

Comparing 2-year outcomes of anterior cruciate ligament reconstruction using either patella-tendon or semitendinosus-tendon autografts: A non-randomised prospective study

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ABSTRACT

Purpose. To compare the results of anterior cruciate ligament (ACL) reconstructions using either a patella-tendon autograft or a semitendinosus-tendon autograft.

Methods. Based on surgeon experience and preference, 68 patients underwent ACL reconstruction using either a quadruple-strand semitendinosus autograft (n=34) or a central one-third bone-patella tendon-bone autograft (n=34). Each patient was assessed preoperatively and postoperatively at 3, 6, and 24 months using the International Knee Documentation Committee (IKDC) knee score, Biodex muscle strength and endurance testing, and the KT1000 instrumented arthrometer test of knee laxity to anterior translation. All assessments at the 2-year follow-up were performed by the same physician and physiotherapist.

Results. While ACL reconstruction improved knee stability and IKDC knee scores significantly, there was

no statistically significant difference between semitendinosus- and patella-tendon autograft reconstructions in terms of long-term knee score or laxity to anterior translation. Semitendinosus graft reconstruction was associated with less donor-site morbidity and hamstring weakness. Meniscectomy was associated with poorer long-term knee scores.

Conclusion. ACL reconstruction is associated with a significantly better IKDC knee score and laxity measurement at 2-year follow-up. However, we were unable to demonstrate a significantly better long-term outcome in knee score or laxity to anterior translation with either a patella-tendon autograft or a semitendinosus-tendon autograft.

Key words: anterior cruciate ligament; knee injuries; menisci; tibial; tendons; transplantation, autologous

INTRODUCTION

The anterior cruciate ligament (ACL) is the knee's

primary stabiliser against anterior translation and is important in counteracting rotational and valgus stresses.¹⁻³ After ACL injury, most patients experience recurrent episodes of instability, pain, effusion, and decreased function.⁴

Although some authors claim that there is a greater incidence of arthrosis of the knee following surgical treatment,⁵ reconstruction of the ACL allows the patient to resume sporting activities and delays the onset of osteoarthritis, which is associated with loss of meniscal function.⁶⁻¹¹

Reconstruction of the ACL-deficient knee is widely accepted as the therapy of choice for young and active patients. Proponents of the various reconstructive techniques believe that reconstruction of the ACL-deficient knee is essential to restore knee-joint stability.¹² Although several studies have published long-term results of ACL reconstructions, the outcomes reported have not consistently demonstrated the superiority of one technique over another. Furthermore, no previous studies have focused on Asian patients.

MATERIALS AND METHODS

In 2000, we designed a prospective, non-randomised study to compare the 2 methods of ACL reconstruction: patella-tendon autograft and semitendinosus-tendon autograft. The 68 patients (4 women and 64 men) aged between 16 and 40 years (mean, 27.3 years) who underwent ACL surgery between April and September 2000 in Singapore General Hospital were followed up prospectively for a mean of 27 months (minimum, 24 months). Half (n=34) underwent a quadruple-strand semitendinosus autograft, the remaining 34 were treated with a central one-third bone-patella tendon-bone autograft. The choice of graft for each patient was based on surgeon experience and preference.

Preoperative inclusion criteria were willingness to participate in the trial and follow-up, no prior knee surgery, normal contralateral knee, no evidence of osteoarthritis in either knee, absence of significant injury to other ligament structures, aged less than 50 years, a history of knee injury, and clinical evaluation by the surgeon including laxity assessment by Lachman's test. The time between injury and surgery ranged from 3 weeks to 35 months (median, 15 months).

Patella-tendon reconstruction was performed using an endoscopic technique. The middle third of the patella tendon (9–12 mm in diameter) was harvested with 25 mm to 30 mm of bone from the patella and tibial tubercle. A hole was drilled from the

anteromedial aspect of the tibia, entering the joint at the posterior aspect of the ACL footprint. The isometric point on the lateral femoral condyle was determined using an isometer, and a femoral tunnel was drilled. After reaming with an appropriately sized reamer, the tibial bone plug was pushed through the tibial hole into the femoral hole and secured with an interference screw. After impingement was excluded by range of motion manoeuvres, the knee was flexed 10 degrees. The graft was secured with an interference screw under 6.8 kg of tension. After manual laxity was evaluated, the patella tendon, paratenon, subcutaneous tissue, and skin were closed.

