Knee stability after anterior cruciate ligament reconstruction in patients older than forty years: comparison between different age groups

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Abstract

Purpose The aim of this study was to compare clinical and arthrometrical results of a series of patients older than 40 years with those of younger patients following anterior cruciate ligament (ACL) reconstruction. The hypothesis of this study was that certain biological and biomechanical factors related to middle-aged patients, ACL reconstruction would provide different results compared with younger patients.

Methods Thirty-six patients >40 years operated for ACL reconstruction between 2002 and 2010 were selected for this retrospective study, and results were compared with patients in two other age groups (<30 years and 30–40 years). At a minimum follow-up of two years, patients were reviewed and clinically examined subjectively and objectively according to Tegner, International Knee Documentation Committee (IKDC) classification and Lysholm evaluation scales. An arthrometric evaluation with KT-1000 was also performed.

Results No statistically significant difference was found among the three different age groups at the subjective and objective evaluations. However, the KT-1000 arthrometric study showed a statistically significant mean side-to-side difference at 30 lb with 1.8 mm [standard deviation (SD) 2.4] for patients >40 years, 2.7 mm (SD 1.8) for patients aged 30–40 years and 2.6 mm (SD 1.8) for patients <30 years.

Conclusions Our results seem to show that ACL reconstruction is a safe and valid option for patients of all age groups, even for those >40 years. Moreover, in that group, greater

knee stability was found when compared with the younger patient groups.

Keywords ACL · ACL reconstruction · Arthrometer · Over 40

Introduction

Anterior cruciate ligament (ACL) rupture is one of the most common sport injuries. In recent years, ACL reconstruction has become one of the most performed surgical procedures. This surgical treatment is usually reserved for young, athletic patients and is commonly performed to restore knee stability and reduce the risk of further injuries and progression of degenerative changes. The ultimate objective is, therefore, a return the patient to the preoperative level of participation in sports activities, which is a matter of great concern for the patient.

With life expectancy rising and consequently sport activities in middle-aged patients becoming more frequent, the interest in ACL reconstruction in patients >40 years is growing. Conservative treatment was common for such patients because the benefits of the surgical procedure were outbalanced by the risk of complications. It was commonly believed that the population in this age group was not willing to perform highly demanding sport activities. Some authors reported good results with conservative treatment [2, 3, 9]. Ciccotti et al. [3] showed satisfactory results in 83 % of conservatively treated ACL-deficient knees but with a high reinjury rate of 37 %, causing subsequent modification of activity levels and sport activities. Recent studies [6, 20] seem to demonstrate that conservative treatment is not associated with good results, as it may lead to an increased risk of residual instability and associated injuries. Moreover, patients have to cope with their instability, with many necessarily abandoning highly demanding sport activities.

The good clinical results of ACL reconstruction in patients >40 years has been widely documented. However, few studies

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compare clinical and arthrometrical results between different age groups. Although several authors reported no statistically significant difference in arthrometric and clinical results among age groups [13], few analysed arthrometrical results.

The aim of this study was to compare clinical and arthrometrical results of a consecutive series patients >40 years to those of younger patients treated with ACL reconstruction using a doubled semitendinosus and gracilis tendon (DSGT) graft. The hypothesis of this study was that for certain biological and biomechanical factors related to middle age (scar tissue modifications, degenerative knee changes, hormonal factors), ACL reconstruction would provide different results compared with younger patients.

