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Graft selection in anterior cruciate ligament reconstruction – prospective analysis of patellar tendon autografts compared with allografts

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Summary. *A prospective study of 73 arthroscopic anterior cruciate ligament reconstructions using either a patellar tendon autograft or an allograft was made to assess any difference in clinical outcome. Allocation was by availability of an allograft. There were 48 autografts and 25 allografts. Evaluation was by clinical examination and physical tests. At follow-up 2 years after operation, there were no statistically significant differences between the two groups in mobility or in physical tests, but KT-1000 evaluation showed a slightly greater anterior translation in the autografts at 6 months and one year, although at 2 years the allografts developed greater anterior laxity. Cybex testing showed greater quadriceps strength at 6 months and one year in the allografts, but at 2 years the strength was greater in the autografts. Re-rupture occurred in 3 allografts. ACL reconstruction with a patellar tendon allograft does not produce a significant functional deficit. Full quadriceps recovery takes 2 years. Allografts are not recommended as stability deteriorates with time.*

Résumé. *Une étude prospective de 73 reconstructions arthroscopiques de ligaments croisés antérieurs avec tendon rotulien autologue contre allogreffe a été effectuée afin de noter une éventuelle différence du résultat clinique. Le choix de la greffe reposait sur la disponibilité de l'allogreffe, il y a 25 allogreffes et 48 tendons autologues. Les patients ont été évalués à 6 mois, un an et deux ans postopératoires. L'évaluation incluait l'histoire clinique et l'examen clinique, les scores patello-fémoraux de Lysholm, Tenger et Kujala, les mesures au KT-1000, le "hop-test" et les mesures de la force musculaire au Cybex. Au follow-up il n'y a pas de différence statistiquement siginificative entre les 2 groupes quant à la mobilité, les scores de Tegner, Lysholm et Kujala et le "hop-test" ($P > 0.05$). Le KT-1000 montre une translation antérieure légèrement superieure dans le groupe autogreffe à 6 mois et 1 an ($P > 0.05$) mais à 2 ans le groupe allogreffe développe une laxité antérieure supérieure ($P > 0.05$). L'évaluation Cybex montre une force quadricipitale supérieure dans le groupe allogreffe à 6 mois et un an ($P > 0.05$) mais à deux ans le groupe autogreffe est plus puissant que le groupe allogreffe (> 0.05). Une nouvelle déchirure de la greffe a été notée dans 3 cas de patients avec allogreffe. En conclusion, la reconstruction du croisé antérieur avec tendon rotulien autologue ne provoque pas de déficit fonctionnel significatif. La récupération complète du quadriceps dure 2 ans. L'utilisation d'une allogreffe n'est pas recommandée puisque la stabilité semble diminuer avec le temps.*

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Introduction

Untreated instability of the knee which causes symptoms leads to progressive deterioration of the joint [9, 15, 16]. Giving way results from loss of mechanical restraints and proprioception [2].

The goal of reconstruction of the anterior cruciate ligament (ACL) is to improve the functional capacity of the knee and prevent further damage to secondary restraints. The use of a patellar tendon autograft has been become popular since the work of Campbell and Jones [11]. The central one-third of the tendon is strong and revascularises well [1]. Firm initial fixation is achieved by two bone blocks, allowing early rehabilitation [22]. The long-term follow-up results are good for stability and clinical outcome [6, 10, 17].

There is, however, concern that the use of the central third of the tendon can lead to fracture of the patella, tendon rupture, tendonitis, infrapatellar contracture and loss of movement [27], residual quadriceps weakness and anterior knee pain [5, 18, 19, 21, 23]. These problems led to the use of allografts which have the mechanical advantages of an autograft, but need less operative time, produce a satisfactory cosmetic result and avoid the complications of taking the autograft [13]. The clinical results have also been encouraging [15, 23].

The aim of this study was to evaluate any difference in the clinical outcome between patients treated by autografts and allografts.

Patients and methods

Selection was made on the following basis: willingness to participate; no previous knee operations; unilateral ACL rupture with instability causing symptoms; no bimeniscal damage, no meniscal sutures; no grade IV articular lesions and no associated grade III medial collateral injury.

