

Tripled semitendinosus anterior cruciate ligament reconstruction with Endobutton fixation

A 2–3-year follow-up study of 35 patients

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Submitted 99-11-21. Accepted 00-03-07

ABSTRACT – We evaluated the clinical outcome of tripled semitendinosus tendon ACL reconstruction with femoral Endobutton (Acufex, Smith&Nephew, Andover, MA) and tibial Suture Washer (Acufex, Smith&Nephew, Andover, MA) (n 29) or post screw fixation (n 6) in 35 patients on an average of 28 (20–37) months after surgery. On the basis of IKDC criteria, 22 patients showed a normal or nearly normal knee function and 25 patients had a KT 1000 maximal manual side-to-side difference of ≤ 5 mm at follow-up. Subjectively, 28 patients graded their knee function as normal or nearly normal. The average Lysholm score was 88 points, average OAK score 90 points and average modified HSS score 93 points. 19 patients reached their preinjury level of activity at follow-up. The postoperative Lachman test was $\leq 1+$ in 24 patients and 24 patients also showed an absent pivot shift. Significant bone tunnel enlargement occurred in 26 patients on the femoral side and in 23 patients on the tibial side. We found no correlation between bone tunnel enlargement and clinical outcome.

The clinical outcome of tripled semitendinosus tendon ACL reconstruction with Endobutton fixation on the femoral side was not entirely satisfactory. The procedure was associated with a high incidence of bone tunnel enlargement in this series.

even greater tensile strength than 10 mm patellar tendon grafts (Brown and Steiner 1994). In addition, hamstring tendon graft fixation, using soft tissue washers and screws, provides about the same fixation strength as patellar tendon graft fixation with interference screws (Steiner et al. 1994). With the use of hamstring tendons, the extensor mechanism is not affected and fewer patients complain about anterior knee pain (Rosenberg et al. 1992, Howell and Taylor 1996, Nebelung et al. 1998, Barber 1999).

A quick and easy method for femoral fixation of multistranded hamstring tendons is Endobutton fixation (Acufex, Smith&Nephew, Andover, MA). The Endobutton is placed at the outer femoral cortex and connected to the hamstring graft with tape (Rosenberg 1993, Barrett et al. 1995). Only limited data are available concerning the clinical outcome after ACL reconstruction and Endobutton fixation (Hoffmann et al. 1998, Nebelung et al. 1998, Jansson et al. 1999).

We report our experience using a three-stranded semitendinosus tendon autograft in arthroscopic ACL reconstruction with Endobutton fixation on the femoral side.

Patients and methods

During August 1995–November 1996, tripled semitendinosus tendon ACL reconstruction using femoral Endobutton fixation has been performed on 40 patients in our department. 35 patients (18

ACL reconstruction using autologous multistranded hamstring tendons has become popular (Howell and Taylor 1996, Maeda et al. 1996, Clark et al. 1998, Barber 1999). Mechanical tests of multistranded hamstring grafts have shown similar or

women) were followed-up after average of 28 (20–37) months. Their mean age was 31 (21–51) years. 30 patients had an acute ACL injury (mean time from injury to surgery 19 (2–90) days), whereas 5 patients suffered from chronic ACL insufficiency (mean time from injury to surgery 5 (0.5–10) years. 5 patients were lost to follow-up, 4 had moved and 1 could not be located. Patients with bilateral reconstructions, concomitant injuries of the posterior cruciate ligament or posterolateral structures, revision ACL reconstructions or combined high tibial osteotomy-ACL reconstructions were excluded. The presence of an associated tear of the medial collateral ligament was not a criterion for exclusion (n 4) and all MCL injuries were treated conservatively.

