Reconstruction of posterolateral bundle in partially torn anterior cruciate ligament using hamstring tendons

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Purpose
Partial tear of the anterior cruciate ligament (ACL) is a frequent injury. Controversy as regards reconstruction of partially torn ACL is still present. We prospectively evaluated clinical outcome of patients after reconstruction of partially torn ACL that involves posterolateral (PL) bundle with hamstring tendons.
Methods and results
Between August 2008 and August 2011, 20 (PL) bundle tears of ACL-deficient knees of 20 active athletic patients were evaluated and reconstructed with hamstring tendons. There were 17 male and three female patients; the mean age of the patients was 29 years (range: 21–37 years). Assessment was carried out using Lysholm score, International Knee Documentation Committee (IKDC), and KT-1000. Cases were subjected to scoring at 6 months postoperatively with improved outcome using Lysholm score from 65.5 (range: 30–89) to 91 (range: 81–100). A clear difference in IKDC scoring was found as regards knee stability testing. Side-to-side laxity using KT-1000 measurement improved from 3 mm preoperatively to 1 mm postoperatively.
Conclusion
Reconstruction of PL bundle of partially torn ACL provides a logical way to augment knee stability.

Keywords:
anterior cruciate, hamstring, posterolateral bundle

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Introduction

Anterior cruciate ligament (ACL) rupture is the most common cause of knee laxity. A partial tear is a frequent pattern of ACL injury observed in 10–27% of isolated ACL lesions [1].

Early descriptions of two bundles of the ACL were provided by Weber in 1836. Since then, it has been well recognized that the ACL consists of two bundles, the anteromedial (AM) and the posterolateral (PL) bundles, according to their tibial insertions [2,3].

The patient's complaint after partial ACL injury differs according the involved bundle. Siebold and Fu [4] found that, besides recurrent pain and swelling, patients with a symptomatic AM bundle tear describe an anterior instability during activities of daily living and nonpivoting sports activity. In contrast, patients with a symptomatic PL bundle tear complained of rotational instability with pivoting sports.

On examination, in torn AM bundle, patients usually show a significantly increased (+1) anterior drawer test at 90° of knee flexion and a KT-1000 side-to-side difference between 2 and 4 mm. The anterior translation in the Lachman test at 30° is rather small (from 0 to +1) and the pivot-shift test is negative or only slightly positive (from 0 to +1). However, patients with torn PL bundle often show a positive pivot-shift test (+1), and the anterior drawer test and the Lachman test might be from 0 to +1. The KT-1000 usually shows a small side-to-side difference of 1–3 mm [5].

Peterson and Zantop [3] found that a positive pivot-shift test can be considered as an indicator of a rupture of the PL bundle. This theory is supported by recurrent instability after standard, single-bundle ACL reconstruction (AM bundle reconstruction) with a graft positioned in an undesirably vertical position [3].

MRI evaluation may suggest a partial tear of the ACL, but cannot make a definitive diagnosis. The criterion for defining a partial tear is high signal intensity within the ACL, which may have a wavy course and/or focal thinning but maintains its continuity and orientation. Additional oblique views and use of 3 T MRI protocol is currently being studied in the hopes of improving the capacity to image isolated bundle injury [6,7].

Finally, examination under anesthesia and arthroscopic evaluation are considered the final diagnostic steps.

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The purpose of the diagnostic arthroscopy is to rule out injuries that can prevent one from obtaining an accurate result of the pivot-shift test, such as displaced ACL tissue, a displaced meniscus, or osteochondral fragments [5].

A figure-of-4 position of the knee is described by Siebold and Fu [4] that can be used to define the tension of the PL bundle through the AM portal and they give this position a term of Cabot position.

According to De Franco *et al.* [5], the primary goal of ACL reconstruction is to eliminate the pivot-shift phenomenon. If a patient has a single-bundle injury with a negative pivot shift and marginally increased anterior knee laxity, they treat the patient non operatively. If the injury resulted in a positive pivot shift, they interpret this finding as a loss of functional stability and discuss operative treatment with the patient [5].

Noyes *et al.* [8] reported that in up to 50% partial ACL tears develop into full ruptures, primarily as a result of vascular interruption and necrosis of the fibers following their rupture. Conservative treatment can be successful in patients not participating in strenuous physical activity. In patients with a high functional demand, surgical treatment is often required [8].