Semitendinosus-tendon reconstruction was performed with a 3-cm longitudinal incision made over the pes anserinus insertion. The semitendinosus tendon was dissected free in the distal thigh and divided at the musculotendinous junction. A whip stitch of number 5 Ethibond (Ethicon, New Jersey, US) was sutured to the tendon ends and the graft was quadrupled. If there was insufficient length, the gracilis was also harvested. Whenever possible, the sartorius fascia was repaired after harvesting of the graft. Femoral and tibial tunnels were drilled as described above. The graft was secured on the femoral end with a closed-loop EndoButton (Smith and Nephew, Memphis [TN], US) and on the tibial end with sutures tied to a screw post under approximately 6.8 kg of tension at 10 degrees of flexion. The skin was closed after manual evaluation of laxity.

Meniscal integrity was assessed intra-operatively. Partial meniscectomy was performed when the meniscal lesions were deemed irreparable; these included degenerate tears, tears in the avascular region of the meniscus, complex tears, and radial tears. Meniscal repair was performed for fresh lesions and those involving the vascular region or non-degenerative longitudinal tears. Repair methods included all-inside and inside-out techniques.

Postoperative rehabilitation consisted of a combination of open-chain and closed-chain exercises. The protocol included knee flexion and extension exercises using free weights, along with steps and squats for quadriceps and hamstring strengthening. The patients were seen by the physiotherapist weekly for 3 months, then fortnightly for 3 months, and monthly thereafter.

Each patient was assessed preoperatively and postoperatively at 3, 6, and 24 months using the International Knee Documentation Committee (IKDC) knee score, Biodex muscle strength and endurance testing, and the KT1000 instrumented arthrometer test of knee laxity to anterior translation to compare side-to-side difference. All 2-year follow-up assessments

Table 1
Comparison of laxity to anterior translation between the 2 groups at 2-year follow-up

	Patella-tendon autograft (n=17)	Semitendinosus-tendon autograft (n=15)
Mean laxity (mm)	2.52	3.26
Patients with <3 mm anteroposterior translation	9 (52.9%)	6 (40.0%)
Patients with <5 mm anteroposterior translation	13 (76.5%)	13 (86.7%)

Table 2
Comparison of IKDC* scores between the 2 groups at 2-year follow-up

	Patella-tendon autograft (n=17)	Semitendinosus-tendon autograft (n=15)
Patients with good-to-excellent scores (grade A or B)	8 (47%)	9 (60%)
Patients with poor scores (grade C or D)	9 (53%)	6 (40%)

* International Knee Documentation Committee

were performed by the same physician and physiotherapist. Patients who were unable to return for the 2-year follow-up were contacted by telephone to assess symptoms and level of satisfaction with reconstruction using the IKDC subjective assessment questionnaire.

The IKDC standard evaluation form for knee assessment has been shown to be a reliable and valid knee-specific measurement of symptoms, function, and sports activity.^{13,14} It involves 8 groups of parameters that assess knee function, including subjective patient assessment, symptoms, range of motion, ligament function, compartment findings, harvest-site pathology, radiographic findings, and functional testing. A final grade of A, B, C, or D is obtained, for which A and B are designated as excellent and good outcomes and C and D as poor.

The Biodex dynamometer assesses hamstring strength and endurance using constant tension isokinetic contractions of the muscle at 60 degrees per second for strength assessment and 240 degrees per second for endurance assessment. Values for each leg were obtained to compare the treated and uninjured legs. The values were presented as percentages of the uninjured leg.

The KT1000 arthrometer measures the degree of anterior translation of the tibia at 30 degrees of flexion at 89 N and 134 N. Treated and uninjured knees are compared, and a difference of less than 5 mm is considered normal or near normal.^{13,15,16}

Patients were contacted for evaluation by telephone or mail at postoperative 3, 6, and 24 months. A final evaluation was performed at least 24 months (mean, 27 months) postoperatively. At 3 months, 27

patients were available for follow-up, 22 patients at 6 months, and 32 patients at 24 months. Parameters assessed at follow-up included the IKDC knee score, laxity to anterior knee translation, effect of meniscectomy on IKDC knee score, extent of donor-site morbidity, and quadriceps and hamstring strength and endurance. Patients who were unwilling or unable to return for evaluation were interviewed by telephone using the subjective component of the IKDC knee assessment.

RESULTS

Of the 64 patients, 8 suffered subsequent retearing of the reconstructed ACL: 6 by a fall during normal, non-sporting activities, and 2 during sporting activities (one before and one after the completion of rehabilitation). Five patients injured the contralateral ACL during sporting activities after rehabilitation had been completed, precluding meaningful evaluation by KT1000 arthrometer assessment. Eventually, 32 patients were available for 24-month evaluation: 17 and 15 having undergone patella-tendon and semitendinosus reconstruction, respectively.