Materials and methods

Patient selection

From a pool of 830 patients operated for ACL reconstruction in our hospitals and clinics between 2002 and 2010, we retrospectively selected 36 patients >40 years who were available for follow-up. To compare clinical and arthrometrical results of different age groups, reference was made to a previously published study [5] from our medical institution assessing patients operated with the same surgical protocol over a similar time period. As a result, three patient groups were considered for this study: group 1, patients >40 years (36; 27 men, nine women); group 2, patients 30–40 years (25); group 3, patients <30 years (27). All patients had positive preoperative Lachman and pivot-shift tests, with a concurrent history of chronic instability and accepted surgical intervention after identification of the problem. This was a nonrandomized retrospective case series, so precise preoperative values were not available for consideration patients >40 years. We requested information regarding their pretrauma level of sport activities to evaluate return to sports at the time of the follow-up. Average age patients >40 years was 45.4 years. Average follow-up was 3.5 years. The study conformed to the ethical guidelines outlined in the 1996 Declaration of Helsinki and was approved by our institution's Internal Review Board (Prot. n. 134/2012 of the register).

Surgical technique

An arthroscopically assisted, two-incision technique using a DSGT autograft was performed. The semitendinosus and gracilis tendons were identified through a small incision medial to the tibial tubercle and harvested free using a tendon stripper. The tendons were prepared on a graft preparation board as quadrupled grafts using two grafts of equal length doubled and fixed to a Swing-Bridge (Citieffe, Bologna, Italy). Arthroscopy was performed through via a central transtendinous approach and anteromedial portal. Resection

of meniscal tears and ACL remnants was performed. Once prepared, the graft diameter was measured and tunnels drilled accordingly—the tibial tunnel a 65° angle to the tibial footprint of the ACL and the femoral tunnel with an out-in technique about 6 mm in front of the top at the 10:30 or 1:30 o'clock position. The diameter of the tunnels was 9 mm according to graft size. Cortical fixation to the bone was achieved in the femur with the Swing-Bridge device and in the tibia with the Evolgate device (Citieffe).

Rehabilitation protocol

All groups were treated with the same rehabilitation programme. The knee was placed in a full-extension brace for the two week postoperative period, with weight bearing allowed as tolerated with crutches. Progressive range-of-motion (ROM) exercises were then encouraged. After a period of four weeks, weight bearing without crutches was permitted. From two to four months after surgery, a muscle-strengthening programme was prescribed. Gradual return to specific athletic training was allowed between four to six months postoperatively.

Follow-up

Activity level was assessed with reference to the Tegner scale. Subjective functional status was evaluated using the Lysholm score [21] and the International Knee Documentation Committee 2000 (IKDC 2000) score [7]. All patients underwent a standard physical knee examination. Knee stability was assessed with a Lachman test, pivot-shift test and a KT-1000 arthrometric test. Knee examination was classified according to the IKDC 2000 objective evaluation scale. Comparative weight bearing radiographs [anteroposterior (AP) with extended knee and lateral view with monopodal support] were obtained and evaluated using the IKDC grading system.

Statistical analysis

A descriptive analysis was performed on all variables of interest. Comparison among the three patient age groups was performed using the Kruskal–Wallis test. The Mann–Whitney test was used for comparison as appropriate. Analysis was performed using SPSS version 13.0. *P* value was set at 0.05.

Results

At the time of surgery, a meniscal tear was found in 11 patients in the >40 group; all were treated with partial meniscectomy. Chondral damage was also found in six patients. Patients in all groups were subjected to objective and subjective clinical evaluation. Comparison between groups was done using Tegner and Lysholm scores; subjective IKDC evaluations

are summarised in Table 1. There were no statistically significant differences.

Objective results of the clinical examination comparing the three age groups are shown in Table 2. There were no statistically significant differences.

Arthrometric evaluation comparison of the average side-to-side anterior knee translation difference among patients in the three age groups is shown in Table 3. There was a statistically significant difference using the Kruskal–Wallis test at 30 lb ($p=0.035$). There was also a statistically significant difference using the Mann–Whitney test between patients <30 years vs >40 years ($p=0.029$) and those 30–40 years vs >40 ($p=0.037$).

Specific data regarding the number of patients with a side-to-side anterior knee drawer difference >5 mm, a difference between 3 mm and 5 mm and a difference <3 mm are shown in Graph 1.