Another problem that may emerge from conservative management is 'Cyclops Syndrome' of remaining tissues with extension lag that can develop after partially torn ACL [9,10].

Patients and methods

Between August 2008 and August 2011, 20 patients suffered from traumatic knee injuries and instability. There were 17 male and three female patients; the mean age of the patients was 29 years (range: 21–37 years). This study approved by the Ethical committee of Kasr Al-Aini School of Medicine, Faculty of Medicine, Cairo University, Giza, Egypt.

Clinical evaluation

Twelve (60%) patients had injury of the dominant limb and eight (40%) had injury of the nondominant side. Thirteen (65%) cases suffered from knee instability after sport injuries, whereas seven (35%) cases suffered from knee instability after nonsport injury (see Table 1).

All of them suffered incapacity to resume to their previous level of activity because of the instability symptoms, and positive pivot shift test was elicited in all cases. They were scheduled for complete ACL reconstruction.

Preoperative rating was carried out according to IKDC score, the modified Lysholm activity scales, and the KT-1000 laxity test.

Radiographic evaluation

Radiographs were obtained to exclude associated knee arthritis.

MRI was suggestive of partial ACL disruption (Fig. 1).

Surgical technique

Under spinal anesthesia with the use of a pneumatic tourniquet, re-evaluation of the knee ligaments (Lachman, pivot-shift tests, and KT-1000 arthrometer) was carried out comparing with the uninjured side. The exact diagnosis of the partial tear through the PL bundle

Table 1 Demographic data

Parameters	Patients (*n*=20) [*N* (%)]
Affected side	
Dominant	12 (60)
Nondominant	8 (40)
Cause of injury	
Sport injury	13 (65)
Nonsport injury	7 (35)

Figure 1

Arrow indicates partial rupture of ACL through femoral insertion.

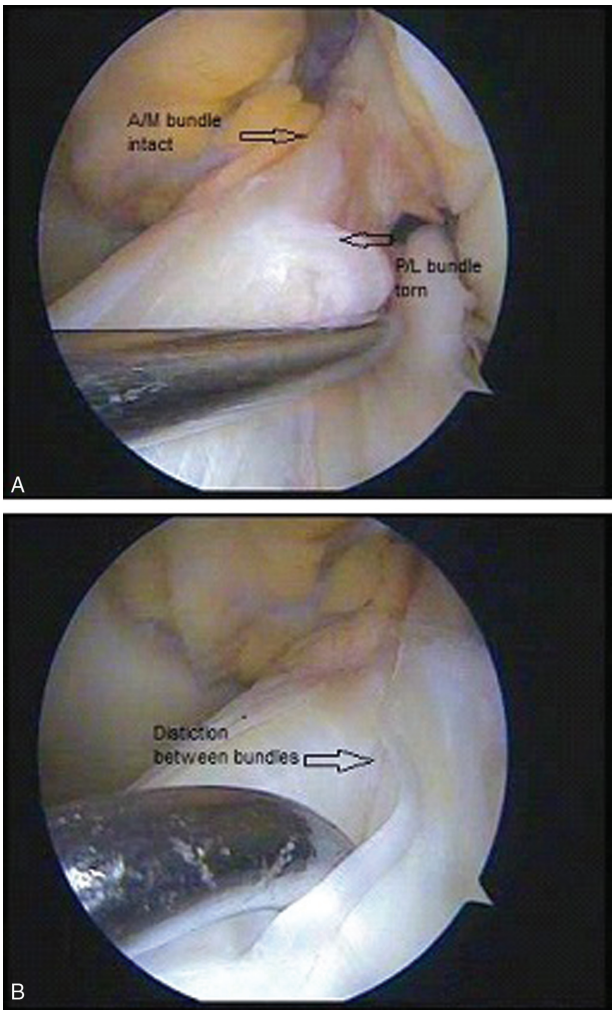
was made during arthroscopy. Following the diagnosis, the decision to proceed to an isolated reconstruction of the PL bundle was taken.

The usual AM and anterolateral portals were used to assess the whole ACL. During the arthroscopic examination, any combined lesion was treated.

