Arthroscopically assisted anterior cruciate ligament reconstruction with bone-patellar tendon-bone autograft without wound drainage: short- to middle-term outcome

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Abstract

Introduction: *Several studies have suggested that anterior cruciate ligament reconstruction (ACLR) without wound drainage has no impact on long-term follow-up.*
Aim: *To investigate a prospective patient series as measured by the patient-administered disease-specific questionnaire Knee injury and Osteoarthritis Outcome Score (KOOS).*
Material and methods: *The study included 101 consecutive patients (71 men and 30 women) with a mean age of 30 years (SD 10, range: 15–62 years), who had undergone primary single incision arthroscopic bone-patellar tendon-bone autograft (BPTB) ACLR without wound drainage. All patients completed KOOS questionnaires, preoperatively and at a mean follow-up of 1.4 years (range: 0.4–3.4). Satisfactory clinical outcome (function recovery – FR) was defined as the lower threshold for the 95% CI of 18–34-year old males and corresponded to a KOOS score > 90 for Pain, 84 for Symptoms, 91 for Activities of Daily Living (ADL), 80 for Sports/Recreation, and 81 for Quality of Life (QOL). A non-satisfactory result was defined as treatment failure (TF) and corresponded to a QOL score < 44.*
Results: *All patients achieved 90° of knee flexion on the first postoperative day and full extension 2 weeks postoperatively. A full range of motion was achieved in less than 6 weeks postoperatively. No postoperative complications were reported. Score improvement at follow-up was observed in the KOOS subscales Pain, Symptoms and ADL. Criteria for FR were fulfilled by 52% of patients for Pain, 47% for Symptoms, 62% for ADL, 34% for Sports/Recreation and 15% for QOL, whereas criteria for TF were fulfilled by 29% of patients.*
Conclusions: *The study demonstrated that the primary ACLRs without wound drainage did not have any negative impact for patient-reported recovery.*

Key words: *drainage, knee, anterior cruciate ligament, Knee injury and Osteoarthritis Outcome Score, arthroscopic anterior cruciate ligament reconstruction.*

Introduction

Anterior cruciate ligament reconstruction (ACLR) is one of the most frequent orthopedic procedures. The operation was formerly done on an inpatient basis, but as medical technology progressed and surgical techniques improved, ACLRs have increasingly been performed as outpatient procedures [1, 2]. Daycare

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ACLR has been reported to be safe, effective for pain control and not related to increased incidence of complications or readmissions to hospital [2]. However, in several orthopedic departments, patients undergoing ACLR stay at hospital for at least 2–3 days, due to wound drainage [1]. Several studies have shown no apparent advantage of drain use in ACLR [3, 4]. Nevertheless, there are surgeons who advocate the use of a wound drain in order to minimize the risk of limb swelling, deep vein thrombosis, intra-articular adhesions and joint stiffness [3, 5], while others, including the authors of the present study, feel that the use of a drain might increase the risk of infection or cause damage to the ACL graft and articular surfaces of the knee joint [4]. There is, however, a paucity of studies reporting that ACLR without a drain is superior to that with wound drainage [4] and, to our knowledge, there are no studies assessing the outcome of ACLR without a drain from the patient's perspective. The development of a number of validated, reliable and responsive self-assessment scores and the patient-relevant outcomes (PROs) for knee ligament injuries made it possible to monitor the outcome of surgical intervention [6]. The largest databases in which ACLR patients report outcome scores on the functioning of their knee using the commonly used PRO Knee injury and Osteoarthritis Outcome Score (KOOS) [7–9] are the National Knee Ligament Registries in Sweden, Norway and Denmark [10] and the MOON Register in the USA [11]. The Swedish ACL register shows that the percentage of subjects who are operated on on an outpatient basis appears to be more than 85% of the total number of operations and is slowly increasing [12]. One can suppose that subjects undergoing day surgery are operated on without the use of wound drainage. However, no separate results for those operated on with and without a drain are available.

Aim

Thus, the purpose of the study was to evaluate the clinical outcome of primary single incision arthroscopic bone-patellar tendon-bone autograft ACLR in a prospective patient series as measured by the patient-administered questionnaire KOOS.