At the preoperative assessment, all patients had laxity to anterior translation—a side-to-side difference of ≥ 5 mm—by KT1000 arthrometry. An IKDC score of poor was obtained in 99% of patients. Postoperatively, the patients in both groups showed significant improvements in both knee laxity to anterior translation and IKDC score ($p < 0.01$).

At 2-year follow-up, 13 (86.7%) of the 15 patients who had undergone semitendinosus reconstruction

Table 3
Comparison of knee function between the 2 groups using the subjective component of IKDC* questionnaire at 2-year follow-up by telephone interview

	Patella-tendon autograft	Semitendinosus-tendon autograft
Patients contacted	25	21
Patients reporting anterior knee pain	8 (32%)	3 (14%)
Patients with IKDC subjective scores of grade A or B (who did not return for physical evaluation)	6/8 (75%)	5/6 (83%)

* International Knee Documentation Committee

Table 4
Comparison of knee laxity (<5 mm anterior translation) between the 2 groups at postoperative 3, 6, and 24 months

Postoperative time	% of patients with <5 mm anterior knee translation	
	Patella-tendon autograft	Semitendinosus-tendon autograft
3 months	86.7%	58.3%
6 months	71.4%	75.0%
24 months	76.5%	86.7%

demonstrated normal or near-normal laxity at 134 N, compared with 13 (76.5 %) of the 17 patients who had undergone reconstruction by patella-tendon autograft (Table 1). This difference was not statistically significant by Fisher's exact test ($p > 0.05$).

According to the IKDC score, 9 (60%) of the 15 patients in the semitendinosus group demonstrated good-to-excellent results, whereas 8 (47.1%) of the 17 patients in the patella-tendon group showed good-to-excellent results (Table 2). Again, the difference was not statistically significant by Fisher's exact test ($p > 0.05$).

Telephone interviews of those patients who declined to return for assessment, using the subjective component of the IKDC score, revealed a higher level of satisfaction in these patients than in those who returned for assessment. Five (83%) of the 6 patients in the semitendinosus group and 6 (75%) of the 8 patients in the patella-tendon group indicated good-to-excellent outcome scores (grade A or B) on the subjective component of the IKDC questionnaire (Table 3). Based on the telephone interviews and clinical assessments, 8 (32%) of the 25 patients who had been treated with patella-tendon autograft reconstructions had anterior knee pain, compared with 3 (14%) of the 21 patients who had undergone semitendinosus autograft reconstructions.

Of the 32 patients who returned for 2-year follow-up, 19 (59%) had been treated with partial meniscectomy. 11 (58%) of these 19 patients scored poorly on the IKDC evaluation, compared with

4 (31%) of the 13 patients who had not undergone meniscectomy.

At postoperative 3 months, a larger percentage of patients who had been treated with patella-tendon autograft reconstructions showed knee stability than those who had undergone semitendinosus autograft reconstruction (86.7% versus 58.3%, respectively), but this trend was reversed at 2-year follow-up (76.5% versus 86.7%, respectively), as shown in Table 4.

Comparison of preoperative and 2-year postoperative Biodex strength and endurance testing between both groups is shown in Table 5. Both groups reported a trend towards improvement of quadriceps strength and endurance over the span of 2 years. However, a trend towards weakness of the hamstring muscles was reported in the semitendinosus group.

DISCUSSION

Compared with preoperative values, ACL reconstruction led to significantly better outcomes in terms of IKDC knee score and laxity to anterior translation, both in the long term and short term ($p < 0.01$).

Long-term outcome studies of ACL reconstruction have been reported previously by other authors. In 1994, Daniel et al.⁵ reported a side-to-side laxity of <3 mm at 134 N force of translation in 45% to 49% of patients who had undergone ACL reconstruction following injury (with no mention of which specific

Table 5
Comparison of preoperative and 2-year postoperative Biodex muscle strength assessments of treated and uninjured legs between the 2 groups

	2-year postoperative median value		% change of median values from preoperative to 2-year postoperative	
	Patella-tendon autograft	Semitendinosus-tendon autograft	Patella-tendon autograft	Semitendinosus-tendon autograft
Quadriceps strength (% of normal leg)	87.1	88.5	9.7	8.8
Quadriceps endurance (% of normal leg)	86.4	91.8	1.6	7.4
Hamstring strength (% of normal leg)	95.2	79.4	-3.3	-6.92
Hamstring endurance (% of normal leg)	95.2	87.7	5.5	-0.21

type of graft had been used) at a mean follow-up of 64 months. Our data, at a mean follow-up of 27 months, revealed a side-to-side laxity of <3 mm in 52.9% of patients in the patella-tendon group and 40% in the semitendinosus group.

