict who will do well after ACL reconstruction. Recently, a systematic review on prognostic factors for outcome after single-bundle ACL reconstruction with hamstring autograft was published [4]. This review, by our group, showed that mainly limited evidence for an association between prognostic factors and outcome for ACL reconstruction was found [4]. Furthermore, it was shown that mostly only univariate analysis was used instead of multivariate analysis, to study possible prognostic parameters independently [4].

Because of the limited evidence about factors that are prognostic for the outcome after ACL reconstruction, we wanted to investigate preoperative patients and surgical factors that are associated with a more rapid recovery after ACL reconstruction with single-bundle hamstring autograft technique. This was done by investigating the recovery results six months after surgery and using multivariate analysis.

The aim of this article was to add evidence about factors that are associated or are prognostic for a more rapid recovery after ACL

* Corresponding author at: Rijksweg 69, 1013GM Naarden, The Netherlands. Tel.: +31 889000500.
E-mail address: m.moen@bergmanclinics.nl (M.H. Moen).

http://dx.doi.org/10.1016/j.knee.2015.06.009
0968-0160/

reconstruction, thereby improving the percentage of operated patients returning to their pre-injury level of sport and competitive sport. Based on the available literature, we hypothesized that gender, age, body mass index (BMI), smoking status, and time from injury until surgery would be associated with a more rapid recovery after ACL reconstruction.

2. Methods

We performed a cohort study to identify factors that are associated with a more rapid recovery after ACL reconstruction. We examined patients who underwent ACL reconstruction at our clinic between January 2010 and January 2013. Based on the available literature [4] and after a consensus meeting with the authors, preoperative and surgical variables were chosen for analysis. We investigated the recovery results six months after surgery to see if those factors are associated with a more rapid recovery after ACL reconstruction.

We chose to study the results six months after ACL reconstruction, because most athletes are allowed to return to sport around six months after injury [34]. Moreover, Valk et al. showed that only few studies examined prognostic factors in this time frame [4]. Before the start of the study, the local medical ethical commission (Verenigde Commissies Mensgebonden Onderzoek (VCMO), Nieuwegein, the Netherlands) approved the study (registration number W14.069).

2.1. Patients

2.1.1. Inclusion

Patients who rehabilitated at our adjacent clinic for physiotherapy were included in this study. In addition, patients were included if at six months after ACL reconstruction at least 95% of the preoperative variables, surgical variables, and outcome variables were available. Another inclusion criterion was that an ACL reconstruction with single-bundle technique and hamstring autograft was performed. This technique is most widely used at our clinic. Patients with associated cartilage damage and meniscal injury were also included. All procedures were performed by two experienced orthopedic surgeons (24 and 14 years of experience in ACL surgery).

2.1.2. Exclusion

Patients were excluded if they had incomplete survey data (>5% data missing), if the surgical technique used was different from the one described earlier, and if revision ACL reconstruction was performed. The ACL injury was initially confirmed by magnetic resonance imaging (MRI) or arthroscopic surgery.

2.2. Outcome variables

The outcome variables six months after ACL reconstruction were Lysholm score and the Knee Injury Osteoarthritis Outcome Score (KOOS) subscales: symptoms, sports and recreation (sport/rec), and quality of life (QOL). Physiotherapists assessed the scores during rehabilitation. The Lysholm score was scored between 0 and 100, where 0 indicates a very poor score and 100 an excellent score [5,6]. The Lysholm score was categorized as "excellent (>90)," "good (84–90)," "reasonable (65–83)," and "bad (<65)" [7]. With the help of a native speaker in English, who is a sport physician, the Lysholm score was translated into Dutch. The Dutch-validated version of KOOS was used [8–10]. A previous study showed that the questions for KOOS subscales, pain and function in daily living (ADL), can be regarded as nonrelevant and/or specific for patients with ACL injuries, because of the high percentage of maximal score at baseline [11]. Therefore, we only analyzed the results for KOOS subscales: symptoms, sport/rec, and QOL (all 0–100 scales, worst to best).

2.3. Patient variables

Demographic variables, subjective variables, and knee function variables were analyzed as possible prognostic factors, and they were obtained 4 weeks before surgery by the physiotherapist in a standardized manner. All variables were documented in our own developed system (combined quality care) for integrated care between physiotherapists and orthopedic surgeons.

2.3.1. Demographic variables

The following demographic variables were scored at baseline: gender, age, smoking status, BMI, highest level of education, time from injury until surgery in weeks, side of the injury, and knee surgery in medical history (see Table 1).

2.3.2. Subjective variables

Four questions (limitations with social activities, highest possible level of activities, pain during the past four weeks, and rated knee function on a 1 to 10 scale) from the Dutch version of the International Knee Documentation Committee Subjective Knee Form (IKDC) were chosen to assess the subjective variables [12] (see Table 1).

2.3.3. Knee function variables

The following knee function variables were assessed: passive knee ROM deficit for flexion and extension, pivot shift test, knee laxity, and knee strength. Passive ROM deficits and pivot shift test were performed and documented according to the 2000 IKDC knee examination form [13]. Preoperative knee laxity was defined as the difference in knee laxity between the injured and non-injured knee in millimeters, using the KT-2000 arthrometer (MEDmetric, San Diego, CA, USA). Preoperative muscle flexion and extension strength were measured by using Biodex System 4 Pro (Biodex Medical Systems Inc., Shirley, NY, USA). The difference between the injured and non-injured knee was defined as a percentage value, by using the formula $(1 - (\text{injured}/\text{non-injured})) \times 100$. This was measured for both flexion and extension, with five repetitive movements at 60°/sec, five repetitive movements at 120°/sec, and 20 repetitive movements at 180°/sec. Before testing, all patients were warmed up on a stationary cycle for 10 minutes (see Table 1).

2.4. Surgical variables

During arthroscopic surgery, the presence of chondral and meniscal injury was examined. If indicated, meniscus tears were treated. Afterwards, all findings were documented in the operative report. The surgical variables included for analyses as possible prognostic factor are listed in Table 1.

2.4.1. Surgical technique

Surgery was performed arthroscopically, using a nonanatomic single-bundle technique with a four-strand hamstrings graft. The tendon of the semitendinosus muscle and the gracilis muscle were harvested in a standard way with a small incision over the pes anserinus [14]. Femoral fixation took place with a transfixation technique (TransFix, Arthrex R, Naples, FL, USA); tibial fixation was performed with a 9/35-mm bioComposite interference screw.

2.4.2. Rehabilitation

Postoperatively, all patients included in this study followed the same standardized rehabilitation protocol (modification of Ref. [15]). This protocol was supervised by our physiotherapists. Rehabilitation was started within one week of surgery. The first weeks of rehabilitation focused on muscle and joint flexibility. Patients were allowed partial weight bearing with crutches during the first four weeks. After this period, muscle strength training, balance training, and coordination