Anterior Cruciate Ligament Reconstruction in Athletes with Restricted Hip Joints: Randomized Comparison of Two Techniques – a Pilot Study

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Abstract

Background: Studies have shown that, at least in soccer players, decreased ipsilateral hip range of motion has a significant influence on the occurrence of anterior cruciate ligament (ACL) injury, with a high incidence of re-ruptures especially after single-bundle reconstruction. This study aimed to compare the ability of two surgical techniques to prevent re-rupture of the ACL in soccer players with ipsilateral restricted hip joints (sum of internal and external rotation < 60°).

Methods: The study was a prospective randomized clinical trial. Thirty male soccer players (mean age, 22 years; range, 18-28) with noncontact ACL ruptures were allocated to two groups. Inclusion criteria were isolated anterior cruciate ligament injury, ipsilateral hip range of rotation below 60°, and being a professional or semi-professional soccer player. Exclusion criteria were persistent hip pain or history of any fracture or previous surgery of the lower limb. One group underwent a combined intra- plus extra-articular reconstruction, while the other was treated with double-bundle reconstruction with hamstrings grafts. All patients were followed up for two years after surgery.

Results: At two-year follow-up of each patient, there were four re-ruptures in the double-bundle reconstruction vs. none in the intra- plus extra-articular reconstruction. In the 27 athletes with intact reconstructions, the amount of residual instability in the physical examination and Lachman test was about the same.

Conclusions: In two years of follow-up, the incidence of re-rupture, although not the same, showed no significant difference between intra- plus extra-articular and double-bundle ACL reconstruction techniques in patients with ipsilateral restrained hip joints.

ABBREVIATIONS

ACL: Anterior Cruciate Ligament; IEG: Intra- Plus Extra-Articular Reconstruction; DBG: Double-Bundle Reconstruction; MRI: Magnetic Resonance Imaging

INTRODUCTION

Rupture of the anterior cruciate ligament (ACL) in athletes and its consequences on rotational stability and performance are well known and documented in the orthopedic literature [1-6]. Since the very first papers proposing ACL reconstruction with patellar or flexor tendon grafts, many reports highlighting the technical advantages of ACL reconstruction have been published, mainly focused on improving graft fixation [7]. However, after some initial success, the results were unable to surpass a certain level of efficacy, and reports about re-ruptures started to appear. The idea that treatment failures could be caused by inappropriate disregard for the original anatomy led to an effort to reproduce the main anteromedial and posterolateral bundles of the ACL [8-12].

A frequent finding after ACL reconstruction is a negative Lachman test with persistent pivot shift, up to 10-30% [13-15]. The best explanation for this is the inability of the intra-articular single tunnel to control certain cases with excessive knee internal rotation. Control of internal/external rotation of the knee would therefore be more properly restored by surgical techniques capable of restoring the anteromedial and posterolateral bundles. At least theoretically, a double- or single-bundle reconstruction with extra-articular tenodesis could provide an advantage when dealing with this problem [16]. Research has yet to clearly establish which patients will likely benefit from the addition of extra-articular tenodesis for additional clinical effects.

Studies have shown that, at least in soccer players, decreased ipsilateral hip range of motion has a significant influence on the occurrence of ACL injury [1-3, 5, 17, 18]. This prompted us to conduct a pilot study comparing two surgical techniques for ACL reconstruction in a group of soccer players with restricted mobility of the ipsilateral hip joint, in search of the best option to control the overload on the knee imposed by the restricted hip joint.

Previous studies have shown a high incidence of re-ruptures after non-anatomic single-bundle reconstruction, especially in soccer players [3]. Therefore, we selected for this study two surgical techniques that theoretically provide higher rotational stability than the conventional single-bundle approach: one group underwent a combined intra- plus extra-articular reconstruction (IEG), while the other was treated with double-bundle reconstruction (DBG). The aim of this study was to compare the ability of both techniques to prevent re-rupture of the ACL in soccer players with ipsilateral restricted hip joints. Our hypothesis was that the incidence of re-rupture would be lower in the DBG than in the IEG after two years of follow-up.

MATERIALS AND METHODS

This study was a prospective randomized clinical trial. From January 2008 to January 2010, 30 male patients aged 18 to 28 years (mean, 22 years) were selected for inclusion in the study (n = 30). Inclusion criteria were isolated ACL injury, ipsilateral restricted hip joints (range of motion less than 60°), and being a professional or semi-professional soccer player. We defined professional athletes as those individuals who played for professional soccer teams and received payment for that activity, and semi-professional athletes as those who competed in amateur championships but did not receive any payment. ACL insufficiency was confirmed by clinical examination—Lachman test, conducted with the aid of the Rolimeter® device (Aircast, Neubeurgen, Germany) with a difference of 5 mm or more, and a positive pivot shift test—and magnetic resonance imaging (MRI), performed in all patients and evaluated by a radiologist, in accordance with standard patient care. The exclusion criteria were persistent hip pain or history of any fracture or previous surgery of the lower limb. The study was approved by the Research Ethics Committee of our institution, under protocol number 07-669. Written informed consent was obtained from all participants prior to their inclusion in the study.