In 1999, Jomha et al.³ conducted a retrospective study of 59 patients treated with ACL reconstruction using patella-tendon autografts and assessing knee function and IKDC score at 7-year follow-up. Their study revealed a side-to-side difference of <5 mm at 89 N in 97.8% of patients, whereas our study showed a side-to-side difference of <5 mm at 89 N in 78.0% of the patella-tendon group. They also reported good-to-excellent IKDC scores in 76.3% of patients who had undergone patella-tendon reconstructions, whereas our series reported good-to-excellent scores in 47.1% of the patella-tendon group at 27 months.

In 2002, Shaieb et al.¹⁷ reported that 88% of patella-tendon reconstructions and 86% of semitendinosus reconstructions had a laxity of <5 mm (force magnitude of the anterior drawer was not mentioned), based on the results of 33-month follow-up of 46 patients. In our study, 76.4% of patella-tendon reconstructions and 86.7% of semitendinosus reconstructions had a laxity of <5 mm at a force of 134 N.

Our data suggest that in the initial postoperative 3-month period, patella-tendon autografts fare better by degree of ligament laxity and IKDC knee score; this trend is reversed at 2 years, when semitendinosus autograft reconstruction demonstrates moderately better results than patella-tendon autograft reconstruction by degree of ligament laxity and IKDC score (Figs. 1 and 2). These differences were not statistically significant because of the small number of patients.

The effect of meniscectomy also appears to have a negative impact on the outcome of reconstruction. Of the 19 patients in our 2-year cohort who were treated with meniscectomy, 11 (58%) scored poorly by IKDC evaluation, compared with 4 (31%) of the 13 patients who did not undergo meniscectomy. Because meniscectomy was performed on patients who had complex tears and lesions when repair was not deemed feasible, our high rate of meniscectomy may be a reflection of severe injury in a large proportion of our patients. This may also explain why our overall outcome is inferior to that of other studies.

Comparing the IKDC score with objective measurement of ligament laxity, we noted a discrepancy in the outcomes: only 47% to 60% had good-to-excellent knee scores on IKDC assessment, whereas objective instrumented laxity showed normal or near-normal anterior translation in 76% to 86% of cases. Our cohort of patients also had lower IKDC scores than those reported by other authors.³ A possible reason for this discrepancy is that a higher proportion of patients who underwent meniscectomy (59%) returned for 2-year follow-up compared with the study population (46%), indicating that the returning patients had more severe knee injury with additional damage to other structures in the knee. Furthermore, the median time from injury to surgery was 15 months, which was long compared with other studies.^{3,5,17} This would have selected for patients who had failed conservative therapy for ACL insufficiency and patients who were more likely to have significant instability with concomitant chronic meniscal injury. Telephone interviews of patients who declined follow-up at 2 years also revealed a higher rate of satisfaction with surgery (75%–83%) compared with those who

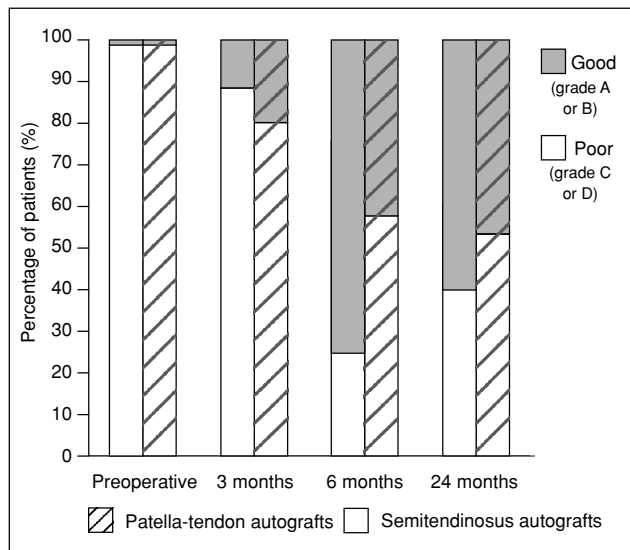


Figure 1 Comparison of preoperative to 2-year postoperative International Knee Documentation Committee (IKDC) scores between the 2 groups.

