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Femoral Tunnel Techniques in ACL Reconstruction with Hamstrings Autograft: Transtibial versus Two Tunnels Technique

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Abstract

Background: In spite of the considerable research focused on ACL reconstruction, the increased risk of early knee osteoarthritis and the presence of rotational instability post-surgery have not been fully investigated yet. As a result, controversy remains regarding the best technique for reconstruction; thus, it is still the subject of extensive research.

Aim of the Work: To assess the radiological and clinical outcomes of arthroscopic single bundle ACL reconstruction using the transtibial or the anteromedial portal (two tunnels) technique for drilling the femoral tunnel in nonprofessional athletes.

Patients and Methods: It is a prospective comparative study including forty patients with a torn ACL underwent arthroscopic reconstruction of the ACL, twenty patients had ACL reconstruction by transtibial (TT) technique and twenty patients had ACL reconstruction by Anteromedial Portal (AMP) technique using hamstring tendons as autograft for all the patients.

Results: All the patients were followed-up clinically with IKDC scores, Lysholm score, Tegner activity score and Radiologically for assessment of tunnel widening and femoral tunnel position using plain X-ray and CT at 3, 6 and 12 months post-operatively.

Conclusion: The AMP independent femoral tunnel drilling technique achieved a more horizontal and anatomic femoral tunnel, but the AMP technique has no clinical superiority compared to the TT technique in ACL reconstruction in nonprofessional athletes as reported by these short-term follow-up results.

Key Words: *ACL reconstruction – Transtibial – Anteromedial portal.*

Introduction

INJURY to ACL can lead to chronic functional instability. This functional instability in many cases has important consequences. It may result in cartilage degenerative changes as well as increased risk of meniscal injury [1].

Surgical reconstruction is now widely accepted as the treatment of choice for functional knee instability due to Anterior Cruciate Ligament (ACL) deficiency especially in young patients who are involved in physically high demanding activities [2].

This procedure is well-known for its ability to allow an individual to return to preinjury activity levels, which may not be achieved with non-surgical treatment [3].

Over the past decade, there has been a trend transitioning from use of the Transtibial (TT) drilling technique toward the Anteromedial Portal (AMP) drilling technique in order to achieve more anatomical femoral tunnel placement. The AMP technique requires independent drilling through an additional anteromedial portal in a more horizontal direction [11].

In hamstring ACL reconstruction, graft fixation is a critical factor for the healing process. Interference screws as well as cross pins are common intraosseous graft fixation techniques. Good clinical results can be achieved with both devices [14].

Patients and Methods

It is a prospective comparative study including forty patients with a torn ACL underwent arthroscopic reconstruction of the ACL, between April 2014 and June 2016 in Kasr Al-Ainy Hospital and El-Helmia Military Hospital. Twenty patients have ACL reconstruction by Transtibial (TT) technique

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and twenty patients have ACL reconstruction by Anteromedial Portal (AMP) technique using hamstring tendons as autograft for all the patients. The study thus included forty knees in forty patients. All grafts were fixed by interference biodegradable screws for tibial fixation and bioabsorbable cross pins for femoral fixation of the transtibial group and interference biodegradable screws for the anteromedial portal group. All patients were available for the post-operative follow-up evaluation for one year.

Inclusion criteria: Active patients suffering from knee instability due to anterior cruciate ligament injury, age: 18-45y.

Exclusion criteria: Non motivated patients, the presence of additional fractures or other ligaments injury around the knee joint and patients underwent meniscal repair, chondral grafts or other maneuvers except for a partial menisectomy.

Surgical technique and post-operative treatment: All patients were operated upon under either regional (spinal or epidural) or general anesthesia, in supine position with the operative leg was placed in an arthroscopic leg holder and under tourniquet. Arthroscopic examination was done through the standard anterolateral (ALP) and anteromedial portal (AMP) sites were used. With Additional Anteromedial Portal (AAMP) done aided by long spinal needle to help in the placement of the femoral tunnel only in the group of two tunnels technique, hamistring autograft was harvested and notch preparation was performed as a routine for all cases to allow visualization of the femoral attachment site and to avoid impingement of the ACL graft.

In transtibial group: A tibial drill guide was used to choose a point above the ACL tibial footprint for emergence of the guide pin. The drill guide was removed and a tibial tunnel was drilled by a drill pit with the same graft diameter. An offset guide was used to place the guide pin at the appropriate position on the superior rim of the notch. The femoral tunnel was drilled to the diameter of the graft and to a depth of 30mm. The graft was fixed in the femoral tunnel with two parallel bioabsorbable cross pins. The graft was then tensioned on the tibial side to ensure fixation. Notch impingement and full range of motion of the knee were tested and verified.