The evaluation of patients included a clinical assessment using the IKDC score, the Lysholm score (Lysholm and Gillquist 1982), the OAK score (Hefti et al. 1990), the Tegner score (Tegner and Lysholm 1985), the modified HSS score (Insall et al. 1976), KT 1000 arthrometer (Medmetric, San Diego, California) measurements and a radiographic assessment using anteroposterior, lateral and patellofemoral radiographs. The incidence of femoral and tibial bone tunnel enlargement was assessed by measuring the distance between the two sclerotic margins of the bone tunnel at its widest dimension perpendicular to the longitudinal axis of the bone tunnel using follow-up radiographs. The measured distance was corrected for magnification and compared with the original size of the bone tunnel (L'Insalata et al. 1997, Höher et al. 1998b). The difference was classified according to criteria recently described by Nebelung et al. (1998) (< 0.5 mm, no enlargement; 0.5–2 mm, questionable enlargement; 2.5–4.5 mm, clear enlargement; > 4.5 mm, massive enlargement).

The correlation between tunnel enlargement and clinical outcome parameters was assessed using Spearman's rank correlation. Statistical analysis was performed using the Mann-Whitney-Wilcoxon U-test. Differences were considered significant at the 0.05 level.

All patients underwent arthroscopy prior to ACL surgery to confirm complete ACL disruption and to treat associated injuries. We performed 3 meniscal repairs (3 × medial meniscus) and 8 par-

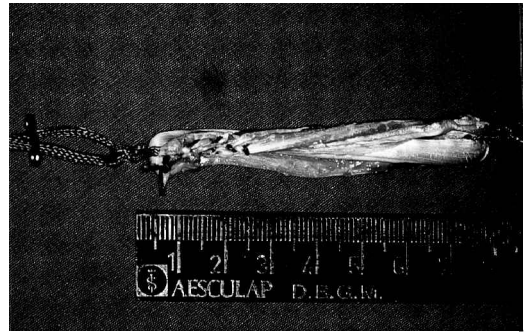


Figure 1. Tripled semitendinosus tendon graft prepared for femoral Endobutton fixation.

tial meniscectomies (5 × lateral meniscus, 3 × medial meniscus).

In all cases, we performed an arthroscopic ACL reconstruction using a tripled semitendinosus tendon graft. The semitendinosus tendon was harvested at its musculotendinous junction using a tendon stripper and armed on both ends with No. 2 Ethibond (Ethicon, Norderstedt, Germany) sutures. Both ends of the graft were connected to a 4 mm Mersilene tape (Ethicon, Norderstedt, Germany) by tying the Ethibond sutures. After looping the tendon graft 2 times, each Mersilene tape was passed through 1 of the loops. By tying the Mersilene tape on both sides, a three-stranded graft was created (Figure 1). We measured the graft size and, based on this size, a tibial drill hole was made entering the joint at the distal isometric point of the ACL, using a guided drilling device (Arthrex, Naples, Florida). The center of the femoral drill hole was positioned at the proximal isometric point of the ACL, using a transtibial femoral guide (Arthrex, Naples, Florida), and a femoral socket was created, using the transtibial femoral drilling technique. The depth of the femoral socket ranged from 25 mm to 35 mm depending on the total graft length. To allow the pullout of the Endobutton, the femoral socket was extended by a 4.5 mm drill hole through the femoral cortex. The length of the Mersilene tape was selected on the basis of the length of the femoral tunnel to connect the tendon graft with the Endobutton. After manual pre-tensioning, we inserted the graft from the tibia to the femur with the Endobutton leading. The Endobutton was flipped, reaching the outer femoral cortex, the graft was tensioned and the knee was moved several times through a full range of motion. We

achieved tibial graft fixation by tying the distal Mersilene tape over a Suture Washer in full knee extension (29 patients). In 6 patients, we tied the distal Mersilene tape over a post screw because the hamstring graft exceeded the tibial bone tunnel.

Postoperatively, the patients were fitted with a functional derotation brace, which was fixed in 10 degrees of flexion for 3 days. During this period, we started physical therapy which included isometric muscle exercises. From day 4 until the end of the second week, range of motion was extended to full extension and 90° of flexion. 3–6 weeks after surgery, the brace was adjusted to a 0°–120° arc of motion and progressive weightbearing was begun. At the end of the 6th week, full weight-bearing was allowed and the brace was removed. Exercises such as cycling, swimming and jogging were started after 3–6 months, with gradual return to full sports activities after 9–12 months.