Material and methods

Study sample

All patients who had undergone ACLR between January 2007 and November 2011 were identified by searching the surgical records at our department. In that period, 325 ACLR procedures were performed. All subjects underwent primary single incision arthroscopic bone-patellar tendon-bone autograft reconstruction. Exclusion criteria were: concomitant meniscal tears requiring suturing, chondral lesion that requires extensive chondroplasty, multiple ligamentous injuries. Inclusion and exclusion criteria were used to identify 101 patients who completed self-administered questionnaires evaluating their knee-specific symptoms and function preoperatively and during follow-up.

Operative technique and rehabilitation

The procedures were performed under subarachnoid anesthesia, in a bloodless field using a pneumatic tourniquet inflated to 250–270 mm Hg. All patients received deep vein thrombosis prophylaxis with subcutaneous dalteparin (Fragmin, Pfizer Inc., Woodcliff Lake, NJ, USA) 5 000 IU/0.2 ml daily. Perioperative antibiotic prophylaxis was provided using a single dose of an antibiotic administered intravenously half an hour before the operation. The patient was placed in a supine position. The thigh was placed in a leg holder with knee unrestricted motion from full extension to 120° of flexion. The central third bone-patellar tendon-bone graft was harvest through a midline skin incision between the patella and tibial tubercle. An oscillating saw was used to create 9 or 10 mm × 20 mm bone plugs with a 9 mm to 10 mm wide tendon. The arthroscope was inserted using an antero-lateral portal. The working portal was medial to the patellar tendon. The knee was examined in a typical manner. If indicated, at that time, additional arthroscopic procedures such as meniscectomies, synovectomies, or shavings were performed. Remnants of the ruptured ACL were removed using a motorized full radius resector. Using a footprint of the native ACL, a femoral tunnel was first drilled through the antero-medial portal. Then the tibial tunnel was placed at an angle determined by the "N + 7" formula to prevent graft extrusion or excessive recession [13]. After passing the graft, the graft bone plugs were stabilized in tunnels using titanium interference screws. The patellar as well as distal bony harvest sites were filled with an absorbable hemostatic gelatin sponge (Spongostan, Ferrosan Medical Devices A/S, Søborg, Denmark). The infrapatellar fat pad, soft tissues around the tibial tunnel and the subcutaneous tissues in the region

of the skin incision were infiltrated with 20 ml of 0.25% bupivacaine/epinephrine solution (Hospira Inc., Lake Forest, IL, USA). No drainage was used. The peritendinous tissue was closed but the tendon defect was left open. The skin incision was closed in layers. The tourniquet was released after applying a sterile dressing and soft-padded bandage. Cold therapy was provided immediately after the operation. On the first day after surgery, the patients were verticalized. Active full extension and flexion of the operated knee to the angle of 90° were introduced. Patients were able to ambulate with mobility aids one day after the surgery with weight bearing of the operated limb "as tolerated". After the second week, unrestricted flexion was initiated/authorized. Crutches could be used for comfort as long as the patient desired, but most of them did not use them for more than 3 weeks. A hinged knee brace was not used. After a full range of motion was achieved/restored, strengthening exercises were added. Usually patients were allowed to return to sports activities after the sixth month, once they had regained their agility, strength and coordination.

Clinical assessment

All subjects underwent a clinical evaluation, including the range of motion in the operated knee, wound healing complications, infections, the number of aspirations for hemarthrosis and occurrence of limb swelling.

Disease-specific questionnaire

The Knee injury and Osteoarthritis Outcome Score was used. KOOS is a 42-item self-administered knee-specific questionnaire that was developed for short- and long-term follow-up studies of knee injuries and knee osteoarthritis (OA), and is commonly used to evaluate the effect of orthopedic surgery, including ACLR [7, 8, 14]. The KOOS scale contains five subscales: Pain, other Symptoms, Activities of Daily Living (ADL), Sports and Recreation and Quality of Life (QOL). A separate score ranging from 0 to 100, where 100 represents the best result, is calculated for each subscale [9]. The KOOS has already been culturally adapted in Polish and validated for ACLR patients [15].

Participants were asked to complete KOOS questionnaires twice, preoperatively and at a routine follow-up.

Outcome measures

The primary outcome was defined as a change from baseline to follow-up assessment in the average score for all KOOS subscales, covering Pain, Symptoms, ADL Function, Sports and Recreation Function, and QOL, with scores ranging from 0 to 100 (worst to best) [9]. Secondary outcomes included results on all five KOOS subscales and an analysis of functional recovery and treatment failure.

