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ORIGINAL ARTICLE

Anterior Cruciate Ligament Reconstruction: Antero-medial Portal *vs* Trans-Tibial Femoral Tunnel Drilling

Luke Saliba, Dorian Xuereb, Lucienne Attard, Ivan Esposito

Introduction
The anterior cruciate ligament (ACL) is an important part of the function of the knee joint. Rupture is common in sporting activities and the resulting instability can preclude athletes from pursuing their sport. A more anatomical technique of drilling of the femoral tunnel in repair of this ligament has been reported to yield better functional outcomes than non-anatomical techniques.

Aim
The aim of this study is to compare functional outcomes of single bundle, bone - patellar tendon - bone, ACL repair using a trans-tibial approach versus an anteromedial portal to drilling of the femoral tunnel.

Method
This was a retrospective study. A total of 43 patients having had surgery were recruited. Each of these patients were operated using an anteromedial approach to femoral tunnel drilling. IKDC (International Knee Documentation Committee) scores were implemented and each patient was asked whether or not they returned to sporting activities 12 months after surgery. The results were compared to those from previous patients having undergone surgery with femoral tunnel drilling through a trans-tibial approach instead.

Results
The results from our study show that the functional status of individuals having undergone ACL reconstruction are significantly improved when an anteromedial approach was adopted over a trans-tibial approach to drilling of the femoral tunnel. This is evidenced by higher IKDC (International Knee Documentation Committee) scores with less 'Below average' and 'Poor' results. A total of 41.5% of patients in the anteromedial approach group had excellent results compared to 36.9% of patients in the trans-tibial approach group. The anteromedial approach also allowed for 86% of patients to return to sport at 1 year after surgery versus 60% with the trans-tibial approach, a statistically significant difference with a p-value of 0.0019.

Conclusion
The results from an anteromedial portal approach to femoral tunnel drilling were superior to a trans-tibial approach. Functional outcomes were improved and on the basis of this study, an anteromedial approach would be recommended over a trans-tibial approach.

Luke Saliba* MD MRCS(Glasg)
Department of Orthopaedics,
Trauma and Sports Medicine
Mater Dei Hospital
Msida, Malta
lsaliba92@gmail.com

Dorian Xuereb MD FRCS(Edi)
Department of Orthopaedics,
Trauma and Sports Medicine
Mater Dei Hospital
Msida, Malta

Lucienne Attard MD FFSEM(UK)
Department of Orthopaedics,
Trauma and Sports Medicine
Mater Dei Hospital
Msida, Malta

Ivan Esposito MD FRCS(Eng)
Department of Orthopaedics,
Trauma and Sports Medicine
Mater Dei Hospital
Msida, Malta

*Corresponding author

Introduction

The Anterior and Posterior Cruciate Ligaments (ACL and PCL, respectively) are integral components of the knee joint. Along with other soft tissue structures, the ACL and PCL help to confer stability to the knee joint, preventing anterior and posterior translation respectively, of the tibia on the femur.[1] Because of its stabilising role, the ACL may be exposed to tremendous multi-planar forces during strenuous multidirectional and rotational activities activities such as football which may result in compromise of this important ligament.[2] ACL rupture may cause instability of the knee joint, especially in persons with a lack of other stabilisers of the joint, such as under-developed surrounding musculature. The resulting injury and instability may cause a 'distrust' of the knee and may even preclude athletes from pursuing their sport. Current orthopaedic practice offers the possibility of reconstruction of this ligament thereby stabilizing the knee but such an operation affecting a joint so crucial to mobility requires a sound understanding of the knee's anatomy in order to attain good functional outcomes, not least because of the potential for degeneration of the joint in the long-term.[3]

The ACL is a ligament which runs from the medial aspect of the lateral femoral condyle superiorly to a more anterior, medial and inferior position on the tibial eminence. The ligament is actually formed by two separate posterolateral and anteromedial bundles.[4] These bundles become taut during different movements of the knee joint and therefore provide stability during different movements of the knee, effectively performing different functions. The posterolateral bundle of the ACL is taut during extension of the knee joint and confers mostly rotational stability at this extreme of movement. The anteromedial bundle of the ACL on the other hand is taut mostly during flexion and confers mainly anteroposterior stability, preventing anterior translation of the tibia on the femur.[5]

