Isolated anterior cruciate ligament reconstruction in patients aged fifty years: comparison of hamstring graft *versus* bone-patellar tendon-bone graft

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Abstract

Purpose Anterior cruciate ligament (ACL) deficiency contributes to symptomatic functional instability of the knee, regardless of age. We evaluated patient-reported clinical outcome, instrumental stability and prevalence of radiological osteoarthritis based on two homogenous patient samples aged 50 years, an average of three years after isolated ACL reconstruction.

Methods ACL reconstruction using a bone-patellar tendon-bone (BPTB) autograft was done in 19 patients and a four-stranded semitendinosus tendon (ST) autograft in 22 patients. Clinical and functional follow-up assessment was performed an average of 32 months after surgical treatment. Clinical and functional follow-up assessment included the International Knee Documentation Committee (IKDC) score, Tegner score and Lysholm score. Instrumental stability testing was carried out using the KT-1000™ arthrometer. The degree of degenerative changes and prevalence of osteoarthritis was based on the Kellgren–Lawrence classification.

Results Mean follow-up was 32 months (range, 28–36). Mean age was 49.4 years in both groups. The median pre-injury Tegner score was 5.5 (range, 2–8) and the median preoperative Lysholm score was 35 (range, 15–69). At two years, all variables improved significantly for both groups compared to the preoperative values ($P < 0.05$), with no significant intergroup differences. Approximately 76 %

of patients were graded A or B according to the IKDC score in both groups. Activity level according to the scores of Tegner and Lysholm was 4.9/5.3 and 83.4/82.5 on two-year-follow up in both groups. Radiological assessment reported degenerative changes of grade I Osteoarthritis (OA) in 36 % of patients. Grade-II OA was found in 31 % of patients. Grade-III OA and grade-IV OA were found in about 24 % and 7 % of all patients, respectively. Correlation analyses showed significant relationships between conservation of knee-joint stability and clinical outcome according to the IKDC score, and activity level according to the Lysholm score ($p < 0.05$).

Conclusion Arthroscopic ACL reconstruction using either BPTB graft or hamstring graft in appropriately selected middle-aged patients results in patient satisfaction and good clinical results, with return to a reasonable level of activity regardless of surgical method and graft choice.

Introduction

Injuries of the anterior cruciate ligament (ACL) in professional and amateur sports are common [1, 2]. Techniques of reconstruction of the ACL have changed over the past decades [2, 3]. The necessity of operative restabilisation (in particular in young athletic patients) is, in general, accepted [4, 5]. Restoration of the long-term stability and function of the knee joint remains the basic principle of any treatment strategy, to avoid severe sequelae such as meniscal or cartilage damage and, in particular, progression of degenerative changes [6–8].

Although restoration of stability slows the progression of osteoarthritis (OA) in chronic ACL deficiency, management of knee instability in middle-aged and elderly patients remains controversial [9–13]. Historically, older patients

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with ACL rupture and coincidental arthritic changes have undergone conservative management [12, 14]. This treatment strategy means that patients were urged to modify their physical activities [15–17]. Only Ciccotti et al. [12] reported satisfactory clinical outcomes for 30 patients treated by nonsurgical means. Jokl et al. [18] also reported the results of conservative treatment and showed satisfactory mid-term results, but noted a significant decline, with older patients constituting the poorest results at final follow-up. Shelbourne et al. [19] reported on benefits with ACL reconstruction in this special subset of patients. They stated that few authors would argue against the importance of the ACL for normal function and kinematics of the knee, but they also stated that the ACL is important to the function and kinematics of the compromised arthritic knee. Therefore, within the last few years, there has been a shift in treatment regimens in middle-aged to elderly active patients with ACL-deficient knees [4, 9, 13, 16, 20].

Several authors at mid-to-long-term follow-up have noted a significant reduction in recreational activity with increased chronic instability and a decline in the level of patient satisfaction [2, 13, 15, 16, 21, 22]. Reports of conservatively treated ACL-deficient knees have documented higher incidences of rotatory instability, meniscal tears and progression of arthritic change [4, 5, 11, 14, 22–24].

ACL reconstruction methods have changed over the past decades, and reconstruction using hamstring autografts has recently become more popular across all patient age groups [5, 6, 11, 25, 26]. As fixation methods have improved, the biomechanical and objective results of hamstring reconstruction have been shown to be equal to reconstruction using bone-patellar tendon-bone (BTPB) grafts, with relatively less surgical comorbidity (principally anterior knee pain related to graft donor site morbidity) [2, 3, 5, 6, 11, 16, 25, 27].