At the final follow-up, IKDC radiological evaluation was available in all patients >40 years; 34 of 36 patients were available in the other age groups (Table 2).

Discussion

The most important finding of this study is the statistically significant difference among patients <40 and >40 years at the KT-1000 arthrometrical examination, with better results in the latter group. No statistically significant differences were found in the other clinical data. Arthrometrical results indicate that patients >40 years have a lower statistically significant mean side-to-side difference at 30 lb compared with patients 30–40 years and those <30 years (Table 3). This is in contrast with the majority of articles in literature, in which no differences were found among groups [13]. Results in our series may be due to several physiological factors of the middle-aged patients assessed, such as different scar tissue formation, initial osteoarthritis, different hormonal patterns (especially in women) and loss of tissue elasticity. It has been widely reported that tendons and myotendinous junctions (MTJs) are modified during ageing by changes in underlying structures and mechanical properties [16] becoming progressively more

Table 1 Subjective follow-up evaluation

	Younger than 30 years (SD); average p value = 28	30–40 years (SD); average p value = 25	Older than 40 years (SD); average p value = 36
Lysholm	97 (3.0)	94 (6.4)	93 (7.5)
Tegner pretrauma	6.3 (3–10)	5.4 (1–9)	4 (2–8)
Tegner	5.3 (3–7)	4.8 (1–7)	5.2 (2–8)
IKDC subjective evaluation	96.1 (3.6)	93 (6.5)	90.8 (8.4)

IKDC International Knee Documentation Committee, SD standard deviation

Table 2 Objective and radiological follow-up evaluation

	Younger than 30 years (%) average p value = 28	30–40 years (%) average p value = 25	Older than 40 (%) average p value = 36
IKDC objective evaluation			
Group A	12 (42.9)	13 (52)	25 (69.5)
Group B	14 (50)	10 (40)	7 (19.5)
Group C	2 (7.1)	2 (8)	3 (8.3)
Group D	–	–	1 (2.7)
Lachman test			
Negative	27 (96.4)	24 (96)	34 (94.4)
Mild (1+)	1 (3.6)	1 (4)	2 (5.6)
Jerk pivot-shift Test			
Negative	18 (64.3)	15 (60)	24 (66.7)
+	8 (28.6)	8 (32)	8 (22.2)
++	2 (7.1)	2 (8)	3 (8.3)
+++	–	–	1 (2.8)
IKDC radiological evaluation (34 of 36 patients)			
Group A	21 (77.7)	12 (48)	8 (23)
Group B	5 (18.3)	10 (40)	13 (38.2)
Group C	1 (4)	3 (12)	11 (32.3)
Group D	–	–	2 (6)

IKDC International Knee Documentation Committee, SD standard deviation

stiff and, subsequently, with further progression, weaker and more likely to suffer tendinosis and rupture [8]. It may be that the arthrometrical difference found in our study is because the graft used was a tendon, the quality of which would be different between age groups. It is still unclear whether or not there is a specific factor(s) involved in the biomechanical changes of tendons due to ageing, and this is highly debated in the literature. Some authors found a different collagen type I and type III expression in tendons of young people compared with the elderly [1, 4, 10, 17], whereas other authors found no difference [11]. In the study by Kostrominova and Brooks [12], decreased expression in elastin (ELN) messenger RNA (mRNA) (the main property of ELN is the ability to deform reversibly with little force and without loss of strength) and in proteoglycan 4 (PRG4) (a glycoprotein with lubricating properties) in elderly tendons was also found, and this could be

Table 3 Mean side-to-side difference in anterior knee translation on KT-1000

Age-based comparison	
< 30 years	30 lb=2.66 (SD 1.8) mm=2.83 (SD 2.3)
30–40 years	30 lb=2.73 (SD 1.8) mm=2.78 (SD 2.2)
>40 years	30 lb=1.83 (SD 2.4) mm=2.12 (SD 2.0)

