ANATOMICAL ACL RECONSTRUCTION WITH DOUBLE BUNDLE: FIRST 40 CASES

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ABSTRACT

Objective: To discuss the technique of anatomical reconstruction of the anterior cruciate ligament (ACL) with a double bundle, the learning curve and the preliminary results. Methods: Forty patients with ACL injury underwent reconstruction with an anatomical double bundle, using the semitendinosus tendon to remake the anteromedial (AM) band and the gracilis to remake the posterolateral (PL) band of the knee. Results: We had two cases of limitation of extension, and in one of them, arthroscopic arthrolysis had to be performed; and there was one case of deep vein thrombosis. Conclusion: ACL reconstruction with double bundle proved feasible, despite having a longer learning curve, and the advantages of the proposed technique still must be proven compared to the single-bundle technique.

Keywords - Anterior Cruciate Ligament/injuries; Anterior Cruciate Ligament/surgery; Orthopedic Procedures; Postoperative Complications

INTRODUCTION

Reconstructions of the anterior cruciate ligament (ACL) are among the orthopedic surgical procedures most performed nowadays. The 1970s marked the apogee for extra-articular non-anatomical reconstruction techniques for the ACL, like the procedure described by Lemaire in 1975[1]. In 1982, Lipscomb et al[2] started to use the tendons of the pes anserinus (semitendinosus and gracilis) for ACL reconstruction. Over these years, another great advance took place in relation to the fixation methods, and the work by Kurosaka et al[3] stood out in this respect. In 1987, they demonstrated that using metal interference screws was effective. From then on, other fixation methods came to be developed.

Although the results from ACL reconstruction have been favorable, several authors have observed persistent residual pain[4], persistent instability (especially rotational)[5] and medium-term evolution to osteoarthrosis, especially when the ligament reconstruction takes place in association with meniscectomy[6-8]. Thus, at the end of the 1990s, greater interest in studying anatomical reconstruction of the ACL using a double band arose, with reconstruction of the anteromedial and posterolateral bundles that made up the original formation of the ACL. The aim was to achieve better restoration: not only anatomically but also with regard to the kinematics and biomechanics of the knee. Recent biomechanical studies have suggested that a double bundle might provide better posterolateral rotational stability than would single-bundle reconstruction[9]. The short-term results have been favorable[9-12], but long-term clinical studies are needed in order to determine whether use of a double

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Work received for publication: March 7, 2010; accepted for publication: July 20, 2010.

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 90º and 120º. 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 90º, 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 120º 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 120º, 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 55º 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 45º, 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 an 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.

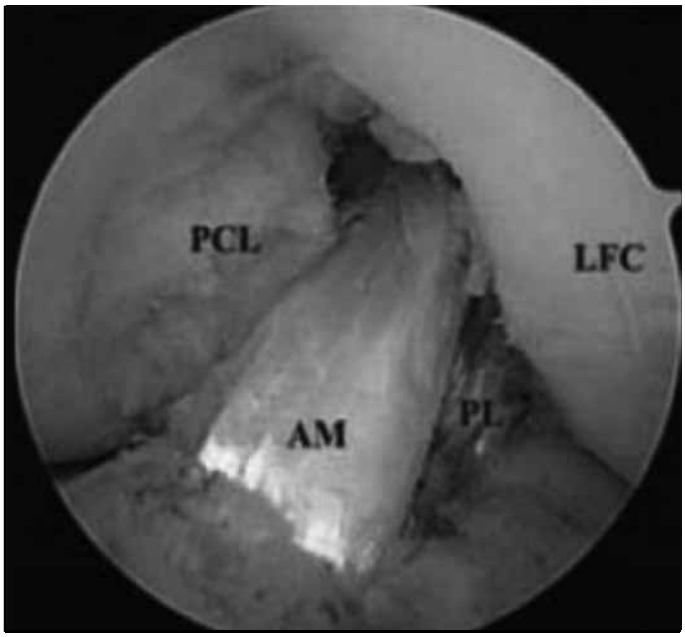

Figure 1 – Arthroscopic image after reconstruction of the ACL using the anteromedial (AM) band and the posterolateral (PL) band, and their positions in relation to the posterior cruciate ligament (PCL) and the lateral femoral condyle (LFC).

COMPLICATIONS

The intraoperative complications included two cases of inversion of the bands, and these were corrected during the operation. There were also two cases in which the biointerference screws were partially extruded in the femur and three cases of confluence of the tunnels (two in the tibia and one in the femur).