In anteromedial portal group: The accessory anteromedial portal was created with the knee in 90º of flexion. Femoral tunnel placement started with placement of the guide pin in the center of the femoral ACL footprint. The knee is flexed to 120º, and the guide pin is advanced through the lateral femoral condyle. Then, the cannulated reamer was carefully inserted over the guide pin into the joint passing the articular cartilage of the medial femoral condyle in a safe distance and the femoral tunnel was drilled to the diameter of the graft and to a depth of 30mm. A suture loop was passed over the guide pin which was removed and the loop stopped at the edge of the femoral tunnel. After that A Tibial Drill Guide was used to choose a point above the ACL tibial footprint for emergence of the guide pin. After guide pin placement, possible impingement was checked to reconfirm a satisfactory position. The drill guide was removed and a tibial tunnel was drilled by a drill pit with the same graft diameter. The suture loop in the femoral tunnel was passed through the tibial tunnel using a grasper or a hook, then the graft was passed over the suture loop and pulled in the femoral tunnel by the strong pulling sutures. A biodegradable interference screw with the same diameter of the graft was introduced through the medial portal over its guide wire beside the graft fixing it in the femoral tunnel, the screw was introduced by a cannulated screw driver until it was flush with the edge of the femoral tunnel with the knee in 120º of flexion, then the screw driver and the guide wire was removed and the graft was then tensioned on the tibial side to ensure fixation. Notch impingement and full range of motion of the knee were tested and verified.

In both groups: After cycling the knee and tensioning the graft, a biodegradable interference screw with a diameter 1mm more than the graft diameter was used for fixation of the graft in the tibial tunnel of both groups with the knee in 20 degrees of flexion and posterior drawer of the tibia.

Ending the operation: Testing for instability ADT and revisualizing the graft, position, tension, and impingement of the graft. Suction drain in the knee was used in all cases followed by skin closure. The end was dressing and elastic bandage rolled around the knee and sofban then crepe bandage extending from the toes till midthigh region, then butting the knee in knee brace locked in full extension. The operative data were recorded.

Post-operative management: Thromboembolism prophylaxis for 2 weeks for all cases. The patient is held in knee immobilizer in full extension from the immediate postoperative; with continuous cooling with compression. Post-operative analgesic, intravenous prophylactic antibiotics for 5 days the patient discharged in the fifth day if infection is excluded.

Post-operative rehabilitation program: All patients had received instructions on the pre-, and post-operative rehabilitation program prior to the surgery. They had an intensive physical therapy two to six weeks pre-operatively for out-patients before hospital admission, and six to nine months postoperatively. Return to sports after 6 months, no contact sports until 9 months.

Follow-up assessments: Clinical evaluation is done intraoperative and immediate post-operative. Patients are appointed outpatient visits as part of the clinical investigation at 3, 6, and 12 months post-operatively. We assess the following items at the scheduled visits: Physical examination, including circumferential measurement of both legs at defined landmarks, Lachman and pivot shift tests, maximum passive ROM, one-legged hop test, IKDC scores, Lysholm score, knee and kneeling pain measured by visual analogue scales and Tegner activity score. Any complications or complaints raised by the patient. Resumption of work and leisure activities. Radiological assessment of tunnel widening and femoral tunnel position using plain X-ray and CT at 6, and 12 months post-operatively Figs. (1,2). All data were collected and statistcal analysis was done.

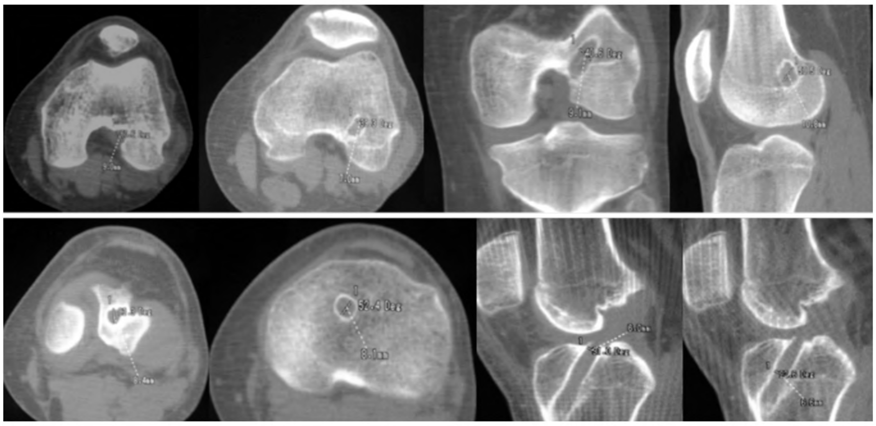

Fig. (1): CT tunnel measurements.