SD standard deviation

Graph 1 Anterior knee translation on KT-1000; comparison among different age groups

responsible for the increased tendon stiffness. Another study [22] shows an increase in metalloproteinase-2 (MMP-2) and MMP-9 activity. The way tendons adapt to mechanical usage, with an increase in tendon stiffness and with a decrease in tendon nonusage [15, 22], has also been reported. However, it remains unclear and is still debated whether or no tendons become stiffer with ageing and what factor is predominant. Osteoarthritis (OA) is certainly a factor in an elderly population and in some patients could modify articular structures, resulting in a more rigid knee. Results obtained in patients >40 years show that 39.8 % are graded C or D on the IKDC evaluation scale as a result of medium- or high-grade OA. That can surely influence arthrometrical results obtained in this series, with more rigid knees found in patients >40. Hormonal changes that occur in the elderly population can also modify biomechanical properties of the tendon.

We found no statistically significant clinical difference among the three patient age groups, with good results in patients both older and younger than 40 years. Conservative treatment is still considered by some orthopaedic surgeons to be appropriate for certain patients, especially for those >40 years due to the possibility of complications following surgery, such as knee stiffness, arthrofibrosis, infections, wound-healing problems and thromboembolic disease [14, 19]. Whereas some studies show fairly good results following conservative treatment [3, 6], patients had to limit sport activities and cope with a residual instability; in the study by Strehl and Eggly [20], 25 of 37 (67.6 %) patients underwent ACL reconstruction approximately 10 months after injury. In all those patients, a DSGT was used to reconstruct the torn ACL. It is possible to speculate that in elderly patients, the risk of anterior knee pain, often associated with bone–patellar tendon–bone (BPTB) reconstruction, is higher than in younger patients because of the possible presence of patellofemoral chondrosis and patellar tendon weakness. Rigid fixation devices with an out-in technique were used to avoid problems related to the slower integration time typical of this kind graft. It is noted, however, that several studies report no difference in clinical results of BPTB reconstruction when comparing it with DSGT [13, 18].

With lifespan increasing, the motivation and desire in middle-aged patients to perform sport at high activity levels

is also growing. More patients in this age group with an ACL tear are now considering the possibility of ACL reconstruction. Moreover, such patients have a strong determination to return to their preinjury activity level compared with younger patients [5]. It must also be noted that ACL reconstruction can successfully restore knee stability, which is useful in activities of daily living. Therefore, careful patient selection is recommended when considering nonoperative vs operative risks.

Analysing results of patients >40 years of age indicated that knee stability at final follow-up was restored, with a side-to-side difference <5 mm in 88 % of patients. These results can be considered satisfactory due to the high patient return rate to sport activities (70 % returning to a Tegner level >5) and the low failure (four of 36 patients; 11 %), with failure considered to be a jerk test result of 2++ or 3+++ or/and a KT-1000 side-to-side difference of >5 mm at maximum manual exertion. It must also be noted that those results are in line with results in the other age groups. X-ray evaluation showed a statistically significant difference between different age groups, with higher OA grade in patients >40 years. OA development is a well-known consequence after ACL reconstruction. However, it must also be considered that restoring knee stability can prevent further OA progression from chronic knee instability following conservative treatment; this is due to a lower risk of subluxations or further injuries.

Limitations of this study are the lack of a true control group for patients >40 years, the number of patients >40 years and the lack of pre-operative values. Another limitation is that there were no pre-operative X-rays to use for comparisons. It was not possible to evaluate a higher number of patients, as patients in this age group with an ACL tear often decide upon conservative treatment.

Conclusion

Results of this study seem to confirm that ACL reconstruction is a valid option for patients >40. Moreover, in comparison with younger patients, they have greater knee stability. The role of tendon stiffness and OA needs to be determined. However, we recommend ACL reconstruction in middle-aged patients because

surgery provides a stable knee and enables longer patient participation in sports activities.

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