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Comparative evaluation of knee stability following reconstruction of the anterior cruciate ligament with the bone–patellar tendon–bone and the double semitendinosus–gracilis methods: 1- and 2-year prospective study

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Abstract An account of a prospective study of anterior cruciate ligament reconstructions with the bone–patellar tendon–bone autograft (BPTB) and the doubled semitendinosus–gracilis autograft (ST–GR) is given in 39 patients and 22 patients, respectively. The BPTB patients were younger, and there were more women in the ST–GR group. There were no statistical differences in the clinical and instrumental evaluations of stability after 1 and 2 years (Lachman and Jerk test, KT1000) between the two groups. Slightly better results were obtained in the BPTB group: mean 0.80 and 0.96 (first and second years) versus 1.18 and 1.20. Both methods, in fact, resulted in very satisfactory anterior knee stability, even when applied in two dissimilar groups of patients.

Keywords Anterior cruciate ligament · Reconstruction · Bone–patellar tendon–bone · Hamstrings

Introduction

The bone–patellar tendon–bone autograft (BPTB) and the semitendinosus–gracilis autograft (ST–GR) are the most frequently grafts use for anterior cruciate ligament (ACL) reconstruction. Some surgeons use one graft, by the exclusion of the other, in their standard practice [17], whereas others use both, but with different indications.

Randomised studies suggest that both methods are equally valid [1–3, 8, 13, 19], though some reports have shown that the ST–GR is less effective, especially in competitive sportswomen [4–6, 10, 14, 21].

Over the last 3 years we have established clear indications for the use of these two methods at our sports traumatology and arthroscopic surgery centre, namely BPTB for young persons and sportspeople and ST–GR for older subjects or those less devoted to recreational sports.

This paper describes the outcome of a prospective study designed to show whether both methods, albeit applied in dissimilar groups of patients, would lead to comparable results in terms of subjective and objective stability alone.

Materials and methods

Sixty-one consecutive patients (40 males, 21 females: mean age 32), all engaged in competitive or recreational sports, were enrolled (Table 1). All the subjects did not show any previous knee pathology. They had been operated by the same surgeon and reviewed by another independent surgeon. The same endoscopic technique had been employed [18]. The only differences were between the type of graft and the femoral fixation.

In the BPTB group, the patellar tendon was fixed with two titanium or bioabsorbable interference screws (as requested by the patient). In the ST–GR group, the doubled tendons were fixed to the femur with two bioabsorbable cross-pins and to the tibia with a bioabsorbable screw.

Table 1 Number of patients, age and sex

	BPTB	ST–GR
No. of patients	39	22
Average age	23.5	40.1
Minimum age	16	21
Maximum age	40	61
Median age	29	41
Standard deviation	8.32	10.2
Male	33	7
Female	6	15

The rehabilitation programme was the same [20], the only difference being in the ROM completely regaining in 2 weeks in the BPTB group and in 3 weeks in the ST–GR group. This slight difference, in our opinion, is related to the difference in the type of biological material of the graft to be fixed: tendon or bone.

The components of the groups differed in age and sex according to our indications—namely BPTB: young persons preferably male and/or competitive sportspeople; ST–GR: older patients, preferably female and/or recreational sportspeople. The BPTB group, in fact, comprised more young persons and more males (Table 1). Only two subjects in this group (recreational, but competitive football players) were over 40, whereas in the ST–GR group six were under 30.

These were three patients not engaged in contact sports (cycling, swimming) and three selected for BPTB reconstruction, but modified intraoperatively due to the discovery of third-degree patellar chondropathy (one was a female professional volleyball player).

The concomitant lesions treated surgically are set out in Table 2. All subjects came in for a clinical stability after 1, 3, 6, 12 and 24 months and a KT1000 side-to-side examination at maximum manual force [7] after 6, 12 and 24 months (by which time a patient should have already resumed every type of activity). ROM was measured with a goniometer.

One BPTB patient was not examined after 2 years because his ACL graft had a tear for a new trauma during a game of basketball at 15 months. He was therefore reoperated with ST–GR and not included in the 2-year follow-up group. Side-to-side KT1000 was used for objective evaluation of the anterior stability of the operated knee. Statistics were obtained with the analysis of variance and the Wilcoxon paired rank test.