Functional recovery and treatment failure

Functional recovery (FR) level was defined as the lower threshold for the 95% CI of 18–34-year-old males from the Swedish reference population [16], which represents a KOOS score above: 90 for the subscale Pain, 84 for Symptoms, 91 for ADL Function, 80 for Sports and Recreation Function, and 81 for QOL, respectively. Treatment failure (TF) was defined as the KOOS subscale QOL score < 44 [17].

Clinically significant difference

The minimal perceptible clinical improvement (MPCI) represents the difference on the measurement scale associated with the smallest change in the health status that could be detected by the patient. A level of 10 points or more on a 0–100 scale was established as a cut-off representing a clinically significant difference [18, 19].

Ethics

The study was approved by the ethics committee (approval no. RNN/190/07/KB). Informed written consent was obtained from all subjects who participated in the study.

Statistical analysis

Continuous outcomes are given as mean [standard deviation, SD] values. We used the Wilcoxon signed ranks test for assessment of comparisons between the groups. Binary data in 2 × 2 tables were evaluated by Fisher's exact test. We calculated the standardized response mean (SRM) by dividing average score change of KOOS subscales by SD of score change and effect size (ES) by dividing score change by baseline SD. Values of $p < 0.05$ were considered significant. All analyses were performed with the SPSS for Windows 15.0 software package (SPSS Inc., Chicago, IL, USA).

Results

Study sample

The study sample consisted of one hundred and one consecutive patients (71 men and 30 women) with a mean age of 30 years (median: 27, range: 15–62 years). No significant differences between the age of men and women was observed (mean: 28 (8) vs. 32 (11) years, $p = 0.06$). The mean follow-up time was 1.4 years (range: 0.4–3.4). The patient characteristics are given in Table I.

Table I. Subject characteristics

Characteristics	
N (% women)	101 (30)
Age, mean (SD) [years]:	
ACL surgery	29.6 (9.4)
Follow-up assessment	31.0 (9.4)
Time to follow-up	1.4 (0.6)

Clinical assessment

All patients achieved 90° of knee flexion on the first postoperative day and full extension 2 weeks postoperatively. A full range of motion was achieved/restored in less than 6 weeks postoperatively. No postoperative complications were reported in the study group.

Patient-relevant outcome

Patients reported statistically significant improvements in scores from before surgery to follow-up in the KOOS subscales Pain, Symptoms and ADL Function. We did not observe any significant improvement in the KOOS subscales Sports and Recreation Function and QOL (Table II).

We found substantial changes when the individual patients' scores before surgery and at follow-up were compared. The number of those who improved following ACLR was greater than the number of those who deteriorated in every KOOS subscale. Most patients improved in the subscales Sports and Recreation and QOL. The number of those who deteriorated was largest in the subscales Symptoms and Sports and Recreation (Table III).

Functional recovery and treatment failure

Twelve (12%) patients out of 101 who had undergone ACLR fulfilled the criteria of FR in all KOOS subscales. The number of subjects who scored over

Table II. KOOS subscale scores before surgery and at follow-up

KOOS subscales	Mean KOOS score (± SD)		*P*-value	Standardized effect size	Standardized response mean
	Before surgery	At follow-up			
Pain	83.1 (14.9)	85.5 (14.5)	0.006	0.16	0.14
Symptoms	76.5 (17.4)	79.5 (16.5)	0.001	0.17	0.15
ADL	87.0 (14.3)	90.2 (13.1)	0.007	0.22	0.20
Sports/Rec	52.0 (27.9)	64.0 (27.9)	0.07	0.43	0.34
QOL	45.8 (22.1)	57.4 (23.7)	0.18	0.52	0.38

Table III. Absolute number of subjects (%) who reported KOOS score change at follow-up compared with before surgery. Cut-off for minimal clinical change was set at 10 points

KOOS subscales	Patients (*N* = 101) *n* (%)		
	Improvement	No change	Deterioration
Pain	27 (27)	56 (55)	18 (18)
Symptoms	33 (33)	42 (42)	26 (26)
ADL	23 (23)	65 (64)	13 (13)
Sports/Rec	59 (58)	15 (15)	27 (27)
QOL	53 (52)	25 (25)	23 (23)

the threshold for functional recovery in separate KOOS subscales was: 52 (52%) for Pain, 47 (47%) for Symptoms, 62 (61%) for ADL, 34 (34%) for Sports and Recreation and 15 (15%) for QOL.

