

Arthroscopic single-bundle posterior cruciate ligament reconstruction: retrospective review of hamstring tendon graft versus LARS artificial ligament

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Abstract Our objective was to compare the results of reconstruction of isolated chronic posterior cruciate ligament (PCL) injury using a four-strand hamstring graft (4SHG) and a LARS artificial ligament. Thirty-six patients were divided into a 4SHG group ($n=15$) and a LARS group ($n=21$). The minimum follow-up time was two years. The outcome measures used were KT-1000 measurements, the International Knee Documentation Committee (IKDC) scoring system, Lysholm knee scoring scale and Tegner activity rating. Both groups improved significantly between the preoperative and postoperative assessment in terms of the knee laxity and functional examination ($P<0.01$). Meanwhile, knee stability was significantly improved in the LARS group when compared with the 4SHG group ($P<0.05$); this was also the case for the Lysholm, Tegner and IKDC scores ($P<0.05$). Our study indicates that using a LARS ligament for PCL reconstruction was clinically more useful than using a 4SHG in the treatment of the PCL-deficient knee.

Résumé Le but de cette étude est de comparer les résultats de la reconstruction des ruptures isolées du ligament croisé postérieur soit par un greffon provenant des ischio-jambiers

avec 4 bandes (SHG) soit par un ligament artificiel (LARS). Matériel et méthode: 36 patients ont été divisés en deux groupes, groupe de 15 patients traité par greffe des ischio-jambiers et groupe de 21 patients traités par ligament artificiel LARS. Le suivi minimum a été de deux ans. Les résultats ont été évalués avec le KT-1000, avec le score IKDC et le score de Lysholm ainsi que l'activité de type Tegner. Résultats: dans les deux groupes l'amélioration est significative entre l'état pré-opératoire et l'état post-opératoire, en termes de laxité et d'examen fonctionnels ($p<0,01$). Cependant la stabilité est nettement améliorée dans le groupe du ligament artificiel ($p<0,05$) aussi bien pour le test de Lysholm, le score IKDC que Tegner ($p<0,05$). En conclusion notre étude montre que l'utilisation du ligament artificiel de type LARS pour la reconstruction des lésions du ligament croisé postérieur peut être plus efficace que l'utilisation d'une greffe de quatre bandes issues des muscles ischio-jambiers.

Introduction

Surgical reconstruction of symptomatic chronic posterior cruciate ligament (PCL) lesions has been increasingly recommended to prevent progressive osteoarthritis and functional limitations [1]. However, controversy continues over the choice of graft tissue, including autografts, allografts and synthetic ligaments. Bone-patellar tendon-bone (BPTB) and hamstring tendon autografts are the most commonly used grafts of choice today. Nevertheless, reports of donor-site morbidity have increased [2, 3] and the use of artificial ligaments which avoids those complications may offer an alternative form of treatment. The LARS artificial ligament (Ligament Advanced Reinforcement System, Surgical Implants and Devices, Arc-sur-Tille, France) has recently been reported to be a suitable material [4–7]. There have been

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few studies focusing specifically on comparison of autografts and LARS artificial ligaments in PCL reconstruction. In order to assess the effectiveness of the two grafts, we compared the outcome after PCL reconstruction using either a four-strand hamstring graft (4SHG) or a LARS artificial ligament.

Patients and methods

Patient data

From August 2002 to March 2006, 54 consecutive patients with isolated chronic PCL rupture were reconstructed using either a 4SHG or a LARS ligament. The diagnosis of chronic ligament rupture was identified by posterior drawer test, positive posterior sag sign and magnetic resonance imaging (MRI). To be included in the study patients had to have a symptomatic isolated PCL rupture. The exclusion criteria were a combined ligament injury, radiographically visible degenerative changes and contralateral knee ligament injury. Furthermore, patients with a follow-up period of less than two years were excluded. Thirty-six patients fulfilled these criteria and were included in this study. The patients were divided into two groups: a 4SHG group with 15 patients and a LARS group with 21 patients. Each patient was fully informed of the disease details and the surgical procedures. All procedures were performed by one surgeon.