Sample

The sample was composed of two groups of 15 individuals each. The patients had an average of 45° internal-external sum of hip rotation. The Lysholm score was obtained in 16 patients preoperatively and in all patients in the first postoperative year. The postoperative score was not compared with the preoperative score, because the 14 patients without a preoperative score were treated in the acute phase (up to two months after trauma); therefore, the data on their preoperative scores were not evaluable. The IEG had two professional athletes, and the DBG had only one. All other participants were semi-professional athletes.

The principles that guided both surgical techniques were not new or original [19-22]. The main difference was the fixation methods that were adapted to our public hospital to achieve lower costs. The first patient was assigned to one of the two methods by throwing a conventional six-sided dice (numbers 1-6): even numbers represented the IEG and odd numbers represented the DBG. Subsequently, each patient enrolled in the study underwent the surgical procedure that had not been performed in the previous case.

All patients were treated by the same surgeon. All procedures were performed with the patient in the supine position and under spinal anesthesia, according to local anesthetic procedure. A tourniquet was used in all procedures. The patients were hospitalized for one day after surgery, according to both Brazilian public and private health insurance requirements.

Regarding preoperative associated lesions, eight patients had ACL injury with meniscal lesions and four with chondral lesions in the IEG, while seven patients had ACL injury with meniscal lesions and five with chondral lesions in the DBG.

Intra-plus extra-articular reconstruction (IEG)

The technique used in the IEG was an intra-articular over-the-top reconstruction with the semitendinosus and gracilis tendons. Both tendons (Figure 1A) were passed through an over-the-top intra-articular route and simultaneously fixed in the lateral femoral condyle together with a strip of fascia lata previously passed under the lateral collateral ligament and a subperiosteal tunnel (Figures 1B and 2A). Femoral fixation was done in external rotation and 60° of knee flexion with the aid of a cancellous screw and a previously made bone washer. The screw works as an external cross pin, whereas the washer, cut with a special 12-mm trephine, not only provides immediate mechanical fixation but also allows future biological fixation by inducing bone ingrowth (Figures 1C and 3) [1, 23]. Tibial fixation of the ACL graft was then done in 40° flexion with a cortical screw and a spiked plastic washer just below the tunnel entrance, holding both tendons. The tendons were also pressed into the tibial tunnel by a bone plug fashioned with a 8.5-mm trephine, which was used to cut the initial half of the tunnel, while the second half of the tunnel was made with a 6-mm drill [19] (Figures 1D and 2B).

Double-bundle reconstruction (DBG)

In the DBG, the anteromedial bundle was also passed over the top of the lateral femoral condyle (Figure 4A), as in the other group, to avoid two tunnels in the femur. A tibial tunnel was made in the same fashion as in the other group, but slightly more anterior than the posterolateral bundle tunnel. The posterolateral bundle was passed through a 5-mm tunnel drilled from an anteromedial portal in the lateral femoral condyle and a 5-mm tibial tunnel slightly more posterior than the anteromedial bundle tibial tunnel. Both bundles were then fixed simultaneously to the lateral femoral condyle with a cancellous bone washer. C) Final lateral view. D) Final frontal view.
screw and bone washer obtained with a special 12-mm trephine. The anteromedial bundle was then fixed onto the tibia with the knee flexed at 40°, whereas the posterolateral bundle was fixed at 10°. Since the posterolateral bundle tunnel is also 5 mm in size, it has a snug fit that precludes further fixation, permitting only post fixation. The semitendinosus anteromedial bundle, however, was fixed with a screw and a spiked plastic washer, with a bone plug compressing the tendons in the distal half of the tunnel to achieve a more snug fit (Figures 4B and 5).

We chose to use the over-the-top route in order to reproduce the anteromedial bundle by eliminating a possible femoral tunnel error, adding reliability to the surgical procedure [16].

Rehabilitation and follow-up

Patients in both groups were allowed full weight bearing without crutches starting two weeks after the procedure. This protocol was adopted because early discharge was frequently painful before two weeks after the IEG. The other double bundle group followed the same protocol to avoid comparisons [20]. Exercise was started as soon as the patients felt comfortable. All patients returned to their preoperative level of soccer practice within 6 to 8 months of surgery, and were reevaluated at the end of the first (first evaluation) and second postoperative years (second and final evaluation). Subjective confidence in the first postoperative year was assessed by asking all patients the following question: “How do you feel about your knee now?”.

Statistical analysis

Comparisons between the two study groups (IEG and DBG) were performed using Fisher’s exact test. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 18.0. The level of significance was set at 5% (p < 0.05).