Seventy-three patients took part, 53 men and 20 women with a mean age of 28 years (range 18 to 43 years). All participated in recreational or competitive sport. The average time between injury and operation was 27 weeks.

Allocation

An allograft was carried out when one was available from the tissue bank. If this was not the case, a patellar tendon autograft was done. The patient was told the day before operation. Forty-eight had an autograft and 25 an allograft. There was no significant difference between the groups relative to age ($P > 0.05$), sex ($P > 0.05$), time between injury and operation ($P > 0.05$), quadriceps and hamstring tested isokinetically at 60°, 180° and 240° ($P > 0.05$), and KT anterior translation measurement ($P > 0.05$).

Operative technique

The allografts were removed under sterile conditions from donors with a maximum age of 45 years, and screened for bacterial and viral infecting agents. All had a shelf life of less than 3 months.

All operations were carried out by one surgeon (JV). A tourniquet was used, but never for longer than 90 minutes. The tendon graft was raised through an anterior longitudinal incision and was always 9 mm wide or less, and never exceeded more than one third of the width of the tendon. The bone block on the tendon was passed through a 9 mm or 10 mm cylinder and was between 20 mm and 25 mm long, in both groups.

Reconstruction was carried out with a standard arthroscopic technique without a lateral incision. Finally, the defect in the patella was bone grafted. The gap in the tendon was not closed.

Rehabilitation

Each patient was treated in the same way. Flexion exercises and patellar mobilisation were begun the day after operation, and weightbearing allowed immediately. The leg was immobilised in full extension during the night for 4 weeks. Closed kinetic exercises were begun at one week, cycling at 3 to 4 weeks and running at 3 months. Return to sport was allowed at 6 months if the hop test performance was greater than 85%.

Assessment

Every patient was evaluated before operation and at 6, 12 and 24 months after. This included the clinical history and examination, Lysholm [14], Tegner [24] and Kujala [12] patellar scores, KT-1000 measurement, hop test performance [4] and Cybex muscle strength measurement.

The clinical examination was carried out by one of us [KG] who was not involved with the operations. Special attention was paid to clinical stability, effusion, thigh circumference, anterior knee pain, range of movement, ability to squat and kneel. A hop test was carried out on every patient and compared with the normal side.

KT-1000 and Cybex measurements of muscle strength were done by the same examiner (EW) before and after operation. The KT-1000 was used at 20 lb as described by Daniel [3]. Quadriceps and hamstring strength was assessed at 60°, 180° and 240° on a Cybex 3000^{R} on the affected and normal side using standard stabilisation with the patient sitting. Patients with allografts which ruptured during follow up were excluded from these measurements.

Statistics

All data were first tested for normality, and nonparametric (Wilcoxon test) and parametric hypothesis (Student *t*-test) testing was applied when appropriate.

Results

There was no statistical difference between the two groups in quadriceps or hamstring strength at all velocities at 6, 12 and 24 months (Fig. 1). The difference between the injured and uninjured was significant at 6 and 12 months ($P < 0.05$), but not at 24 months ($P > 0.05$), for both groups.

KT-1000 anterior laxity measurements showed no significant difference between allografts and autografts at 6, 12 and 24 months (Fig. 2).