Surgical technique

After adequate anaesthesia, standard anterolateral and anteromedial portals were fashioned. Preliminary diagnostic arthroscopy was performed to evaluate the condition of all relevant anatomical structures and to identify the extent of the ligament tear and any associated injuries to the meniscus or cartilage. Any meniscal lesions found were treated by partial meniscectomy.

In the 4SHG group, the semitendinosus and gracilis tendons were harvested and transected at 20 cm. Then they were folded in half and sutured together using a no. 2 absorbable suture to form a quadruple stranded graft. The partial PCL stump interfering with the field of view was debrided with a shaver. The locations of the bone tunnels were the same on the tibial and femoral sides in both groups, the former near the most distal and lateral fibres of the PCL footprint and the latter at a point 8–10 mm posterior to the articular junction. The tunnel was then drilled to a size that matched the diameter of the graft. After the grafts (4SHG or LARS ligament) were pulled from the tibial portal through the bone tunnels using a wire loop out of the femoral portal, a cannulated interference screw was driven along a guide pin inserted through the gap between the graft and the osseous tunnel wall to secure the graft at

the femoral side. Then the maximal manual tension was applied to the distal sutures of the graft and the knee was cycled through full flexion and extension several times for graft pretensioning and settling. The knee was then placed at 70° flexion and a strong anterior drawer force was applied to the proximal aspect of the tibia. The tendon end of the graft was fixed to the anteromedial tibia by using an interference screw in a way similar to the femoral side.

Postoperative rehabilitation

For the 4SHG group the knee was braced in extension for three weeks. Quadriceps isometric exercises and straight-leg raises were performed. Flexion exercises began from the third week. A hinged brace was used for the first two months locked between 0 and 90° to prevent extension limitation and prevent inadvertent flexion. Full weight-bearing was allowed after ten weeks without use of a brace. Flexion beyond 120° was allowed after three months. Patients usually returned to normal daily activity in three months and to light sports activity by six months. Resumption of full pre-injury sports activities can be undertaken between 9 and 12 months following reconstruction.

For the LARS group quadriceps isometric exercises, straight-leg raises and knee flexion exercises were initiated from the first day following surgery. Knee flexion began from 45° and increased gradually to the complete flexion and extension within one week. Patients usually walked with the help of a crutch from three days following surgery. The crutch was discarded after three weeks. Resumption of light sports activity could be undertaken by two months and full pre-injury sports activities between three and four months following reconstruction.

Evaluation

The patients were followed up for more than two years and evaluated with the manual Lachman test and KT-1000 arthrometer test for knee laxity measurement as well as the International Knee Documentation Committee (IKDC), Lysholm and Tegner rating scales for the functional examination. The evaluation data at 12 months and at the latest follow-up were gathered and eventually analysed with SPSS 11.0 software. The median (range) values are presented. The results of the two groups were compared using the Wilcoxon signed rank test. Differences at a level of $P < 0.05$ were considered statistically significant.

Results

The groups were comparable in terms of gender, age, cause of injury, time between injury and operation (Table 1). At

Table 1 Patient data

Group	Male	Female	Age	Cause of injury			Time from injury to surgery (months)	Symptoms		
				Traffic	Sports	Fall		Pain	Giving way	Weakness
4SHG (<i>n</i> =15)	13	2	20–43	8	5	2	5–32	10	11	6
LARS (<i>n</i> =21)	17	4	18–47	11	7	3	6–34	17	19	9

arthroscopic examination, in the 4SHG group there were four medial meniscal tears, two lateral meniscal tears and nine cartilage lesions and in the LARS group eight medial meniscal tears, three lateral meniscal tears and 16 cartilage lesions. The last follow-up review occurred between two and three years postoperatively arranged according to the patients' convenience, and the mean follow-up was 2.4 years and 2.2 years in the 4SHG and LARS groups, respectively.

Preoperative and postoperative assessments of knee stability are summarised in Table 2. Improvement in the posterior drawer test was achieved in both groups at the one-year follow-up ($P<0.01$) and two-year follow-up ($P<0.01$). The postoperative results showed that the LARS group had significantly less posterior displacement than the 4SHG group at the one-year and two-year follow-up ($P<0.05$). The same was noted in the KT-1000 side-to-side test (25° flexion and 134 N) of posterior laxity ($P<0.05$, respectively).

