The authors declare that there was no conflict of interest in conducting this work.
bundle for ACL reconstruction presents any improvement in patients’ prognoses, in comparison with single-bundle techniques\(^{(13,14)}\).

**MATERIAL**

Between October 2007 and February 2009, 40 anatomical ACL reconstruction procedures were performed using a double bundle, using the semitendinosus tendon to remake the anteromedial (AM) band and the gracilis to remake the posterolateral (PL) band of the knee.

The patients’ ages ranged from 19 to 45 years, with a mean of 30.4 years. In total, 40 knees were operated, of which 22 were right knees and 18 were left knees. Thirty-seven were male and three were female. The postoperative period ranged from eight to 23 months, with a mean of 14 months. Associations with meniscal lesions were found in 27 knees, osteochondral lesions in six knees, and meniscal and osteochondral lesions in three knees. Thirty primary reconstructions and ten revisions were performed.

The grafts were fixed using two Endobuttons\(^{®}\) in the femur and two biointerference screws (Smith & Nephew, Inc, USA) in the tibia in 30 cases; and using four Arthex\(^{®}\) biointerference screws in ten cases. In two cases, this was done together with fixation using one staple; and in one case, together with a screw and washer of post type. These cases presented bone with greater porosity.

**SURGICAL TECHNIQUE**

With the patient in horizontal dorsal decubitus, we attached a box to the surgical table using adhesive tape such that the patient’s foot would be supported while the knee was flexed at between 90\(^{°}\) and 120\(^{°}\). We made an incision of around 6 cm below the medial interline and around 4 cm medially to the anterior tuberosity of the tibia in order to perform conventional excision on the semitendinosus and gracilis tendons. These were then prepared on an auxiliary table such that they were put together, as a double bundle. In cases in which the gracilis had a diameter of less than 5 mm, we prepared a triple bundle.

We constructed the conventional anteromedial and anterolateral portals for knee arthroscopy. We started the arthroscopic inspection of the knee and treated the associated lesions (meniscal and osteochondral lesions), as well as preparing the bed of the ACL. With the knee flexed at 90\(^{°}\), we started to construct the AM tunnel, with placement of a guidewire in the posterior region of the intercondylar sulcus, on the lateral face at around one o’clock on the left knee and eleven o’clock on the right knee. In some cases, we made an accessory portal 1 cm more medially and around 0.5 cm more distally than the anteromedial portal, in order to facilitate access and improve the viewing. We used a 4.5 mm drill bit, measured the length of the femoral tunnel and decided on the size of the graft and the quantity of wall remaining, in accordance with the conventional fixation technique using Endobutton\(^{®}\) (Smith & Nephew, Inc, USA). We used the appropriate drill bit to enable passage of the double semitendinosus tendon, which was generally 7 to 8 mm, with a predetermined depth. Next, the knee was flexed at around 120\(^{°}\) and we made the PL tunnel in the femur, which was around 3 mm anterior and parallel to the AM tunnel, at around three o’clock in the left knee and nine o’clock in the right knee, given that with the knee flexed at 120\(^{°}\), the AM and PL femoral tunnels were parallel. We constructed the tunnel for the PL bundle in the same way as done for the AM bundle, choosing the size of the Endobutton\(^{®}\) and the size of the graft that would remain in the tunnel. After constructing the femoral tunnels, we started on the tibial tunnels. The AM tunnel in the tibia was made using a conventional guide for ACL in the tibia, at 55\(^{°}\) and was positioned medially to the anterior tuberosity of the tibia. The guide was positioned medially to the posterior margin of the anterior cornu of the lateral meniscus, in the remaining impression of the ACL. We passed a guide wire of 2.5 mm through, and then a drill bit of diameter compatible with the double semitendinosus tendon. We then placed a guide at 45\(^{°}\), fitted around 1 to 2 cm medially to the AM tunnel, in order to construct the PL tunnel around 5 mm posteriorly and laterally to the AM tunnel, exactly medially to the lateral spine of the tibia. We passed a guidewire through, and then a drill bit of diameter corresponding to the double or triple gracilis tendon. After making the AM and PL tunnels in the femur and tibia, we passed an Ethibond\(^{®}\) No. 5 thread through the PL tunnel between the tibia and femur and raised the graft from the gracilis, which was...
then fixed to the femur by means of the Endobutton® or using a biointerference screw. We then passed the AM bundle through, with the double semitendinosus, and fixed this with one Endobutton® or one biointerference screw, in the femur. After passing the tendons through, we performed pretensioning and fixation to the tibia using absorbable interference screws, with the knee flexed at between 45º and 60º for the AM band and between 0º and 15º for the PL band (Figure 1). We placed one drain inside the knee joint and another in the region where the tendons had been removed from the tibia. We closed the subcutaneous tissue and the skin. The postoperative period proceeded in the conventional manner, as in ACL reconstruction with a single bundle.

**DISCUSSION**

ACL reconstruction performed with a single bundle from flexor tendons or the patellar ligament has been widely used by knee surgeons worldwide, with a satisfactory rate of excellent and good results over recent decades(15).

The technique in which using a double bundle from the flexor tendons is recommended started to be used in the 1990s with the aim of reproducing the anatomy of the ACL and diminishing the external rotation movements of the tibia in relation to the femur. Through this, diminution of excessive rotational movements was achieved, thus theoretically avoiding or delaying the appearance of arthrosis after the ACL injury(13,16).

With regard to the surgical technique, certain points need to be taken into consideration:

1) Positioning the patient in dorsal decubitus with a support under the foot, while keeping the knee flexed at between 90º and 120º, is especially helpful for making the bone tunnels. In most cases, conventional arthroscopy portals are sufficient for viewing the tunnel construction in the femur. In some cases, an accessory portal located more medially should be used.

2) The tunnels should be made starting with the AM bundle, but the graft of the posterolateral bundle should be the first one made, thus facilitating viewing of the AM band. To make the posterolateral tunnel in the femur, it is important for the knee to be flexed at between 110º and 120º, so that sufficient wall length in the lateral femoral condyle can be achieved.

3) Attention to the passage of the grafts is very important, so that switching the AM and PL bands of the tibia with those of the femur can be avoided.

4) A space of at least 3 mm between the tunnels needs to be maintained, thereby avoiding their confluence while passing the drill bit through. The commonest complication is confluence of the tunnels, which may be acceptable in the tibia but should not be accepted in the femur.

5) The AM bundle in the femur should leave suffi-
cient space in relation to the PCL, so that there is no impingement on extending the knee.

6) The AM bundle should be fixed at flexions of between 45° and 60° and the PL, between 0° and 15°.

7) The fixation can be with four interference screws or with two Endobuttons® and two absorbable screws.

We had more difficulties with fixations using four interference screws because of the lack of availability of screws of diameters 5 and 6 mm in Brazil.

Another factor that causes difficulty is the financial aspect, given that we used twice the amount of fixation material, compared with the single-bundle technique, thus making the surgical procedure more costly.

CONCLUSION

It is feasible to reproduce the technique of anatomical ACL reconstruction with a double bundle, but the learning curve is longer than in the single-bundle technique and demands attention and skill, especially for the arthroscopic work with the knee flexed at 120°. It should be avoided by surgeons who are just starting their careers.

The advantages of the double-bundle technique over the transtibial single-bundle or transportal technique have yet to be proven. We will have to evaluate our patients with longer follow-up, in comparison with other techniques.

REFERENCES