Some forms of surgery employ this specific anatomical knowledge using a so-called double-bundle technique of ACL grafting but other surgeons prefer to use a single-bundle technique for ACL reconstruction. There have been mixed results, however, with no definite consensus on which yields better results.[6-8] In addition to this anatomical knowledge, the ACL's attachment to both the tibia and femur are also important if an adequate reconstruction is to be performed. This ligament's femoral attachment is circular to oval in shape and lies posterior to a landmark known as the lateral intercondylar ridge (Resident's Ridge), with the posterior edge marked by the condyle's posterior cortex. The main load-bearing part of the ACL consists of 'direct' fibres which enter the condyle at an angle approaching 90 degrees (horizontal). There exist more 'indirect' fibres which fan off from the main bulk of the ligament and are thought to bear only a small portion of the load on the ACL.[4, 9-10]

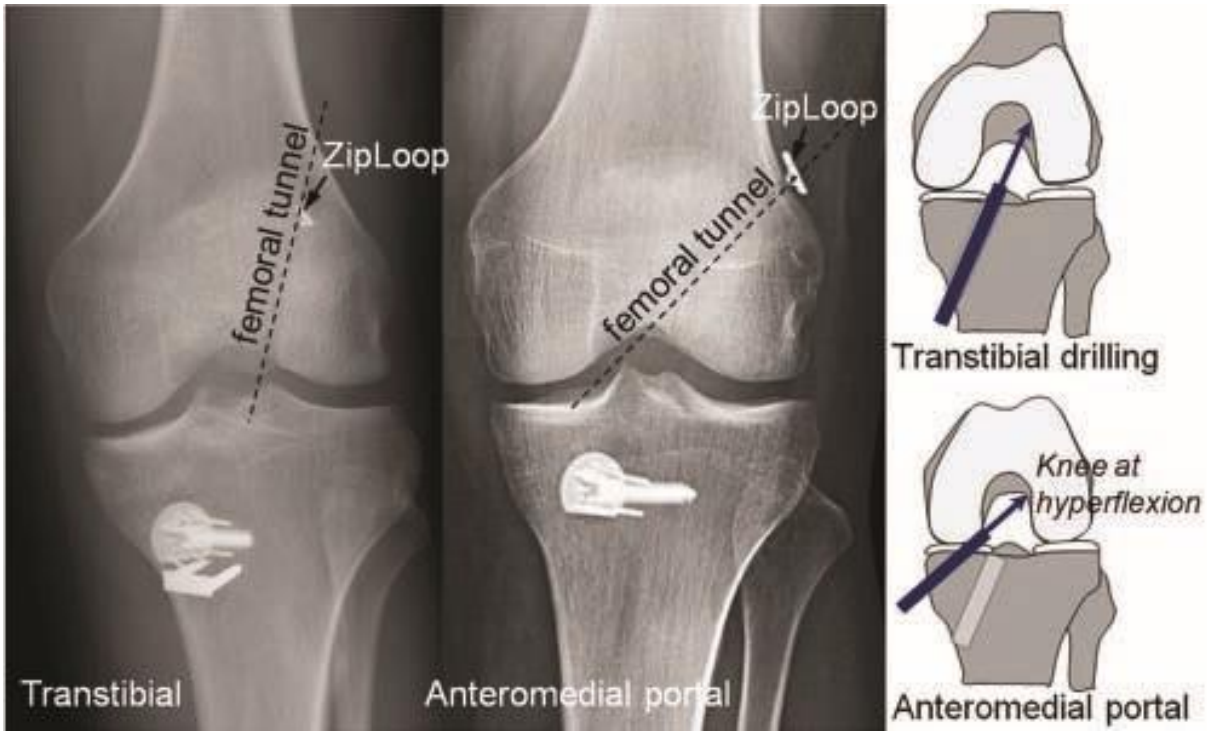
The ACL's footprint is important to bear in mind during reconstruction as anatomical reconstruction requires the femoral footprint of the graft to be placed through the ACL's native footprint. There is a growing body of evidence to support a more anatomical placement of the femoral footprint of the ACL during reconstruction.[11] Trans-tibial drilling of the femoral tunnel does not respect the native ACL's anatomy and so this reconstruction is considered non-anatomical. More modern techniques of ACL reconstruction have in fact shifted to a more anatomical method of

reconstruction with one such method using an anteromedial portal to the knee joint in order to drill the femoral tunnel. This approach allows the femoral tunnel to be placed in the footprint of the native ACL, with an insertion angle of the graft that resembles anatomical specimens. Results of such reconstructions appear to be more promising.[12-15]