As shown in Table 3, both groups improved significantly between the preoperative assessment and follow-up in terms of the Lysholm knee scoring scale ($P<0.01$). Meanwhile, the score in the LARS group was significantly higher than in the 4SHG group at follow-up ($P<0.05$). The same was noted in terms of the Tegner activity level and the one-leg hop test ($P<0.05$). The final IKDC evaluation was significantly improved in both groups between the preoperative assessment and one-year or two-year follow-up ($P<$

0.01). Overall, nine patients (60%) at the one-year follow-up and 11 patients (73%) at the two-year follow-up were graded as normal or nearly normal in the 4SHG group and 19 patients (90%) and 19 patients (90%), respectively, in the LARS group. At the same time, the final IKDC evaluation was significantly higher in the LARS group compared with the 4SHG group at the one-year follow-up ($P<0.05$) and did not reveal significant differences between the two groups at the two-year follow-up ($P=0.285$).

In both groups, there were no immediate postoperative complications that required revision or readmission. Each group had one patient who complained of anterior knee pain. Two patients in the 4SHG group felt paraesthesia on the medial side of the knee and totally recovered around six months postoperatively. One knee in the 4SHG group developed arthrofibrosis that required arthroscopic lysis and manipulation of the knee, and the result was satisfactory.

Discussion

Treatment of PCL injuries still needs to be researched, although improvements are occurring due to recent progress in the surgical technique and the knowledge of PCL anatomy and biomechanics. The purpose of this study was to compare the results of PCL reconstruction using either a 4SHG or a LARS ligament. From the outcome of this midterm follow-up, we have found that the 4SHG could not

Table 2 Posterior knee instability before and after reconstruction

	4SHG group (<i>n</i> =15)			LARS group (<i>n</i> =21)		
	Preoperative	1 year postop.	2 years postop.	Preoperative	1 year postop.	2 years postop.
Posterior drawer test						
0–5 mm	0	6	6	0	15	16
6–10 mm	0	3	5	0	6	5
11–15 mm	11	6	4	15	0	0
>15 mm	4	0	0	6	0	0
KT-1000 examination						
0–2 mm	0	3	4	0	9	10
3–5 mm	0	4	3	0	9	8
6–10 mm	0	5	6	0	2	3
>10 mm	15	3	2	21	1	0

Table 3 Total knee function examination

	4SHG group (<i>n</i> =15)			LARS group (<i>n</i> =21)		
	Preoperative	1 year postop.	2 years postop.	Preoperative	1 year postop.	2 years postop.
Lysholm score, median (range)	71 (28–99) points	83 (31–100) points	85 (33–100) points	70 (26–95) points	93 (39–100) points	93 (43–100) points
Tegner activity level, median (range)	2 (1–5)	5(1–9)	6 (1–9)	2(1–6)	7 (2–10)	7 (2–10)
One-leg hop test (%), median (range)	71 (0–107)	76 (0–136)	82 (0–124)	69 (0–111)	90 (0–151)	91 (0–145)
Final overall IKDC rating results						
Normal	0	6	8	0	16	14
Nearly normal	0	3	3	0	3	5
Abnormal	6	5	3	11	2	2
Severely abnormal	9	1	1	10	0	0

offer enough strength mechanically in single-bundle PCL reconstruction, and that using the LARS ligament can improve the objective results.

Use of hamstring tendon grafts has been more popular compared with BPTB grafts in recent years because there is less morbidity, particularly with regard to pain on kneeling and extension deficit. There are many clinical studies using a 4SHG for isolated ACL reconstruction, in which 83–100% were graded as normal or nearly normal on the IKDC rating [8–18]. Few clinical studies have reported the outcomes of using a 4SHG for isolated PCL reconstruction. From the current literature, the outcome of this technique varied from 76% normal to 89% nearly normal based on IKDC ratings [19–22]. These results show that there is a difference between the outcomes of ACL reconstruction and of PCL reconstruction with a 4SHG graft, though it has not been proved by any statistical study, and using a 4SHG for PCL reconstruction might be far from perfect.