Results

28 patients considered their knee function as normal or nearly normal, whereas 22 patients had normal or nearly normal knee function, according to IKDC criteria (Table 1). The average Lysholm score was 88 (SD 13) points, the average OAK score 90 (SD 7) points and the average HSS score 93 ± 7 points.

Follow-up KT 1000 tests showed an average maximal manual side-to-side difference of 3.5 (SD 3.0) mm. Table 2 shows the KT 1000 results as well as the results of Lachman's knee ligament test and pivot-shift testing.

The evaluation of the level of activity using the Tegner score revealed that 19 patients regained their preinjury activity level (Table 3). The mean Tegner score decreased from 6.9 (SD 1.1) points prior to injury to 6.0 (SD 1.4) points at follow-up.

33 patients showed full knee extension and 30 patients showed full knee flexion at follow-up (Table 3). 26 patients had a significant femoral tunnel enlargement (definite or massive) and 23 patients showed a significant tibial tunnel enlargement on follow-up radiographs (Figure 2, Table 4). The tunnel diameter increased on average from 7.7 (SD 0.6) mm to 11 (SD 1.9) mm on the femo

Table 1. Results of IKDC score and related subjective assessment

Assessment		n
IKDC	A	1
	B	21
	C	12
	D	1
Subjective results	normal	11
	nearly normal	17
	abnormal	7
	severely abnormal	–

Table 2. Assessment of KT 1000 maximal manual test, Lachman test and pivot-shift

Assessment		n
KT 1000	≤ 3mm	16
	≤ 5mm	25
	> 5mm	10
Lachman test	negative	4
	1+	20
	2+	11
	3+	–
Pivot-shift	negative	24
	1+	9
	2+	2
	3+	–

Table 3. Assessment of Tegner score and motion

Assessment		n
Tegner points (preop.–postop.)	0	19
	1	4
	2	10
	3	2
	> 3	–
Extension deficit	0°	33
	5°	2
	10°	–
	20°	–
	> 20°	–
Flexion deficit	0°	30
	5°	2
	10°	2
	20°	1
	> 20°	–

Table 4. Assessment of tunnel enlargement

Tunnel enlargement	All patients (n 35)		Post screw fixation (n 6)	
	femoral	tibial	femoral	tibial
None (< 0.5mm)	3	2	1	–
Borderline (0.5–2 mm)	6	10	–	1
Definite (2.5–4.5 mm)	20	18	4	4
Massive (> 4.5 mm)	6	5	1	1

ral side and from 8.1 (SD 0.6) to 11.0 (SD 1.8) mm on the tibial side. There was no correlation between bone tunnel enlargement and IKDC scores ($r = -0.17$), OAK scores ($r = 0.054$), Lysholm scores ($r = -0.17$), modified HSS scores ($r = -0.13$), Tegner scores ($r = 0.041$), KT 1000 results ($r = -0.21$), range of motion ($r = -0.23$) or the pivot-shift test ($r = 0.17$).

We found no significant difference between tibial Suture Washer and post screw fixation according to the incidence of tibial ($p = 0.8$) or femoral ($p > 0.8$) tunnel enlargement, IKDC scores ($p > 0.8$), KT 1000 measurements ($p = 0.3$), Tegner scores ($p = 0.2$), range of motion ($p = 0.8$) or piv-

ot-shift testing ($p = 0.5$). In 2 patients with post screw fixation and in 3 patients with Suture Washer fixation, the material had to be removed because of persistent discomfort.

2 patients needed arthroscopic treatment because of limited motion 6 weeks after surgery. Both reached full knee extension and flexion at follow-up. There were no instances of septic arthritis, deep venous thrombosis, nerve or artery injury in this study group.

Discussion

There are many methods for fixation of multi-stranded hamstring grafts available in reconstructive ACL surgery (Rosenberg 1993, Steiner et al. 1994, Howell and Taylor 1996, Clark et al. 1998, Nebelung et al. 1998, Barber 1999). However, the most effective fixation method has not been determined.