Table 2 Associated treated lesions

	BPTB	ST–GR
Isolated ACL reconstruction	21	6
Plus medial partial meniscectomy	8	6
Plus lateral partial meniscectomy	2	1
Plus medial and lateral partial meniscectomy	3	4
Plus medial meniscal suture	2	3
Plus microfractures	1	1
No. of patients	39	22

Table 3 KT1000 results in the two groups (in millimetres)

	BPTB	ST–GR
1 year min.	−3	−3
1 year max.	3	4
1 year average	0.80	1.18
2 years min.	−1	−1
2 years max.	3	4
2 years average	0.96	1.20

Results

After 1 year, all patients had resumed sport at the same level as before the trauma and were satisfied with their results. ROM had been completely recovered, except by one BPTB subject with a 3° limitation of extension; this was subsequently treated by arthroscopic cleaning of a "cyclops syndrome" (due to a graft hypertrophy) [12].

The KT1000 side-to-side results after 1 and 2 years are illustrated in Table. 3, 4; Figs. 1, 2, 3, and 4. Clinical evaluation of stability (Lachman and Jerk tests) is illustrated in Table 5.

There were no between-group differences in concomitant disorders. Anterior knee pain was sporadic in

Table 4 Detailed KT1000 results in the two groups at 1 and 2 years

Millimetres	1 year		2 years	
	BPTB # (%)	ST–GR # (%)	BPTB # (%)	ST–GR # (%)
−3/0	13 (33.3)	5 (22.8)	12 (31.6)	6 (27.2)
0.5/2.5	25 (64.1)	15 (68.2)	24 (63.2)	13 (59.1)
3	1 (2.6)	1 (4.5)	2[a] (5.2)	2 (9.1)
4		1 (4.5)		1 (4.5)