The normal PCL is twice as strong as the normal ACL. So a 4SHG may be adequate for the latter, but this may not be the case for the former. The ultimate tensile strength of the PCL has been estimated to be 1,800 N compared to 4,000 N [23] for the 4SHG. This suggests that the initial strength of the graft should be adequate. However, the tendon-bone interface cannot restore the normal histological structure using this technique of ligament reconstruction, which leads to the whole graft strength decreasing and not returning to its original level [24]. Furthermore, autografts have to undergo revascularisation, cell proliferation and remodelling to fulfill ‘ligamentisation’, which takes nearly one year and is prone to collapse and loosening in this course. There has been no study with respect to researching the graft strength in and after the course of ligamentisation and comparing it with the normal PCL. Dustmann et al. [22] reconstructed the ACL with a superficial digital flexor tendon in a sheep model. At one year postoperatively they

researched the mechanical and structural properties of the graft and found that neither anteroposterior laxity nor structural properties of the intact ACL were fully restored. The 4SHG strength might change similarly in and after the course of ligamentisation, which contributes to the imperfect results in PCL reconstruction.

Compared with the 4SHG group in this study, the knee laxity and function examination results were better in the LARS group, except for the IKDC score at the two-year follow-up. The LARS ligament does not possess elasticity. Suffering persistent 1,700 N traction and being relaxed in 24 hours, the increased length is less than 1.5%. A few studies have reported the outcome of using the LARS ligament for ACL reconstruction. The knee laxity and patient satisfaction were significantly improved after operation [4, 5], and the Knee Injury and Osteoarthritis Outcome Score (KOOS) evaluation and instrument-tested laxity were better with use of the LARS ligament than with the BPTB graft at one year postoperatively [6]. There are few clinical studies that have reported the outcome of isolated PCL reconstruction with a LARS ligament. Brunet et al. [7] reported on using a LARS ligament for PCL reconstruction in 14 cases with a mean follow-up of 36 months. In the final IKDC ratings, 58% of the patients (7 of 12) were assessed as normal or nearly normal, which differs obviously from the results of our study. In Brunet et al.’s study all patients were competition athletes except one, the traumatic condition was serious (six combined laxities and five knee dislocations), the number of patients was small and two patients did not participate in the IKDC evaluation; those factors might be the reasons for the difference.

Due to the advantages of no donor site morbidity compared with autografts and no potential disease transmission compared with allografts, the synthetic material for ligament reconstruction was recommended in the 1980s. However, the enthusiasm for these implants gradually

waned because of the intermittently reported problems, mainly referring to the high device failure rate and reactive synovitis [23, 24]. The LARS ligament was taken as a new generation of artificial ligament owing to its special design, and there were no serious problems following ACL and PCL reconstruction with it reported in the current literature [4–7]. Nevertheless, concerns over the complications associated with the LARS ligament, similar to other types of artificial ligaments, have remained under discussion since its use [4–7]. In our study we did not find any obvious sign with respect to ligament rupture. It is possible that some fibres of the LARS ligament have worn, which cannot be documented through arthroscopy. It is worthwhile to note that none of the patients reported here had clinically evident synovitis. The main weakness of this study is the insufficient follow-up period, for two years appears to be too short to examine the efficacy of one type of artificial ligament. We presumed that some problems related to using a LARS graft for ligament reconstruction may gradually occur over time [25]. Longer follow-up is necessary to determine the role of the graft in PCL reconstruction. Furthermore, another weakness of this study is the unmatched postoperative rehabilitation between the two groups of patients, because the patients of the LARS group were allowed normal activities of daily living much earlier than the patients of the 4SHG group. The difference in postoperative rehabilitation might cause the evaluation of the knee function between the two groups to be unequal. But we thought that as the patients of the two groups recovered to a similar level of activities eventually, one year postoperatively at most, the negative effect on the comparison between the two types of grafts should obviously decrease, especially with respect to the comparison at the two-year follow-up. A double-blinded prospective study, with patients following the same postoperative rehabilitation protocol, may be better for evaluation of the efficacy of the two different types of grafts. However, performing such a study would be unethical, because it is well known that patients with a LARS ligament in PCL reconstruction could resume pre-injury activities much faster, owing to its sufficient strength, than patients with 4SHG reconstruction.

Our study indicates that using a LARS ligament for PCL reconstruction was clinically more useful than using a 4SHG in the treatment of the PCL-deficient knee, regarding restoration both of the knee stability and of the knee function.

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