The postoperative complications included two cases of limitation of extension and one case of deep vein thrombosis. In just one of the cases of limitation of extension, we performed arthroscopic arthrolysis, with a good result. We did not have any cases of infection.

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 45º and 60º and the PL, between 0º and 15º.
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 120º. 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

1. Lemaire M. [Chronic knee instability. Technics and results of ligament plasty in sports injuries]. J Chir (Paris). 1975;110(4):281-94.
2. Lipscomb AB, Johnston RK, Snyder RB, Warburton MJ, Gilbert PP. Evaluation of hamstring strength following use of semitendinosus and gracilis tendons to reconstruct the anterior cruciate ligament. Am J Sports Med. 1982;10(6):340-2.
3. Kurosaka M, Yoshiya S, Andrish JT. A biomechanical comparison of different surgical techniques of graft fixation in anterior cruciate ligament reconstruction. Am J Sports Med. 1987;15(3):225-9.
4. Anderson AF, Snyder RB, Lipscomb AB Jr. Anterior cruciate ligament reconstruction. A prospective randomized study of three surgical methods. Am J Sports Med. 2001;29(3):272-9.
5. Yagi M, Kuroda R, Nagamune K, Yoshiya S, Kurosaka M. Double-bundle ACL reconstruction can improve rotational stability. Clin Orthop Relat Res. 2007;454:100-7.
6. Fithian DC, Paxton EW, Stone ML, Luetzow WF, Csintalan RP, Phelan D, et al. Prospective trial of a treatment algorithm for the management of the anterior cruciate ligament-injured knee. Am J Sports Med. 2005;33(3):335-46.
7. Cohen M, Amaro JT, Ejnisman B, Carvalho RT, Nakano KK, Peccin MS, et al. Anterior cruciate ligament reconstruction after 10 to 15 years: association between meniscectomy and osteoarthrosis. Arthroscopy. 2007;23(6):629-34.
8. Kessler MA, Behrend H, Henz S, Stutz G, Rukavina A, Kuster MS. Function, osteoarthritis and activity after ACL-rupture: 11 years follow-up results of conservative versus reconstructive treatment. Knee Surg Sports Traumatol Arthrosc. 2008;16(5):442-8.
9. Muneta T, Koga H, Mochizuki T, Ju YJ, Hara K, Nimura A, et al. A prospective randomized study of 4-strand semitendinosus tendon anterior cruciate ligament reconstruction comparing single-bundle and double-bundle techniques. Arthroscopy. 2007;23(6):618-28.
10. Fu FH, Shen W, Starman JS, Okeke N, Irrgang JJ. Primary anatomic double-bundle anterior cruciate ligament reconstruction: a preliminary 2-year prospective study. Am J Sports Med. 2008;36(7):1263-74.
11. Yasuda K, Kondo E, Ichiyama H, Tanabe Y, Tohyama H. Clinical evaluation of anatomic double-bundle anterior cruciate ligament reconstruction procedure using hamstring tendon grafts: comparisons among 3 different procedures. Arthroscopy. 2006;22(3):240-51.
12. Kondo E, Yasuda K. Second-look arthroscopic evaluations of anatomic double--bundle anterior cruciate ligament reconstruction: relation with postoperative knee stability. Arthroscopy. 2007;23(11):1198-209.
13. Zantop T, Herbort M, Raschke MJ, Fu FH, Petersen W. The role of the anteromedial and posterolateral bundles of the anterior cruciate ligament in anterior tibial translation and internal rotation. Am J Sports Med. 2007;35(2):223-7.
14. Adachi N, Ochi M, Uchio Y, Iwasa J, Kuriwaka M, Ito Y. Reconstruction of the anterior cruciate ligament. Single- versus double-bundle multistranded hamstring tendons. J Bone Joint Surg Br. 2004;86(4):515-20.
15. Maletis GB, Cameron SL, Tengan JJ, Burchette RJ. A prospective randomized study of anterior cruciate ligament reconstruction: a comparison of patellar tendon and quadruple-strand semitendinosus/gracilis tendons fixed with bioabsorbable interference screws. Am J Sports Med. 2007;35(3):384-94.
16. Woo SL, Kanamori A, Zeminski J, Yagi M, Papageorgiou C, Fu FH. The effectiveness of reconstruction of the anterior cruciate ligament with hamstrings and patellar tendon . A cadaveric study comparing anterior tibial and rotational loads. J Bone Joint Surg Am. 2002;84(6):907-14.