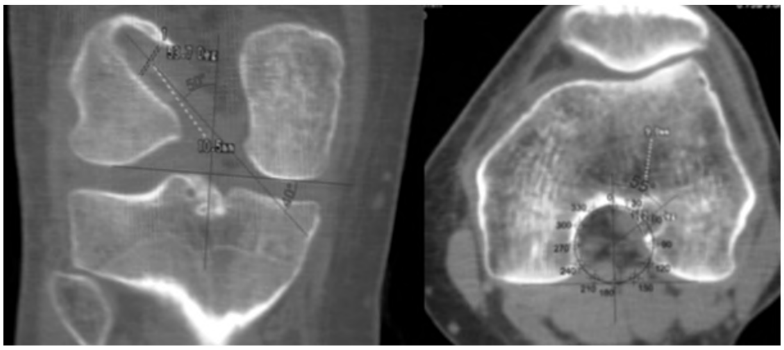

Fig. (2): Femoral tunnel coronal obliquity and modified clockwise position on CT.

Results

Statistically significant differences were not found between the groups with regard to age, sex, time from injury to surgery and duration of operation. The objective and subjective clinical results of the present study were similar between the TT and AMP groups, with outcomes such as Lachman test, pivot shift test, Lysholm and objective IKDC score that were slightly higher in the AMP group but with no statistical significance. In the present study, the target femoral tunnel position was ≥30 degrees for left knees and <330 degrees for right knees according to the modified clockwise position by Rue et al. There were no outliers in the AM portal group, but 2 (10%) of 20 femoral tunnels in the TT group were evaluated as outliers, and a statistically significant difference was determined between the groups. Femoral tunnel obliquity in the coronal CT reconstruction also confirmed that the femoral tunnel obliquity in the AMP group was more horizontal than that of the TT group, and a statistically significant difference was determined between the groups. There was a slight femoral and tibial bone tunnel enlargement with the diameters of the tunnels measured after 6 and 12 months compared to the intraoperative tunnel diameters , are much lower than the suggested threshold of 50%, which is considered to be significant for tunnel enlargement, also there is overall minimal differences of tunnel measurements from 6 months to one year follow-up.

Discussion

Most studies compare the two main techniques for drilling the femoral tunnel, the transtibial technique and the use of a separate anteromedial portal. Overall, most studies agree that the anteromedial portal technique allows a more anatomic femoral tunnel position when compared to the transtibial technique. Recent studies have shown that more anatomically placed bone tunnels provide better kinematics of the knee and prevent graft stretching and loosening [3,4]. Dargel et al., 2009 [3] reported that drilling the femoral tunnel through the tibial tunnel resulted in a significantly more vertical position of the femoral tunnel. Alternatives to transtibial drilling have been developed to avoid the limits inherently set by transtibial approaches on femoral start point and angle. There is still debate as to whether this changes the clinical outcomes for the patient. No difference in functional outcome was demonstrated by two large cohort studies [5,6,13]. However, some benefits of AMP technique have been documented such as increased stability with a higher Lysholm score, better lateral movement functional tests at 3 and 6 months, significantly lower recovery time from surgery to walking without crutches, return to normal life, return to jogging and significantly higher activity level at 3-5 and 6-10 year follow-up [7,8]. In addition, there is still discussion about the ideal point to drill the tunnel, given that recent anatomical and histological studies have shown direct and indirect fibers on the ACL; thus, perhaps the ideal drill point is still undefined [9]. Recent studies also found no significant clinical differences and more anatomical femoral tunnel when using AMP technique [10,11]. A recent meta-analysis of 5 randomized controlled trials done by Chen et al., in 2017, all of them comparing TT and AMP techniques in single bundle ACL reconstruction using hamstring autograft, and concluded that the AMP technique is better the TT technique in terms of postoperative stability and functional recovery of the knee [12,14]. Weber et al., 2015 used MRI to follow-up patients who underwent single bundle ACL reconstruction using bioabsorbable screw for femoral and tibial fixation for 2 years, and found that the significant tunnel expansion was present at both tunnel apertures and the tibial tunnel midsection, with no consistently significant associations between functional outcome scores or objective measures of knee laxity and tunnel cross sectional area, furthermore, tunnel expansion at time points greater than 6 months may suggest poor graft-to-bone healing, which may lead to increased laxity over time and potential risks for tunnel widening were young age, male sex, and prolonged duration between trauma and surgery [15,16]. The results of this study demonstrate a slight femoral and tibial bone tunnel enlargement following ACL reconstruction with hamstring grafts. These values of the diameters of the tunnels measured after 6 and 12 months compared to the intraoperative tunnel diameters, are much lower than the suggested threshold of 50%, which is considered to be significant for tunnel enlargement, also there is overall minimal differences of tunnel measurements from 6 months to one year follow-up [19].