The biomechanics of the knee joint are dependant on its anatomy but allow for a deeper understanding of the mechanisms of injury and subsequent pathophysiology. Being a synovial joint with a significant soft tissue component (including both menisci), the knee exhibits two main movements, these being rolling and gliding. Both medial and lateral tibio-femoral points of contact are able to perform both these movements, gliding occurring mostly in flexion with rolling occurring towards extension.[16] In spite of this however, differences between the two compartments occur during extension when rolling preferentially occurs within the lateral compartment. This becomes more obvious at the extremes of extension when a greater gliding movement in the medial compartment allows the tibia to externally rotate on the femur. This movement puts significant strain on the posterolateral bundle of the ACL, the reason for which this ligament may be injured during forced extension of the knee joint such as kicking a football. On the other hand, the anteromedial bundle of the ACL is put to work mainly in flexion where gliding becomes a more prominent movement of the joint, placing more strain on the anteromedial bundle of the ACL.[17]

This study aims to examine the results of autologous Bone-Patellar Tendon-Bone (B-PT-B) single bundle ACL reconstruction with drilling of the femoral tunnel through the anteromedial portal and compare these to those obtained from a previous audit in the same centre but using trans-tibial drilling of the femoral tunnel. (Figure 1).

Figure 1 Anteromedial and Trans-tibial approaches to drilling of the femoral tunnel.[18]



Materials and Methods

A list of patients who underwent ACL reconstructive surgery as performed by a single orthopaedic surgeon during the period between March 2017 and April 2018 was sorted according to the inclusion and exclusion criteria as listed below and patients were contacted retrospectively by phone. Once contacted, patients were explained the reason for the interview and verbal consent was obtained from every patient. Demographic details and each patient's status with regards to previous sport and return to sport after the procedure were also recorded. International Knee Documentation Committee (IKDC) forms were completed and a performance score was calculated for each patient. Application of the IKDC form involved the patient responding to a standard set of questions in order to document their current pain and functional status with regards to ACL reconstruction. If any queries arose, consent was gained in order to review the operating notes. The data gained was then tabulated and comparisons made to an audit performed a few years prior (2005-2008). This audit was carried out in the same centre by the same operating surgeon but using a trans-tibial approach to femoral tunnel drilling rather than an anteromedial approach and used the same parameters for evaluation (IKDC score and return to sport). A *p*-value was then calculated using a Z-test for two proportions, comparing the likelihood of return to sporting activities after each approach.

Inclusion Criteria:

- All patients undergoing single bundle B-PT-B ACL reconstruction via the an anteromedial portal under the care of a single operating surgeon, operated between March 2017 and April 2018

Exclusion Criteria:

- Patients who had not yet had 12 months of post-operative recovery and physiotherapy at the time of data collection
- Patients who had other ligamentous injury noted either intra-operatively or radiographically
- Patients having revision ACL surgery
- Patients having autologous grafts other than B-PT-B
- Patients having a synthetic graft implanted
- Patients having anything other than Meniscectomy performed during the same procedure
- Patients having prior surgery on the same knee other than simple meniscectomy

Results

A total of 83 patients were found to have had ACL reconstruction procedures between the months of March 2017 and April 2018. Of these patients, 40 were excluded. Of the 40 excluded, 1 patient refused to take part in the study and a further 6 could not be traced or contacted. The remaining 33 patients had procedures which included synthetic graft implantation, revision surgery or previous surgeries for more complex meniscal injuries. This left 43 patients who were eligible for this study and these were contacted in turn and asked for consent to partake in the study.

Of the 43 patients, 35 (81.4%) practised football as their primary sport with other sports including rugby, skiing and martial arts among others. All 43 patients did some form of sport prior to injury, most being injured while playing their sport of choice. 65.1% of injuries

(28 patients) involved a twisting injury, often when changing direction suddenly while practicing their sport. The majority of patients were male (38 or 88.4%) with only 5 (11.6%) patients being female.

The age of patients included in the study had ages which ranged from 17 to 36 with mean and median ages of 26 and a mode of 29. A total of 25 patients (58%) had a meniscectomy performed at the same operation with 2 patients (4.7%) having had previous arthroscopy. One of these 2 patients had a meniscectomy performed in the first operative procedure.