With regard to our study, operative management for ACL deficiency was indicated in patients aged 50 years, to prevent further secondary adverse effects and to allow a return to an activity level observed before injury.

Our primary objective was to evaluate and compare functional and clinical outcomes, as well as prevalence of OA, in a patient cohort aged 50 years or more, an average of two years after isolated anterior cruciate

ligament rupture and operative restoration, using either BPTB autograft or a four-stranded semitendinosus tendon (ST) autograft. We postulated that reconstruction represents an appropriate intervention, in particular in patients desiring a continued physically active lifestyle regardless of age, operative technique and degenerative changes.

Material and methods

A total of 886 primary ACL reconstructions were carried out between 2000 and 2009 in our department. Since the establishment of ACL reconstruction via autologous hamstring grafts in the year 2004, ACL reconstruction using autologous bone-patellar tendon-bone (BPTB) autograft was the primary operative method in our department. Therefore, in a retrospective analysis of our institutional database, we found 41 patients (23 male) aged 50 years with ACL reconstruction using either BPTB autograft or four-stranded ST-autograft (Table 1). These patients were part of a patient cohort whose data have been previously published [28]. Follow-up examination for both groups, including clinical evaluation according to the International Knee Documentation Committee (IKDC) graduation and the scores of Tegner and Lysholm, took place an average of 32 months (range, 29–36) after ACL-reconstruction (Table 1). Inclusion criteria consisted of: (1) isolated arthroscopic ACL reconstruction; (2) no previous knee ligament surgery; and (3) a normal contra lateral knee. Exclusion criteria were additional ligamentous injuries, significant articular surface damage (focal cartilage lesions > Outerbridge grade II), meniscal lesions, evident higher degree OA (> Kellgren-Lawrence grade II) or concomitant medial collateral ligament repair at the time of reconstruction [29, 30].

Surgical methods and rehabilitation

BPTB group

Reconstruction was performed with an autogenous BPTB autograft from the middle third of the patellar tendon. The

Table 1 Demographic analysis of BPTB autograft and four-stranded ST-autograft groups

BPTB group (N=19)	Location	Age (range)	Follow-up (range)
Sex			
10 male	12 right	49.1 years	36 months
9 female	7 left	(45–62 years)	(29–39 months)
Hamstring group (N=22)	Location	Age (range)	Follow-up (range)
Sex			
13 male	14 right	49.4 years	32 months
9 female	8 left	(46–64 years)	(28–34 months)

central third of the patella (ten millimetres in width) was harvested through a single longitudinal incision. The graft was removed with a rectangular bone plug (20–25 mm in length). An arthroscopic-assisted reconstruction was used. The ruptured ACL was debrided and the anatomical tibial and femoral footprints were identified and left intact. The tibial tunnel was drilled using a drill guide under arthroscopic view through the posterior part of the middle of the tibial ACL footprint. To create the femoral tunnel, a five millimetre offset guide system was placed in a trans-tibial direction at the posterior margin of the intercondylar notch. Bone blocks were positioned in the tunnel, and the autograft placed with its cortical edge oriented posteriorly within the femoral tunnel. Exact anatomical positioning of the femoral insertion tunnel was performed in 120° knee flexion. Femoral graft fixation was carried out by press-fit positioning in the inserted tunnels and by additional joint-distant mini-plate-fixation via a lateral incision. Exact intra-articular graft positioning of the tibial insertion tunnel was done in 90° knee joint flexion using a 45° sight and positioned concentrically in the stump of the ruptured ACL. Afterwards, tibial graft fixation was performed by press-fit fixation and additional joint distant staple fixation. After femoral fixation, the affected knee was cycled several times to assess graft fixation and isometry. Final tibial fixation was achieved by additional joint-distant staple fixation to fix the threads.