In our study, we performed trippled semitendinosus ACL reconstruction with Endobutton fixation on the femoral side and Suture Washer/post screw fixation on the tibial side. Nebelung et al.



Figure 2. Radiographs 30 months after ACL reconstruction with definite tunnel enlargement on the tibial side and massive tunnel enlargement on the femoral side.

(1998) used the double semitendinosus ACL reconstruction also with femoral Endobutton fixation. They reported comparable IKDC scores (two thirds of patients normal or nearly normal), but found better KT 1000 values with maximal manual differences of ≤ 5 mm in 90% of patients. They gave no information about follow-up, Lysholm scores or results of the Lachman test or pivot-shift. Enlargement of the femoral bone tunnel was seen in our study and theirs in three quarters of the patients, but enlargement of the tibial tunnel appeared less often (one third) in their study than in the present one (66%). Nebelung et al. (1998) used staple fixation on the tibial side. However, we performed tibial fixation by tying a Mersilene tape over a Suture Washer or post screw. Höher et al. (1998a) showed that repetitive cyclic loading of a semitendinosus graft construct with Endobutton/tape and suture/post screw fixation resulted in a substantial, permanent elongation of the construct; 97% of the elongation occurred in the fixation materials and interfaces and only 3% in the tendon tissue. Therefore, the use of additional elastic fixation material on the tibial side might have led to increased instability and increased graft tunnel motion in the tibial bone tunnel.

The site of ACL graft fixation is critical. L'Insalata et al. (1997) found a significantly higher incidence of bone tunnel enlargement after ACL reconstruction, if the points of fixation were far from the anatomical insertion site of the ACL. Steiner et al. (1994) showed that hamstring graft constructs with a long fixation site distance have low stiffness. Ishibashi et al. (1997) reported that graft fixation near the natural insertion site of the ACL produced better knee stability than graft fixation far away from the anatomical location. Since Endobutton/tape, Suture Washer/tape and post screw/tape fixation lead to graft fixation far away from the anatomical insertion site of the ACL, this may have been the reason for reduced knee stability and bone tunnel enlargement in the present study.

Recently, hamstring fixation methods which provide graft fixation close to the anatomic insertion site of the ACL have been described. Barber (1999) performed tripled semitendinosus-cancellous bone ACL reconstruction using anatomic Bioscrew fixation and reported favorable clinical results with no evidence of bone tunnel enlarge-

ment. Clark et al. (1998) used a femoral cross-pin fixation technique and found normal or nearly normal knee function in nine tenths of their patients.

Besides the graft fixation method, the strength of the inserted graft seems to affect the outcome after hamstring ACL reconstruction. Hoffmann et al. (1998) found more favorable results using a four-stranded than using a two-stranded semitendinosus tendon graft. In a recent study, Jansson et al. (1999) reported good clinical outcome using a four-stranded semitendinosus/gracilis tendon graft with femoral Endobutton fixation in a small group of patients (n 14). However, bone tunnel enlargement occurred in all of their patients.

The etiology of bone tunnel enlargement is still unclear. Besides graft tunnel motion (Peyrache et al. 1996, L'Insalata et al. 1997, Höher et al. 1998b, Nebelung et al. 1998), other mechanical factors, such as local stress deprivation or increased graft forces due to improper graft placement and biological factors, such as a cytokine-mediated non-specific inflammatory response or cell necrosis from drilling (heat effect) or graft remodeling (avascularity) are discussed (Höher et al. 1998b, Clathworthy et al. 1999). Furthermore, the clinical relevance of bone tunnel enlargement has not been clearly defined. While some authors consider this phenomenon a serious complication and early sign of graft failure (Peyrache et al. 1996, Nebelung et al. 1998), others question the relevance of this phenomenon (Shino et al. 1986). As in many previous investigations (Peyrache et al. 1996, Nebelung et al. 1998, Clathworthy et al. 1999), we could not find a correlation between bone tunnel enlargement and clinical outcome.

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