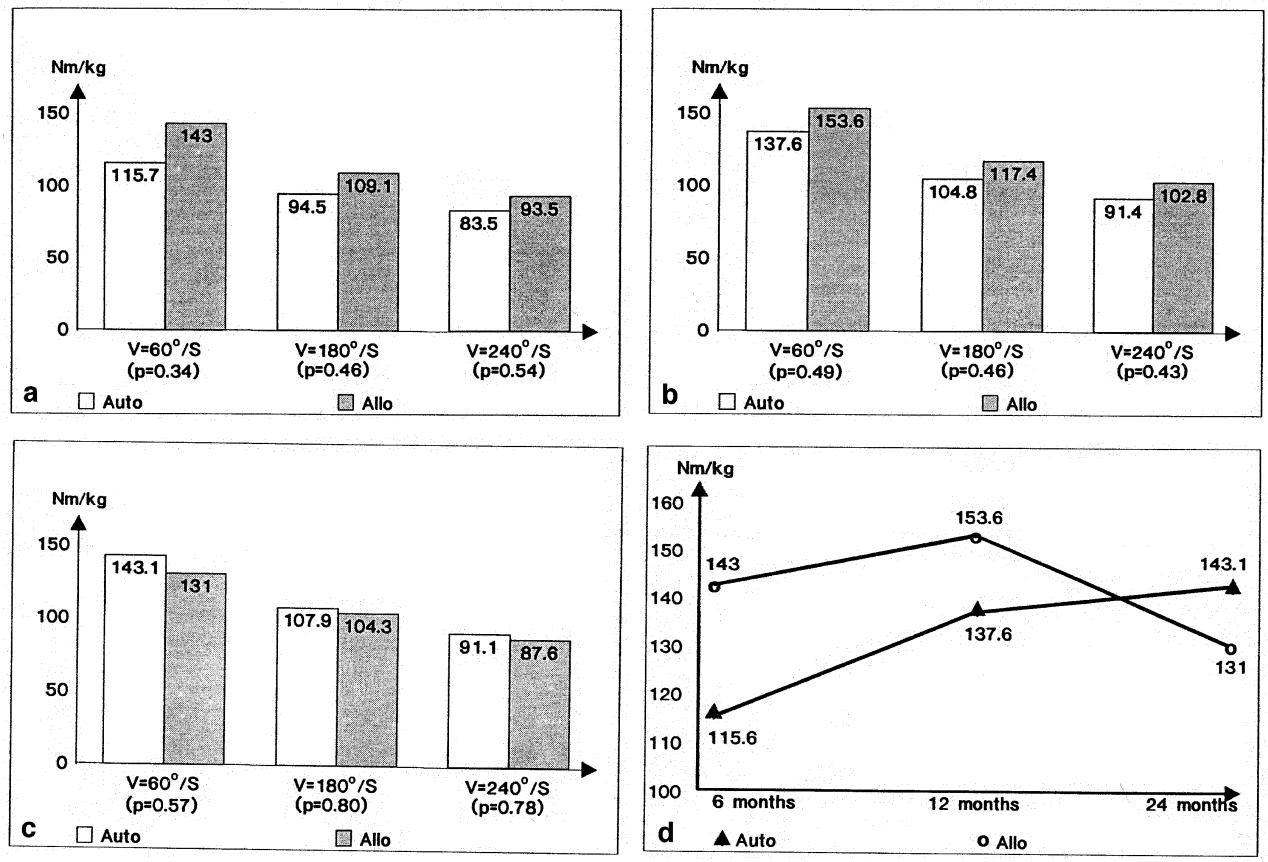

Fig. 1 a–d. Cybex measurement of quadriceps strength. Body weight ratio (Nm/kg) at 60°, 180° and 240°. **a** Results at 6 months. **b** Results at 12 months. **c** Results at 24 months. **d** Evolution of isokinetic strength at v = 60° in the autografts and allografts; this is not statistically significant

The Kujala patellofemoral score (maximum 100) was 91.6 for autografts and 87.8 for allografts, but the difference was not significant ($P = 0.39$). Twenty patients with autografts and 10 with allografts had transient anterior knee pain.

The functional scores were 4.75 (Tegner) and 92.6 (Lysholm) for the autografts and 4.41 and 85.4 for the allografts. The difference was not significant ($P = 0.5$ and $P = 0.27$ respectively).

The hop test performance was 93.3% for the autografts and 91.2% for the allografts ($P = 0.41$).

No patient had swelling of the affected knee joint. Rupture of the allograft occurred in 3 patients between 18 and 24 months following minor trauma.

There was no significant difference between the thigh measurements 15 cm proximal to the patella at 12 and 24 months after operation in both groups. Flexion, measured lying on the back, was full in every patient, but a slight difference was noted when squatting. Extension was also full.