Hamstring group

Reconstruction was conducted using the standard anatomical single-bundle method. The ST was harvested (minimum length, 26 cm) through a 2.5 cm-long incision centered one centimetre medial and 1-cm distal to the medial margin of the tibial tubercle. For the tibial bone tunnel, the tibial drill guide was set to 60°. The intra-articular tip was positioned in the anteromedial part of the tibial ACL stump. A guidewire was overdrilled by a conventional reamer according to the size of the ST graft. The centre of the femoral bone tunnel was marked with a microfracture awl in 100° to 110° of knee flexion [15]. Using the modified lateral clock wall model, the average centre was at the 11 o'clock position for the right knee and at 1 o'clock for the left knee in 100° to 110° of knee flexion. Then a guide wire was positioned at the centre of the femoral insertion, the knee was flexed to a maximum of 130°, and the femoral bone tunnel established through a low anteromedial accessory portal using a headed reamer. The drill system for an EndoButton Continous Loop fixation (Smith & Nephew Endoscopy, Andover, MA, USA) was then used to create a femoral tunnel. The graft was then passed and the EndoButton was inverted in the standard fashion for femoral fixation. Afterwards, the knee was cycled from 0° to 120° approximately 25 times for preconditioning of the graft. Then, tibial-graft fixation was performed by SutureWasher™ fixation (Smith & Nephew Endoscopy,

Andover, MA, USA) with the knee at full extension with a forced posterior drawer.

Postoperatively, patients of both groups were immobilised in a full-extension orthosis for two days. Full weightbearing was allowed according to the pain level directly after surgery. Patients were treated with a flexion-limiting orthosis (extension/flexion 0°/0°/90°) for six weeks according to the concept of rehabilitation practiced at our institution. After six weeks of rehabilitation, there was no additional limitation concerning range of motion (ROM). High-demand pivoting sports activities were allowed after six to nine months.

Assessments

The clinical and functional follow-up assessment was carried out according to the IKDC score [31]. Further criteria of clinical evaluation were based on the scores of Tegner and Lysholm [23, 32]. Patients who scored more than 92 points were classified as “excellent”. Patients with scores between 91 points and 76 points were rated as “good” and scores under 76 points were rated as “fair/poor” according to the Lysholm score. Clinical evaluation using the IKDC score and the scores of Tegner and Lysholm was performed before ACL reconstruction and 32 months after operative restoration. Furthermore, pre-trauma status was documented for the scores of Tegner and Lysholm. Assessment of anterior laxity was carried out with the KT 1,000™ arthrometer (MEDmetric®, San Diego, CA, USA) according to a modified IKDC graduation (degree of differential instrumental laxity in side comparison) [33]. Radiographic evaluation was done using conventional radiographs in three planes to evaluate the prevalence of radiographic tibio-femoral and patello-femoral knee OA. Radiographic evaluation of pre-trauma status supplemented the overall radiographic assessment. The degree of OA was evaluated according to the Kellgren–Lawrence classification [29]. Grades I and II of this classification were rated as “minor osteoarthritic changes”, and grades III and IV were rated as “major osteoarthritic changes”.

Statistical analyses

Statistical analysis was performed using the software SPSS 17.0. version for windows. The Pearson-chi square test and Mann–Whitney-U test were used to assess the significance of differences between groups. $P < 0.05$ was considered significant.

Results

Evaluation of IKDC score

Clinical evaluation according to the IKDC score prior to ACL reconstruction showed a poor overall clinical result for

both groups with no significant inter-group differences. For both groups, functional assessment according to the IKDC score revealed no patients to have a score of A or B. Analyses of the BPTB group showed 11 patients (57.9 %) to be grade C and eight patients (42.1 %) to be grade D according to IKDC criteria. With regard to the ST group, we found 15 patients (68.2 %) to be grade C and seven patients (31.8 %) to be grade D before ACL reconstruction. The worse clinical results were related to pain and progressive swelling of the knee joint even under a moderate load, and a prominent giving way symptoms in the subjective IKDC. Furthermore, an evident extension deficit, intermittent intra-articular effusion or striking differential laxity on assessment using the Lachman test accounted for worse results within the objective IKDC evaluation.

On two-year follow-up, we found significant improvement in clinical results according to the IKDC score (Fig. 1). With regard to the BPTB group, functional assessment revealed four patients (21.1 %) with an IKDC A score, 11 patients (57.9 %) with a B score, three patients (15.8 %) with a C score and one patient (5.3 %) with a D score. With regard to the hamstring group, functional assessment revealed six patients (27.3 %) with an A score, 11 patients (50.0 %) with a B score, four patients (18.2 %) with a C score and one patient (4.6 %) with a D score. Overall, we could not detect significant inter-group differences on final follow-up. Inferior clinical results were again related to pain and intermittent swelling of the knee joint even with a heavy load in both groups, and anterior knee pain at the graft-harvesting site within the BPTB group in the subjective IKDC questionnaire. Furthermore, an evident extension deficit, intermittent intra-articular effusion or striking differential laxity on assessment using the Lachman test accounted for worse results within the objective IKDC evaluation.