Harvesting of the graft through oblique medial incision in the proximal of the tibia was carried out to isolate the semitendinosus and gracilis tendons. The graft from muscle tissue was cleaned, and the whole graft was folded into a quadruple loop and both ends were sutured together.

Through an accessory low AM portal, the center of the femoral PL bone tunnel was marked 5 mm posterior to articular cartilage of the lateral femoral condyle. A tunnel was drilled in 130° of knee flexion for 40 mm depth (Figs 2 and 3).

Figure 2



Partial ACL tear through P/L bundle with distinction of the two bundles. (a) Torn P/L bundle. (b) Distinction between the bundles.

Tibial tunnel preparation

The tibial tunnel was created with ACL guide set to 55°. The guide was entered from a point 3.5 cm medial to the tibial tuberosity. For PL bundle reconstruction, the point at which the tibial tunnel entered the joint was immediately PL to the fibers of AM bundle (Fig. 4).

Graft fixation

Through the low AM portal, a stainless steel cerclage wire (folded in the form of circle) is passed through the femoral tunnel with the aid of a Beath needle. The free end of the wire is grasped through the tibial tunnel to the outside and the free parts of the graft sutures are attached to the end of the wire. The wire is pulled to drag the sutures through the femoral tunnel to outside the skin and pulled until the graft is tight by reaching the bony end of the femoral tunnel. The femoral attachment is fixed with a biodegradable interference screw with the knee flexed beyond 120°. The graft is tensioned through repeated cycles of flexion and extension and final fixation of the graft with a biodegradable interference screw on the tibial side in extension (Fig. 5).

Rehabilitation protocol

The same is used for a standard ACL reconstruction. Running is permitted after 3 months and pivot sports after 6 months.

Patient assessment

Clinical assessment was performed using the IKDC and Lysholm knee scores at 3, 6, and 9 months after

Figure 3

Femoral tunnel preparation.

surgery. Follow-up was scheduled after this period at 1.5 and 2 years for some cases.

Results

Associated injuries

Sixteen cases with meniscal injuries were identified intraoperatively: eight cases with lesions of the medial meniscus, five cases with lesions of the lateral meniscus, and three cases with torn menisci (Table 2).

Possible complications

In the immediate postoperative period, three patients suffered from wound hematoma of the proximal tibia, due to the tendon harvest, which resolved with medications.

Figure 4

Applying the tibial guide in proper point. Intact A/M bundle is noted.

Functional outcome

Preoperative Lysholm score ranged from 30 to 89 with a mean of 65.5. The postoperative score at 6 months ranged from 61 to 100 with a mean of 91.

As regards IKDC, clear difference was found with respect to knee stability preoperatively and 6 months postoperatively. It is summarized in Table 3.

Side-to-side laxity using KT-1000 measurement was carried out preoperatively and was found to range from 1 to 4 mm (mean: 3 mm). Postoperative KT-1000 difference at 6 months was found to range from 0 to 2 mm (mean: 1 mm).

Discussion

There are three reasons to preserve the remnants of ACL during reconstruction. Mechanically, remaining fibers act as graft protection during the healing. The microvessels present in the native ACL tissue may enhance the vascularization of the ACL augmentation. Mechanoreceptors in the residual ACL fibers may have proprioceptive function that allows better rehabilitation [11,12].

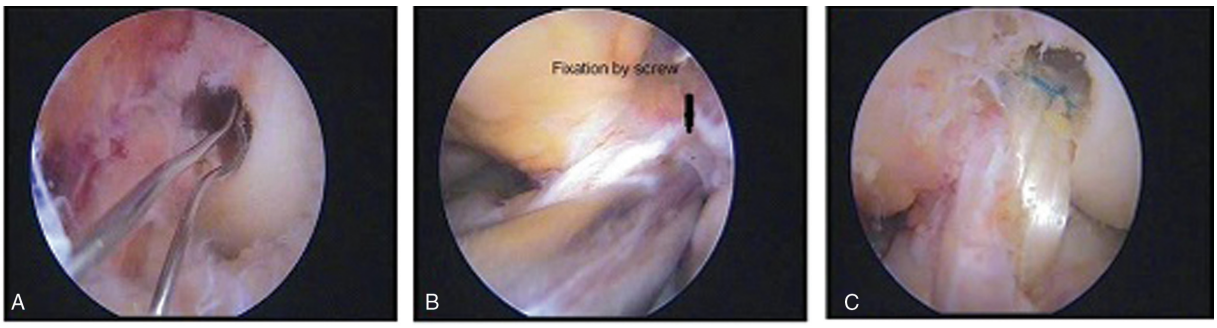
Since 1992, Ochi *et al.* [13] performed partial ACL augmentation without resection of the ACL remnant using an autogenous semitendinosus tendon. Two incisions at the medial aspect of the proximal tibial and at the lateral femoral condyle were made, because