Return to sport was as follows: no more sport – 5 (3 allografts, 2 autografts); at a lower level than before – 7 (1 allograft, 6 autografts); to the same level – 61 (21 allografts, 40 autografts). Full giving way occurred with the 3 ruptured allografts.

Discussion

Factors to be considered in choosing a graft for intra-articular ACL reconstruction are the initial strength of the graft, the rate of revascularisation, initial fixation, the morbidity of harvesting the graft, and the risk of infection. The ultimate goal is a return to normal function of the injured limb so that any disability caused by taking the graft is important. Athletes will suffer from any loss of movement, muscle strength and proprioception. Some consider that the use of the central third of the patellar tendon leads to troublesome sequelae [18, 19, 21, 23]. Rosenberg et al. state that this may lead to permanent quadriceps weakness, functional

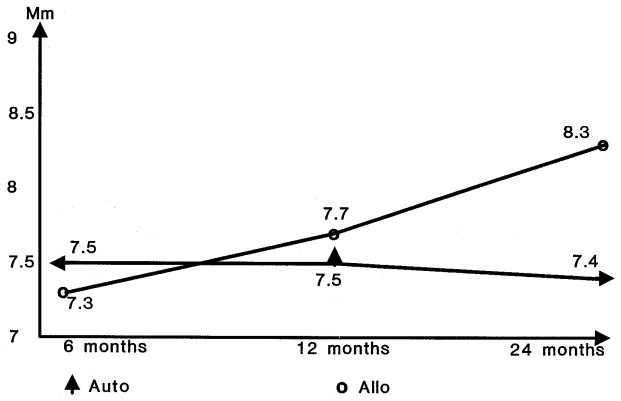

Fig. 2. KT-1000 anterior laxity measurements (20 lbs) showing a trend towards increasing laxity in the allograft group which is not statistically significant

defects, patellar chondrosis and pain [19]. In his study of only ten, mostly female, patients, there was no control group and most also had a simultaneous extra-articular procedure, so that it is not clear that the reported complications were due to using the central part of the tendon.

We aimed to detect the negative effects of using the central part of the patellar tendon, and the allografts served as a control group with an identical operative procedure except for taking the graft by the same surgeon, and an identical rehabilitation programme.

Measurements of the quadriceps function showed a nonsignificant trend towards faster recovery in the allograft group. However, at 24 months, the autografts showed no quadriceps deficit compared to the allografts, the strength returning to the same level as preoperatively. Others have indicated a difference in quadriceps strength between autografts and allografts at 6, 12 and 24 months respectively [8, 21, 25]. The studies with the shortest follow up have the worst results for quadriceps power in the autografts. Lephart et al. considered that this difference in measured strength can be caused by different times of follow up or different rehabilitation [13]. In the series of Sachs et al, for example, the patients were treated by cast immobilisation in 30° of flexion and then by a range-of-motion brace with a 30° extension stop for 3 to 5 weeks [21]. Lephart et al. [13] had similar data to ours with regard to quadriceps strength and stressed that their good results were related to the high competitive level of their patients (Tegner 7.4). This was not the case with our patients suggesting that quadriceps recovery in the autografts was due to aggressive and rapid rehabilitation with adequate follow up.

Three graft failures occurred in our allograft group and stability deteriorated slightly at the end of 24 months in the whole of this group, although this was not statistically significant. Re-rupture suggests that some allografts may not revascularise and might act as passive restraints until they fail from fatigue and abrasion. Sequential biopsies in humans appear to show delay in tissue maturation compared to autografts [7].

We found no difference in anterior knee pain between the two groups, and the Kujala score was good at final follow-up. Kneeling was difficult in most autograft patients because of tenderness over the tibial tuberosity but this was not reflected in the scores.

Our results show that using the central one third of the patellar tendon does not cause harmful long-term effects on the extensor mechanism in most patients. Rapid rehabilitation is the key factor in recovery of knee function. The functional results at 24 months do not favour the use of allografts, although they do avoid tenderness over the tuberosity.

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