Lysholm knee scoring scale/Tegner activity scale

Clinical assessment according to the Lysholm knee scoring scale and Tegner activity scale showed significant

improvement of the overall clinical constitution on follow-up, and is presented as a mean value and range (Table 2). At two years, all variables significantly improved for both groups compared to preoperative values ($P < 0.05$) and nearly returned to the activity level observed before injury, with no significant inter-group differences.

Assessment of anterior laxity (Lachman test)

Instrumental assessment of anterior translation with the KT-1000™ arthrometer showed satisfactory to excellent values on two-year follow-up, according to the modified IKDC graduation without significant inter-group differences (Fig. 2).

Prevalence of osteoarthritis

Radiographic assessment prior to ACL reconstruction with regard to the BPTB group revealed signs of degenerative change in sense of a grade-I osteoarthritis (OA) according to the Kellgren–Lawrence classification in eight patients (42.1 %). In 11 (57.9 %) subjects, degenerative changes according to a grade-II OA were detected upon radiographic assessment. Radiographic assessment before surgery in the ST group showed a grade-I OA in nine (40.9 %) patients and a grade-II OA in 13 patients (59.1 %). At two-year follow-up, an increase in degenerative changes was detected upon radiological evaluation without significant inter-group differences (Fig. 3).

Correlation analyses

Instrumental stability vs. clinical constitution

Correlation analyses of instrumental anterior laxity with the KT-1000 arthrometer, and clinical results according to the IKDC score ($p < 0.05$) and Lysholm score ($p < 0.05$), showed a significant correlation on two-year follow-up for both groups without evidence of significant intergroup differences (Figs. 4 and 5).

Fig. 1 Knee function and activity level according to the International Knee Documentation Committee (IKDC) score at 2-year follow-up

Table 2 Results of Tegner and Lysholm scores through the period of follow-up

	Pre-trauma status	Preoperative status	2-year Follow-up
BPTB group			
Knee function: Lysholm scoring Scale	87.3 (65–95)	35.4 (15–70)	84.4 (25–100)
Activity level: Tegner activity score	5.5 (2–8)	2.5 (2–4)	4.9 (2–8)
STS group			
Knee function: Lysholm scoring Scale	88.6 (65–100)	34.8 (15–70)	82.5 (25–100)
Activity level: Tegner activity score	5.6 (2–8)	2.5 (2–4)	5.3 (2–8)

Discussion

This retrospective study evaluated clinical and radiological mid-term outcomes after isolated ACL reconstruction using either autologous BPTB autografts or four-stranded ST-autograft in middle-aged and elderly patients. The most important finding of this study was that good clinical results (antero-posterior stability; level of activity according to the scores of Lysholm and Tegner, and the IKDC score) were observed in most of the patients aged 50 years or more, with significant improvements compared to pre-surgery status. ACL reconstruction, regardless of surgical method and graft choice, significantly improved functional outcome and allowed a return to a reasonable level of activity (though not to pre-injury levels) for most patients. The results of our study confirmed the hypothesis that clinical outcome and level of activity in middle-aged and elderly patients are correlated to restoration and conservation of stability after isolated ACL rupture and operative reconstruction.

Yet ACL reconstruction in a population aged 50 years and over remains controversial [2, 4, 9, 12, 16, 20, 34]. There is no clear consensus whether a conservative approach or surgical reconstruction is favourable for middle-aged patients with ACL deficiency [12, 13, 20, 34, 35]. In the past, conservative treatment was advocated due to concerns that ACL reconstruction in the elderly might contribute to complications including progressive arthrofibrosis, infections or thrombembolism [12, 13, 15]. Many of these concerns were based on theoretical considerations of the effects of age. Furthermore, some authors argued that pre-