Table 2 Associated lesions

Combined injuries	Patients (*n*=20) [*N* (%)]
Torn medial meniscus	8 (40)
Torn lateral meniscus	5 (25)
Torn both menisci	3 (15)
Torn ACL only	4 (20)

ACL, anterior cruciate ligament.

Figure 5



Fixation and final position of the graft (a) After drilling femoral tunnel and passage of steel wire. (b) Fixation with biodegradable screw. (c) Final position of the graft.

Table 3 IKDC for knee stability

IKDC	Preoperative				Postoperative			
	Normal (A)	Near normal (B)	Abnormal (C)	Severe abnormal (D)	Normal (A)	Near normal (B)	Abnormal (C)	Severe abnormal (D)
Lachman	0	12	8	0	9	8	3	0
Pivot shift	0	5	11	4	12	6	2	0
One-leg hop	0	0	14	6	14	4	2	0

the semitendinosus tendon was fixed to the femur through the over-the-top route. In a consecutive series of 169 ACL reconstructions, Ochi *et al*. [13] reported augmentation for partial ACL tears in 13 cases of AM bundle and four cases of PL bundles.

In 2009, Ochi *et al*. [13] published a series of 45 patients with minimum 2 years of follow-up. They used a transtibial femoral tunnel preparation and through low AM portal in some cases, and they fixed the femoral attachment with Endobutton resting on the lateral femoral cortex and staples on the tibial side. The side-to-side difference in the anterior displacement of the tibia (measured using the KT-2000 arthrometer) was 3.4±2.4 mm (on average) preoperatively, but significantly improved to an average of 0.5±2.7 mm postoperatively. The median Lysholm knee scores improved from 75 (range: 44–99) to 100 points (range: 81–100) after surgery [12–14].

In a more recent study, Sonnery-Cottet *et al*. [15] performed AM bundle reconstruction in 36 patients with a mean follow-up of 24 months. They used outside–in technique for femoral tunnel. At last follow-up, 24 (73%) patients were graded A, eight (24%) were graded B, and one (3%) as C at IKDC objective evaluation. The mean side-to-side instrumented laxity was 4.8 mm (minimum: 3, maximum: 6) preoperatively and 0.8 mm (minimum: 0, maximum: 2) postoperatively [15].

Serrano-Fernandez *et al*. [11] reported a series of 24 patients who underwent ACL semitendinosus autograft reconstruction and were followed up for 2 years. They used over-the-top position with graft fixed to the lateral femoral cortex through lateral skin incision. The median follow-up was 6.2 years (2–15.6 years). Using KT-1000, in 11 patients, no differences in laxity were detected between the healthy and reconstructed knees, whereas 10 exhibited a difference of 1 mm and three patients a discrepancy of 2 mm. Sixteen of the 24 patients achieved an IKDC score of A, and the other eight patients, six achieved a score of B, one with the score of C, and one an IKDC score of D. The mean Lysholm scale score was 95 (90–100) [11].

In this study, low AM portal was used to make the femoral tunnel, and fixation tool was biodegradable interference screw for both femoral and tibial sides. Improvement in objective parameters of IKDC as regards laxity was as follows: 12 patients, group A; six patients, group B; and two patients, group C and no patients in group D. Postoperative mean KT-1000 difference at 6 months was found to be 1 mm (0–2 mm). As regards Lysholm scoring, the mean was 91 (range: 61–100).

Conclusion

Augmentation of PL bundle of partially torn ACL can be a beneficial method to help athletes to return to preinjury activities.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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