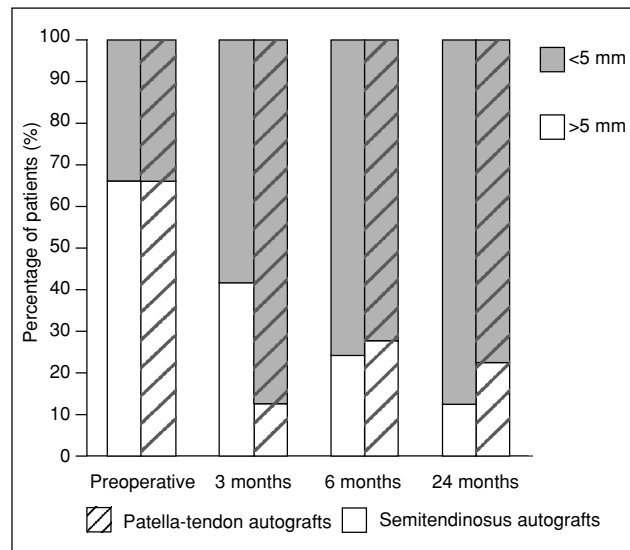


Figure 2 Comparison of preoperative to 2-year postoperative degree of ligament laxity to anterior translation of the tibia between the 2 groups.

returned for follow-up assessment (58.8%–73.3%). This further reinforces the possibility that patients who returned for follow-up represented a subgroup that was generally more dissatisfied with the outcome of the surgery. This may underestimate the efficacy of treatment in our study population.

EndoButton fixation was performed on the femoral side and screw-post fixation on the tibial side in semitendinosus reconstructions of the ACL. There have been reports that this leads to significant tunnel widening^{18,19}; however, we concurred with Ma et al.¹⁹ that this did not confer a statistically significant disadvantage in knee laxity and IKDC score when compared with rigid aperture fixation, which was performed for patella-tendon autografts. This was further evidenced by the patients in the semitendinosus group having less anterior translation compared with the patella-tendon group. We are unable to comment on the presence of tunnel widening in our series as it was not our aim to assess this effect, and radiographs of the knee were not routinely taken after the first postoperative consultation if recovery was uneventful.

Regarding the issue of weaker hamstring strength and endurance at 2 years compared with preoperative values in patients treated with hamstring graft reconstructions, we went a step further to evaluate whether the weakness was more marked in patients who had both the semitendinosus

and gracilis tendons harvested. Of the 15 patients who underwent hamstring graft reconstruction, 9 required semitendinosus-only autografts, whereas 6 had both semitendinosus and gracilis tendons harvested. Comparisons of hamstring strength and endurance at postoperative 2 years with preoperative values revealed that the patients who had semitendinosus-only reconstructions were weaker at postoperative 2 years than preoperatively by a median of -12.5% (mean, -11.8%). Contrary to what we expected, patients who had both semitendinosus and gracilis graft reconstruction showed an improvement in strength by a median of 3.6% (mean, 7.0%) [Table 6]. The difference was not statistically significant. One possibility for this apparently conflicting result could be the disparity in the time from injury to surgery between the semitendinosus-only group (mean, 21.7 months) and the semitendinosus and gracilis group (mean, 10.4 months). The occurrence of partial meniscectomy was distributed similarly in both groups, with 5 (55.6%) of 9 patients in the semitendinosus group and 3 (50%) of 6 patients in the semitendinosus and gracilis group. This might dismiss meniscectomy as a reason for the disparity of results. A larger series of patients controlling for other factors may reveal the true effect of harvesting both semitendinosus and gracilis tendons on subsequent hamstring strength and endurance.

Table 6
Comparison of preoperative and 2-year postoperative hamstring strength and endurance between semitendinosus-only autograft harvesting and both semitendinosus and gracilis autograft harvesting

	2-year postoperative median value		% change of median values from preoperative to 2-year postoperative	
	Semitendinosus-only autograft (n=9)	Semitendinosus and gracilis autograft (n=6)	Semitendinosus-only autograft (n=9)	Semitendinosus and gracilis autograft (n=6)
Hamstring strength (% of normal leg)	79.4	88.7	-12.5	3.6
Hamstring endurance (% of normal leg)	87.7	90.5	-2.2	5.9

CONCLUSION

Reconstruction of the ACL is associated with a significantly better outcome at 2 years in terms of IKDC knee score and instrumented measurement of laxity. However, we are unable to demonstrate a significantly better long-term outcome in knee score and laxity in anterior translation with either patella-

tendon or semitendinosus-tendon autograft. Donor-site morbidity is less with semitendinosus reconstruction, and there is a trend toward weaker hamstring strength and endurance in patients undergoing semitendinosus-only reconstruction compared with those undergoing both semitendinosus and gracilis tendon autografts. Meniscectomy correlated with poorer knee score.

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