existing degenerative and osteoarthritic changes could prevent a satisfactory overall clinical outcome at all [19, 36]. Only a few studies have reported successful clinical outcomes with conservative treatment [12, 15]. Ciccotti et al. [12] reported satisfactory clinical outcomes in 83 % of patients aged 40–60 years with non-surgical treatment. However, that study showed that most of the conservatively treated patients had to modify their activity by renouncing any pivoting sports. Limitations and modification of activity levels after non-surgical treatment have also been observed in other studies with heterogeneous patient cohorts [13–16]. Strehl and Eggly [17] reported the results of 37 patients (age range, 16–55 years) with ACL rupture and conservative treatment. Twelve patients (32.4 %) reported good-to-excellent outcomes and returned to previous sporting activities. However, 25 patients (67.6 %) underwent secondary ACL reconstruction at an average of nine months after injury. With regard to long-term results, Mihelic et al. [14] as well as Streich et al. [37], compared surgical vs. conservative treatment and reported significant differences in the mean IKDC score and documented significant differences in the prevalence of OA in both groups, with a significantly higher prevalence and progression of OA with conservative treatment. Careful analyses of the literature does not reveal further evidence advocating conservative treatment [12, 13, 16]. In contrast, residual instability and the subsequent potential of meniscal and/or chondral damage remain problematic in the absence of operative re-stabilisation in the younger and elderly patient population [2, 5, 16, 22, 38]. Furthermore, there has been no reported increase in the

Fig. 2 Results of the anterior laxity assessment via the KT-1000 arthrometer at 2-year follow-up

Fig. 3 Prevalence of osteoarthritis (OA) according to the Kellgren-Lawrence classification on 2-year follow-up

prevalence of complications such as graft failure, knee laxity or arthrofibrosis in middle-aged patients after ACL reconstruction [10, 20, 22, 34]. Hence, there is an increasing body of evidence supporting ACL reconstruction in symptomatic and active older patients [2, 16, 22]. Several studies have demonstrated satisfactory clinical results with considerable recovery of function and stability after surgical reconstruction in selected and motivated middle-aged patients [2, 9–11, 16, 21, 22, 27, 39]. Osti et al. [22] reported satisfactory-to-excellent results after ACL reconstruction in 85 % of patients aged 50–62 years on follow-up examination at an average of 32 months after surgery. The study group additionally reported high satisfaction rates and good to excellent clinical outcomes according to the IKDC score (85–92 points) and the Lysholm score (89 points). In addition, Dahm et al. [27] reported 72 months (range, 25–172 months) after ACL reconstruction using either BPTB graft or allograft in patients aged 55 years, of excellent

clinical results according to the IKDC score (90 points) and the Lysholm score (92 points). Furthermore, the authors showed an improved functional outcome and activity level according to the Tegner score (4.3/–0.1 points in comparison with the pre-injury level). ACL reconstruction enabled a return to pre-injury activity levels for most patients. With regard to our results, all variables improved significantly for both groups compared to preoperative values ($P < 0.05$), with no significant inter-group differences. Approximately out 76 % of patients were graded A or B according to the IKDC score in both groups. Pain and swelling upon carrying out strenuous activities were recorded for inferior clinical results in the subjective IKDC questionnaire for both groups. In addition, intermittent anterior knee pain due to donor-site morbidity was reported in the BPTB group. Furthermore, an extensive deficit, intra-articular effusion or striking differential laxity on assessment with the KT-1000™ arthrometer

Fig. 4 Correlation of anterior laxity and clinical constitution according to International Knee Documentation Committee (IKDC) score

Fig. 5 Correlation of anterior laxity and clinical constitution according to the Lysholm score

accounted for inferior results within the objective IKDC evaluation.

Activity level according to Tegner and Lysholm scores significantly improved to 4.9/5.3 and 83.4/82.5 on two-year follow up in both groups. A median Tegner score of 5 and a mean Lysholm score of 83.4/82.5 at final follow-up is similar to that recorded in other studies, which have reported of Tegner scores between 4 and 6 and values for the Lysholm score between 82 and 94 points [10, 11, 27, 34, 39].

Assessment of anterior laxity using the KT-100 arthrometer showed an overall differential laxity of < 3 mm for 77 % of all patients with no significant inter-group differences. Overall performance with respect to the anterior translation measured on the KT 1,000 arthrometer assessment was comparable to the results of Osti et al. [22] as well as Stein et al. [40], with 75 % to 95 % of patients having a differential laxity of under three millimetres.