The results of a previous audit performed in the same centre between 2005 and 2008 are included in table 1 below for comparison, this audit having included a total of 83 patients.

Table 1 International Knee Documentation Committee (IKDC) Score Results

IKDC Category	IKDC Score	Number of Patients (Anteromedial Portal)	Percentage Patients (Anteromedial Portal)	Percentage Patients (Trans-Tibial Approach)*
Excellent	90 - 100	18	41.9%	36.5%
Very Good	80 < 90	12	27.9%	32.4%
Good	70 < 80	10	23.2%	20.3%
Average	60 < 70	3	7%	0%
Below Average	50 < 60	0	0%	4.1%
Poor	<50	0	0%	6.8%

*'Trans-Tibial' data reproduced with permission from Mr. Dorian Xuereb MD FRCS (Edi), Dr. Lucienne Attard MD FFSEM (UK) and Mr. Ivan Esposito MD FRCS (Eng)

Discussion

The ACL is an important ligament for normal knee biomechanics. Unfortunately however, it is often subject to trauma, especially during sporting activities requiring sudden changes in movement such as football and volleyball. For this reason, it is important to consider the restoration of normal biomechanics when reconstructing this ligament. In order to do this however a sound anatomical knowledge is required in order to respect the native ACLs anatomy and consequently the normal biomechanics of the knee as best as possible. Indeed, current literature agrees that an anatomical reconstruction of the ACL affords better biomechanics to the operated knee over a less anatomical reconstruction.[19]

Considering the importance of anatomy in ACL reconstruction, an anteromedial approach to drilling of the femoral tunnel has been studied in an attempt to improve the ACL graft's anatomy. Doing this may hence improve the biomechanics of the operated knee with

benefits for the patient, including a better functional status, especially when considering high demand activities such as football and other sports. Current evidence is in agreement that an anteromedial approach to drilling of the femoral tunnel provides a better anatomical result when compared to a trans-tibial approach. This is because it allows for positioning of the ACL graft within the native ACL footprint and also a more horizontal placement of the graft within the femoral condyle, similar to native ACL anatomy.[13,20-23]

In this study, the authors compare the results of an anteromedial portal approach versus a trans-tibial approach to drilling of the femoral tunnel in ACL reconstruction. In order to do this, a well-documented and validated score was implemented, the IKDC score. This incorporates a number of questions targeted at different aspects of the operated knee's status including pain, ability to perform activities such as climbing stairs and also more strenuous activities such as sports. In doing this, the authors were able to deduce that patients having had ACL reconstruction with femoral tunnel drilling through an anteromedial portal had better functional results when compared to a trans-tibial approach. This was evidenced by a shift of the IKDC score in the anteromedial approach group toward the upper range with no patients having recorded 'Below average' or 'Poor' results as compared to 10.9% of patients in the trans-tibial approach group having recorded these results. In addition to this, an anteromedial approach resulted in a higher rate of return to sport with a total of 86% of patients returning to regular sporting activities compared to a more modest 60% of patients in the trans-tibial group, this difference reaching statistical significance. This figure is of particular interest as it signifies the ability of the anteromedial approach to offer a better result to the patient with regards to return to pre-morbid state and function. This in turn may also translate into a better quality of life and improved patient satisfaction.

The results reported here in this study are congruent with the results of other studies published in the literature. Other reports also show an increased rate of return to sport with some also showing improved recovery times. [(24)] In addition to this, there is also evidence to suggest that revision rate may be lower with an anteromedial approach.[25]

This study was carried out using the data from the same operating surgeon who was similarly experienced in both techniques. This affords a chance to better compare the techniques themselves as there is no operator difference to consider here. In contrast to this, considering data from a single operating surgeon may mean that results are less relatable to the more general orthopaedic community, especially considering that this particular operating surgeon specialises particularly in this field of orthopaedics. It must also be mentioned that the present study considers relatively low patient numbers. Having said this however, it must be stressed that an anatomical reconstruction of the ACL is of utmost importance and an anteromedial portal approach allows anatomy to be respected better than a trans-tibial approach. If the operator is able to perform either technique therefore, the authors of this study suggest an anteromedial approach to drilling of the femoral tunnel over a trans-tibial approach as there is now a good evidence bank to support this method.

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