RESULTS

All enrolled patients were followed up for two years after surgery and completed the study (n = 30). On first evaluation, at the end of the first year of follow-up, there were no cases of re-rupture or any other noncontact knee injuries. The Rolimeter™ showed an average 2 mm anterior displacement in the Lachman test in the operated knee, compared with the opposite side, and the pivot shift test was negative in all 30 athletes. The mean preoperative Lysholm score obtained in 16 patients was 57 (range, 46-68). At one-year follow-up, the mean Lysholm score was 96 (range, 94-99) for all 30 cases. At this time point, all participants had returned to the practice of soccer and reported satisfaction with the outcome of surgery. There was no statistical difference between groups in relation to the question made (12 patients in the IEG answered “normal”, while only eight in the DBG responded similarly; p = 0.245).

Neither of the groups showed superficial or deep infections or vascular complications. Inability to fully extend the operated knee was observed in three patients: one patient in the DBG and two in the IEG had postoperative extension 5° short of full range compared with the contralateral knee. On second evaluation, at the end of the second year of follow-up, ACL re-rupture was diagnosed in four athletes in the DBG by physical examination and confirmed by MRI after a new noncontact rotator event. None of the patients in the IEG had ACL re-rupture. In this group, two athletes had an ACL rupture in the contralateral knee that required surgery and one athlete...
underwent arthroscopic meniscectomy in the operated knee. The two athletes with ACL rupture of the contralateral knee were then treated with single-bundle reconstruction, and one of them had evidence of re-rupture of the reconstructed ACL in the contralateral knee at the two-year final evaluation. This athlete was a professional player for the leading soccer team in the state and was one of the first to be operated on in the sample. This patient had a hip range of rotation (sum of internal and external rotation) of only 30°.

There were no statistically significant differences between the two study groups (p = 0.224, Fisher’s exact test) in re-rupture rates.

**DISCUSSION**

In this study, we compared the ability of two surgical techniques (IEG and DBG) to prevent re-rupture of the ACL in soccer players with ipsilateral restricted hip joints, and hypothesized that DBG would be associated with a lower incidence of ACL re-rupture after two years of follow-up. Our hypothesis was not confirmed since the IEG and DBG showed no significant differences in the rate of ACL re-ruptures.

As soon as ACL reconstruction became a widespread and common surgical procedure, unsatisfactory results and cases of re-rupture began to appear [20, 24-26]. Initially, these events were attributed to poor positioning of the tunnel, but, over time, this reason could no longer justify all faults. Failure of ACL reconstruction would then become associated with a conceptual technical deficit rather than with inability of the surgeon. There was increasing pressure for the points of fixation for grafts to mimic the anatomy, but, over time, the double-bundle concept failed to show the expected results that would justify its greater complexity and higher risk of complications [4, 27-30]. All of these propositions, however, were made without consideration for the role of the hip joint in noncontact ACL events, since all biomechanical laboratory studies were carried out in lower limbs amputated below the hip joint, disregarding the importance of this joint in rotational movements and dribbling below the waist.

Because the correlation between a restricted hip joint and noncontact ACL injuries had already been demonstrated in a population of soccer players [18], a more restrictive ACL reconstruction appeared to be the best way to prevent noncontact re-rupture [1,2,16,19,31]. This approach could be especially important for athletes with restricted hip joints, because any intra-articular reconstruction alone has a leverage arm smaller than what is necessary to antagonize the rotational forces transmitted to the knee in a cutting maneuver by a moving pelvic girdle through the restricted hip [31-33].

The concept that certain orthopedic conditions, such as congenital clubfoot, can be improved but will never reach normality also applies to the case of ACL injuries in soccer players. Efforts must be made in the pursuit of a “normal” knee in athletes that have suffered a contact ACL injury, but these patients are different from those who had a noncontact injury and have a restricted hip [1,2,32,33].

In soccer players, even if one were able to restore a new ligament to exactly the same state of the original ligament prior to trauma, re-rupture would be a definite possibility, because risk factors for injury would remain unchanged. Therefore, in our practice, we try to avoid re-rupture by using more reinforced surgical techniques in those patients with a hip range of rotation below 60°, which represents less than two-thirds of the hip mobility observed in the normal population [32], since studies in search of hip range of motion recovery through stretching exercises score have not been fully successful [34].

Limitations of this study include the small sample size, which limits statistical power, and the lack of blinding of investigators. This happened because our research ethics committee recommended starting with a smaller sample as there are no references in the literature about ACL reconstruction in restricted hip joints. Therefore, unexpected harmful outcomes could occur in one of both groups of patients. This led us to use an additional question in combination with the Lysholm questionnaire. Such question was not statistically significant and was not validated. All that occurred because, to the best of our knowledge, this is the first prospective study involving only athletes with ACL injury and limitation of joint mobility of the ipsilateral hip joint.

In conclusion, our findings demonstrate that, in two years of follow-up, there was no significant difference in the incidence of ACL re-ruptures between intra-plus extra-articular and double-bundle ACL reconstruction techniques in patients with ipsilateral restrained hip joints. However, the four re-ruptures (26.6%) with the DBG cannot be ignored. Therefore, the better outcome of the IEG was attributed to a better tibial internal rotation control secondary to a more well positioned leverage arm provided by the lateral tenodesis [35,36].

**REFERENCES**