We identified 29 (29%) patients who obtained a score of < 44 in the KOOS subscale QOL, thus fulfilling the criteria of TF. Out of those who had TF, four subjects improved at follow-up by ≥ 10 points, two subjects deteriorated by ≥ 10 points and 23 subjects did not change.

Discussion

The analysis of the primary outcome measure for patient follow-up in the current study demonstrates an improvement in the KOOS subscales Pain, Symptoms and ADL Function and no significant improvement in two KOOS subscales: Sports and Recreation Function and Quality of Life.

Although the follow-up outcomes are comparable to those reported by others, one would certainly anticipate a little larger and statistically more significant differences between the preoperative stage and follow-up outcome. These findings are, however, not unexpected. Our results in the subscales Sports and Recreation Function and Quality of Life were inferior to those of others [12, 20, 21], partly due to the relatively small study group and partly due to the criteria of patient selection [22]. As our qualification policy is quite liberal, we operated on even such patients who scored relatively well in the KOOS subscales before the ACLR. These patients usually did not change clinically or even deteriorated at follow-up assessment. By contrast, those subjects who improved to the greatest extent usually had the lowest scores following the preoperative rehabilitation. Thus, subjects with high preoperative scores might have made the ACLR results remarkably underestimated.

Our secondary outcome measure was to analyze the functional recovery and treatment failure. We found that about half of the patients undergoing ACLR achieved functional recovery in the KOOS subscales Pain and Symptoms. The percentage of those who recovered in the subscale ADL Function was even higher (62%). The same ADL Function subscale included the smallest number of patients who deteriorated. It has previously been shown, however, that for younger and active patients, the KOOS subscale ADL Function is less sensitive than other subscales and can be omitted [23, 24]. Thus, an assessment of the clinical outcome aside from the ADL Function score was suggested [23]. The percentage of patients who scored < 44 in the KOOS subscale of knee-related QOL and thus fulfilled the criteria for treatment failure was relatively high, but similar to that reported in other studies [12]. Since it has been reported that at 1-year follow-up the ACL is not fully functional, one can expect that the QOL score would be higher the next year and beyond.

In addition, our study revealed that ACLR can be carried out without wound drains. This finding seems to be important in view of the fact that this procedure is increasingly performed as day-case surgery [5, 12, 25].

However, Müller-Rath *et al.* evaluated the current standards of perioperative management following outpatient arthroscopic surgery of the knee in Germany and revealed that suction drainage was applied by 36% of surgeons regularly and by 45% occasionally. A drain was left for one day by 79% of surgeons, while 11% used it only for several hours [26].

We found no tendency to any local complications such as perioperative bleeding, hematoma needing a puncture and aspiration, limb ischemia requiring special treatment or abnormal wound healing. El Khalifa *et al.* in a prospective randomized control trial (RCT) of ACLR with four-strand hamstring autograft showed that patients with a drain suffered less pain and hemarthrosis than those without a drain. The range of movements in the first week following the operation was better in the drain group than in subjects without a drain. The drain was removed on the first postoperative day [27]. In another RCT, Dhawan *et al.* found that the use of a drain after ACLR with a BPTB autograft provided no benefit in terms of the range of motion, effusion, or pain in the early postoperative period [28]. No functional differences in subjects undergoing ACLR with BPTB autograft at 6-month follow-up were reported by Straw *et al.* [5].

To our knowledge, the present study describes the largest series of patients to date who underwent ACLR without wound drainage. The study is also the first attempt to assess the clinical outcome of these patients with PROs. The strengths of our study also include prospective evaluation as well as standardization of hospitalization procedures with the participation of the same operating team and the use of an identical rehabilitation regimen, objective evaluation by an indirect method assessing the range

of motion in the operated joint and a subjective assessment using the KOOS questionnaire.

Our study findings must be interpreted considering the study limitations. First, the number of subjects does not entitle us to express an opinion about the strength of the obtained results. It is, however, sufficient for a statistical evaluation. Second, since we do not perform ACLR with drains, we cannot compare the results of these two approaches. Finally, our patient follow-up endpoint was about one year after surgery. Since we know that at that time the ACL tends not to be fully functional [12], a longer follow-up period is needed to report more reliable results.

Conclusions

The present study demonstrated that primary single incision, arthroscopic bone-patellar tendon-bone autograft ACLR without wound drainage, did not have any negative impact for patient-reported recovery.

Conflict of interest

The authors declare no conflict of interest.

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