[a]Plus one failure after a new trauma at 15 months

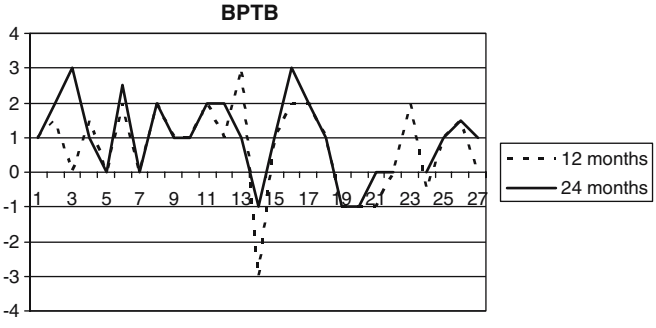

Fig. 1 Graphic of the KT1000 results in the BPTB group

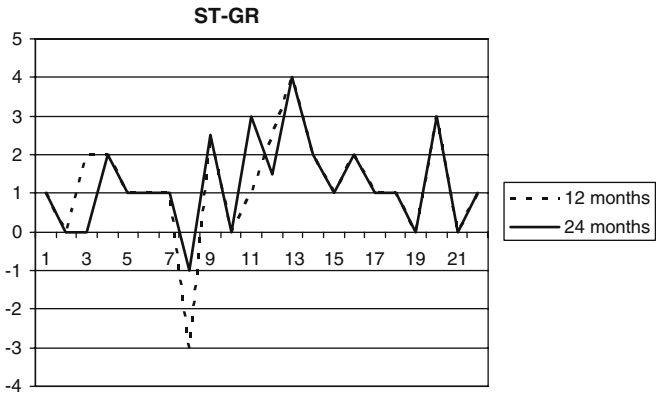

Fig. 2 Graphic of the KT1000 results in the ST–GR group

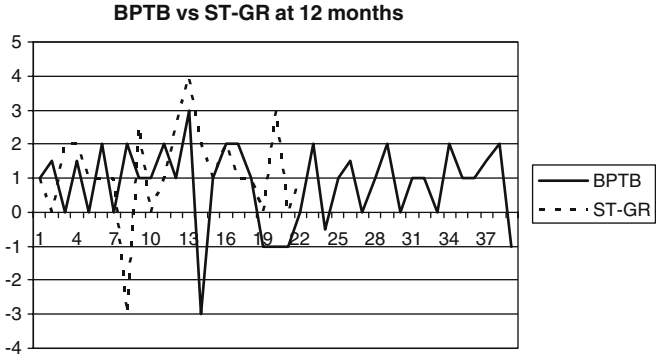

Fig. 3 Graphic of the KT1000 results in the compared two groups at 1 year

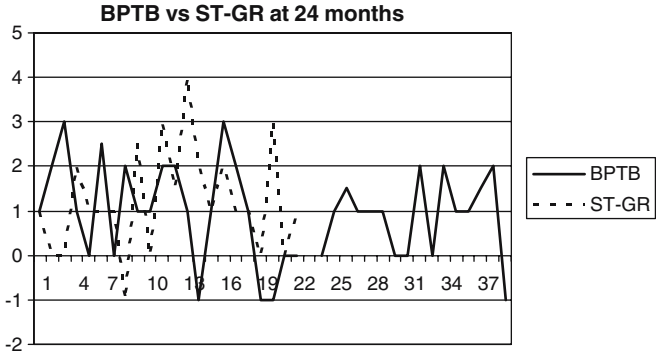

Fig. 4 Graphic of the KT1000 results in the compared two groups at 2 year

both groups. It was always intermittent only and mostly in relation to the lower muscle tone with respect to the type of graft employed [3, 4, 11, 19, 21].

The KT1000 statistics in the BPTB group for the first year (mean 0.80) and the second year (mean 0.96) were not significantly different, and the same was true for the ST–GR group (1.18 and 1.20, respectively) (Figs. 3, 4). There were also no statistical differences between the results for the two groups, though the absolute values were slightly higher in the BPTB group (Table. 3, 4) (Figs. 1, 2, 3, 4).

Two patients, one in each group, had a constrained knee (-3 mm at the KT1000 side-to-side evaluation) without any symptom (Figs. 1, 2).

Table 5 Clinical test results in the two groups at 1 and 2 years

	1 year		2 years	
	BPTB	ST–GR	BPTB	ST–GR
Lachman−	29	14	27	14
Lachman + firm	10	7	10	6
Lachman + soft		1	2	2
Jerk−	39	21	38[a]	21
Jerk + mild		1		1

[a]Plus one failure after a new trauma at 15 months

Discussion

As stated earlier, this study was designed to show whether the results of ACL reconstruction with different types of graft in two dissimilar groups of patients were comparable in terms of stability. In effect, the results were similar, though there was a slight, nonsignificant shift in stability in favour of the BPTB method. The KT1000 mean values at 1 and 2 years, in fact, were 0.80 and 0.96 for the BPTB group versus 1.18 and 1.20 for the ST–GR group, respectively. Subjects with a 3–4 mm side-to-side difference were 5% in the BPTB group versus 12% in the ST–GR group.

Generally speaking, therefore, our results were excellent in terms of stability and recovery of knee function. Stress may also be laid on the fact that a different choice of graft in two groups dissimilar in age and sex nonetheless led to superposable results.

Selection of the ST–GR method with its lower postopeartive morbidity proved well indicated for non-competitive sportspeople and recreational sportswomen. Selection of the BPTB method, undoubtedly "more weighty" in terms of rehabilitation, produced slightly better results in terms of stability, taking into account also the fact that it benefited sportspersons at a greater competitive risk.

Our indications, not supported in the past by objective results such as those provided by the KT1000, have proved indisputably appropriate to the type of patient we have to treat. Provision via the same surgical technique of a type of treatment differed for every patient; "à la carte" as this is usually described, turned out to be suitable for the needs of both the patient and the surgeon.