The 6 months and the final follow-up CT tunnel measurements confirmed that, there was no significant difference between the groups in respect to all tunnel measurements except for T1 (tibial tunnel at joint line in axial cuts), there was statistically significant difference between the groups in the 6 months follow-up CT and borderline significance in the final follow-up CT, also for T3 (tibial tunnel at joint line in sagittal cuts), there was statistically significant difference between the groups in the final follow-up CT, which may be related to overdrilling through the predrilled tibial tunnel, which positioned the femoral guide wire eccentric and more posterior in the tibial tunnel, as the tibial tunnel was used for drilling of the femoral tunnel in the TT group, but drilling of the femoral tunnel in the AMP group was performed independently.

Previous studies have stated that in order to position the femoral tunnel more horizontally, the tibial tunnel should also be positioned more horizontally close to the joint line [20-22]. Yau et al., 2013 reported that the clock position of the femoral tunnel was significantly better in the transportal group. The present study confirmed the findings of Yau et al. [21].

Femoral tunnel obliquity in the coronal CT reconstruction also confirmed that the femoral tunnel obliquity in the AMP group was more horizontal than that of the TT group, and a statistically significant difference was determined between the groups. These results confirm the findings of Lee et al., 2016 in a recent meta-analysis comparing femoral tunnel length and obliquity between TT, AMP and outside-in techniques in single bundle ACL reconstruction which concluded that using AMP and outside-in techniques resulted in a shorter length and greater coronal obliquity of the femoral tunnel than did the TT technique ,however, these 3 techniques resulted in similar obliquities of the femoral tunnel and graft in the sagittal plane [22].

Conclusion:

The AMP independent femoral tunnel drilling technique achieved a more horizontal and anatomic femoral tunnel, but the AMP technique has no clinical superiority compared to the TT technique in ACL reconstruction in nonprofessional athletes as reported by these short-term follow-up results. The use of a strong and stiff femoral and tibial "intratunnel" fixation construction with a fixation point of the graft close to the joint line could contribute to minimizing the tunnel enlargement. A prospective randomized study with a 10-year follow-up period should be designed to investigate the possible differences in clinical outcomes of both techniques.

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حفر نفق فخذى مستقل فى جراحة إعادة بناء الرباط الصليبى الآمامى بإستخدام الآوتار الخلفية للركبة بالمقارنة مع عمل النفق الفخذى من خلال القصبة

تزداد حالات إصابة الركبة بقطع فى الرباط الصليبى الآمامى مع إزدياد ممارسة الرياضة، لذلك تعد من آكثر إصابات الملاعب شيوعا.

وقد تم شرح الطريقتين المستخدمتين فى هذه الدراسة لإعادة بناء الرباط الصليبى بواسطة المنظارالضوئى وذلك إما بإستخدام الطريقة المعتادة وفيها يتم عمل النفق الفخذى من خلال القصبة، وتم تثبيت الرقعة به بإستخدام مسامير مستعرضة ذاتية الذوبان، آو عن طريق إستعادة بناءه بشكل يقارب الشكل التشريحى الطبيعى عن طريق حفر نفق فخذى مستقل من خلال فتحة آمامية آنسية بالإضافة إلى الفتحتين الآنسية والوحشية اللتين يتم من خلالهما المنظار الضوئى، وتم تثبيت الرقعة بإستخدام المسمار التداخلى ذاتى الذوبان، وفى الطريقتين تم تثبيت الرقعة فى القصبة بإستخدام المسمار التداخلى ذاتى الذوبان.

وقد خضع لهذا البحث آربعون مريضا، كلهم رجال إستكملوا المدة الكاملة للمتابعة وهى عام، وتم عمل العملية لنصفهم بإحدى الطريقتين وللنصف الآخر بالطريقة الآخرى حيث تم متابعتهم جميعا من الناحية الإكلينيكية وآيضا تم عمل إشاعات مقطعية بعد ستة آشهر وبعد عام من العملية وذلك لتقييم مدى توسع الإنفاق التى تم تثبيت الرقعة بها وآيضا تقييم وضع النفق الفخذى التشريحى.

وقد آظهرت النتائج إختلاف واضح بين الطريقتين فى وضع النفق الفخذى حيث بينت الإشاعات المقطعية آن وضع النفق الفخذى يميل للوضع التشريحى آكثر إذا تم عمله من خلال فتحة آمامية آنسية عما إذا تم عمله من خلال القصبة، وتؤكد هذه النتائج ما آظهرته الدراسات الآخرى التى تعرضت لهاتين الطريقتين، ونحن بحاجة إلى دراسات طويلة المدى تصل إلى عشر سنوات متابعة للمرضى كى تتضح لنا آفضلية إحدى الطريقتين عن الآخرى من الناحية الإكلينيكية.