Other studies have compared clinical outcomes after ACL reconstruction in subjects aged 40 years or more with those of younger patients [10, 20, 22, 34]. The authors reported that surgery elicited favourable outcomes in the older patient population in terms of knee stability and patient satisfaction with findings similar to those observed in the younger patient population [20, 34]. Barber et al. [20] did not find significant differences between a group of patients with an average age of 27 years (91 % good results) and a group with an average age of 44 according to the Lysholm score (89 % satisfactory outcomes, 95 points on average) and the Tegner score (5.7 on average). Brandsson et al. [34] compared the results of ACL reconstruction in patients aged 24 years and patients over 40 years; no significant differences were found in terms of IKDC, Lysholm knee score, or Tegner activity level. Furthermore, they found significantly more patients with good-to-excellent results within the elderly group. None of the authors reported an increased risk of complications (stiffness, arthrofibrosis, infections) compared to the control group [10, 20, 22, 34]. Additionally, Seng et al. [38] demonstrated that surgery was the optimal treatment of ACL rupture in patients aged 40 years and over. They concluded that individuals above 40 years of age were extremely averse to accepting potential knee instability during pivoting and thus preferred ACL reconstruction, despite the risk of surgical complications.

The choice of ACL graft in the elderly population is controversial. Although the BPTB autograft has been widely used, reconstruction using hamstring grafts is becoming more popular because of reduced donor-site morbidity and potentially fewer problems with the extensor mechanism in secondary knee arthroplasty [21, 24, 35, 39]. However, only a few reports have focused on autologous BPTB and hamstring tendon graft ACL reconstruction. Blyth et al. [35] compared preoperative and postoperative Tegner activity

rating scale scores in patients older than 40 years undergoing ACL reconstruction, and found no significant differences with regard to surgical method and graft choice. In our study, we found no significant differences between the outcomes. Based on our results, ACL reconstruction using either a standard BPTB graft or a four-stranded hamstring graft resulted in satisfactory-to-excellent clinical and functional results without significant inter-group differences. In general, satisfactory results of ACL reconstruction in older population groups have been achieved with all graft types: BPTB [11, 35], quadrupled hamstrings [21, 41] or with allograft [40]. Our correlation analyses revealed a significant correlation of instrumental anterior laxity with the KT-1000 arthrometer and clinical results according to the IKDC score and Lysholm score for both groups without evidence of significant inter-group differences. With regard to our results, it is more important to restore and conserve knee joint stability than to focus on graft choice. There is still no consensus whether ACL deficiency or reconstruction in elderly patients represents a greater risk for the development of OA [8, 9]. In our study, radiological assessment revealed grade-I OA in 36 % of all patients. Grade-II OA was found in 31 % of patients. Grade-III OA and grade-IV OA were found in about 24 % and 7 % of patients, respectively. In accordance with literature, we did not find significant inter-group differences for the degree and progression of OA with regard to the reconstruction technique and graft choice [5, 35]. Blyth et al. [35] reported a correlation between inferior clinical results and advanced osteoarthritic changes at mid-term follow-up for patients above 50 years of age. On the other hand, the same authors showed an overall improvement in stability, function and patient satisfaction after ACL reconstruction.

Despite the evidence of osteoarthritic changes in approximately 30 % of patients in our study, the underlying mechanisms of OA development are still unclear [8, 9]. Possible explanations besides ACL reconstruction include in general greater trauma to a knee-joint in patients who underwent reconstruction compared to those treated conservatively or prolonged interval of instability before decision for surgical reconstruction [5, 8, 9, 20]. With regard to our results, we found a significant improvement of all clinical variables and level of patient satisfaction when compared to preoperative status, despite the mentioned evidence of 30 % OA. Re-establishment of knee joint stability seems to be more important for the overall therapeutic success than radiological degree of OA.

The study has limitations. First, we assessed a relatively small patient cohort and therefore the statistical power was limited. Second, a group of patients with ACL deficiency managed by conservative means was not included. Third, we did not give a randomised report of clinical and radiological results comparing the prevalence of OA after ACL

reconstruction with the non-injured contra-lateral knee. Nevertheless, our study provided strict exclusion criteria, such as intermittent surgical procedures due to partial or total meniscectomy, based on a homogenous study sample with a standardised surgical procedure and postoperative rehabilitation.

Conclusion

Arthroscopic ACL reconstruction using four-stranded ST autografted or autologous BPTB autografts in middle-aged and elderly patients provided high patient satisfaction and satisfactory-to-excellent clinical results with significant improvements compared to the pre-surgery status. Symptomatic OA developed in approximately 30 % of all patients. But ACL reconstruction, regardless of surgical method and graft choice, significantly improved functional outcome, and reestablishment of knee joint stability seems to be more important for the overall therapeutic success than radiological degree of OA. Our findings suggest that ACL replacement in middle-aged, active patients is advisable. Age itself is not a contraindication to ACL surgery. Physiological age, physical status and expectancy of life and activity level are more important than chronological age.

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