References

1. Aglietti P, Buzzi R, Zaccherotti G, De Biase P (1994) Patellar tendon versus doubled semitendinousus and gracilis tendons for anterior cruciate ligament reconstruction. Am J Sports Med 22:211–218
2. Aglietti P, Giron F, Buzzi R, Biddau F, Sasso F (2004) Anterior cruciate ligament reconstruction: bone–patellar tendon–bone compared with double semitendinosus and gracilis tendon grafts: a prospective, randomized clinical trial. J Bone Joint Surg Am 86:2143–2155
3. Aune AK, Holm I, Risberg MA, Jensen HK, Steen H (2001) Four-strand hamstring tendon autograft compared with patellar tendon–bone autograft for anterior cruciate ligament reconstruction. A randomized study with two-year follow-up. Am J Sports Med 29: 722–728
4. Barrett GR, Noojin FK, Hartzog CW, Nash CR (2002) Reconstruction of the anterior cruciate ligament in females: a comparison of hamstring versus patellar tendon autograft. Arthroscopy 18: 46–54
5. Beynnon BD, Johnson RJ, Fleming BC, Kannus P, Kaplan M, Samani J, Renstrom P (2002) Anterior cruciate ligament replacement: comparison of bone–patellar tendon–bone grafts with two-strand hamstring grafts. A prospective, randomized study. J Bone Joint Surg Am 84:1503–1513
6. Corry IS, Webb JM, Clingeleffer AJ, Pinczewski LA (1999) Arthroscopic reconstruction of the anterior cruciate ligament. A comparison of patellar tendon autograft and four-strand hamstring tendon autograft. Am J Sports Med 27:444–454
7. Daniel DM, Malcom LL, Losse G, Stone ML, Sachs R, Burks R (1985) Instrumented measurement of anterior laxity of the knee. J Bone Joint Surg Am 67:720–726
8. Eriksson K, Anderberg P, Hamberg P, Lofgren AC, Bredenberg M, Westman I, Wredmark T (2001) A comparison of quadruple semitendinosus and patellar tendon grafts in reconstruction of the anterior cruciate ligament. J Bone Joint Surg Br 83:348–354
9. Ejerhed L, Kartus J, Sernert N, Köhler K, Karlsson J (2003) Patellar tendon or semitendinosus tendon autografts for anterior cruciate ligament reconstruction? A prospective randomized study with a two-year follow-up. Am J Sports Med 31:19–25
10. Feller JA, Webster KE (2003) A randomized comparison of patellar tendon and hamstring tendon anterior cruciate ligament reconstruction. Am J Sports Med 31:564–573
11. Freedman KB, D'Amato MJ, Nedeff DD, Kaz A, Bach BR (2003) Arthroscopic anterior cruciate ligament reconstruction: a metaanalysis comparing patellar tendon and hamstring tendon autografts. Am J Sports Med 31: 2–11
12. Jackson DW, Schaefer RK (1990) Cyclops syndrome: loss of extension following intrarticular anterior cruciate ligament reconstruction. Arthroscopy 6:171–175
13. Jansson KA, Linko E, Sandelin J, Harilainen A (2003) A prospective randomized study of patellar versus hamstring tendon autografts for anterior cruciate ligament reconstruction. Am J Sports Med 31:12–18
14. Noojin FK, Barrett GR, Hartzog CW, Nash CR (2000) Clinical comparison of intraarticular anterior cruciate ligament reconstruction using autogenous semitendinosus and gracilis tendons in men versus women. Am J Sports Med 28:783–789
15. O'Neill DB (1996) Arthroscopically assisted reconstruction of the anterior cruciate ligament. A prospective randomized analysis of three techniques. J Bone Joint Surg Am 78:803–813
16. Otero AL, Hutcheson L (1993) A comparison of the doubled semitendinosus/gracilis and central third patellar tendon autografts in arthroscopic anterior cruciate ligament reconstruction. Arthroscopy 9:143–148
17. Ott SM, Ireland ML, Ballantyne BT, Willson JD, McClay Davis IS (2003) Comparison of outcomes between males and females after anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc 11:75–80
18. Rosenberg TD (1991) Endoscopic technique for anterior cruciate ligament reconstruction with PRO-TAC tibial guide. Acufex Microsurgery Technical Bulletin, Norwood
19. Shaieb MD, Kan DM, Chang SK, Marumoto JM, Richardson AB (2002) A prospective randomized comparison of patellar tendon versus semitendinosus and gracilis tendon autografts for anterior cruciate ligament reconstruction. Am J Sports Med 30:214–220
20. Shelbourne KD, Nitz P (1990) Accelerated rehabilitation after anterior cruciate ligament reconstruction. Am J Sports Med 18:292–298
21. Yunes M, Richmond JC, Engels EA, Pinczewski LA (2001) Patellar versus hamstring tendons in anterior cruciate ligament reconstruction: a meta-analysis. Arthroscopy 17:248–257