Femoral tunnel drilling in anterior cruciate ligament reconstruction: anteromedial or transtibial portal? 
Current review

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Abstract

Introduction
Anterior cruciate ligament tear is a serious injury that results in immediate knee instability, lengthy rehabilitation and increased risk of early onset knee osteoarthritis.

The optimal surgical technique for anterior cruciate ligament reconstruction remains a topic of controversy. However, femoral tunnel position in anterior cruciate ligament reconstruction is critical to a good outcome, while incorrect tunnel placement is considered as the most common cause of clinical failure. There are two alternatives for femoral tunnel placement: anteromedial approach and transtibial approach. The transtibial portal for femoral tunnel placement is limited by the angulation of the tibial tunnel. Therefore, the anteromedial portal was introduced to overcome these limitations and to increase the rotational stability of the anterior cruciate ligament reconstruction. The purpose of this article is to review the literature for femoral tunnel placement. AM portal and provide background information on this topic.

Conclusion
In general, the anteromedial technique can be more technically demanding and have a steep learning curve. Therefore, careful and meticulous surgical techniques and expert surgeons are indicated for these cases.

Introduction
A more anatomic approach to anterior cruciate ligament (ACL) reconstruction has recently received an increase in interest1. Anatomic ACL graft positioning is considered a key factor for the proper postoperative knee function and restoration of the physiological kinematics of the knee joint in ACL reconstruction2. However, the optimum tunnel position for positioning the graft is debatable. Nonetheless, it is well known that vertical tunnel positioning in the femur only restores anteroposterior stability, not rotational stability3. A more oblique femoral tunnel position may improve rotational stability and tensioning patterns4.

Generally, there are two alternatives for drilling the femoral tunnel, the transtibial (TT) approach and anteromedial (AM) approach. The traditional TT approach for femoral tunnel placement is limited by the angulation of the tibial tunnel and places the femoral tunnel higher in the intercondylar notch5. Therefore, the AM surgical approach was evolved with the aim of increasing rotational stability. In 1995, O’Donnell and Scerpella4 described an alternative method for femoral tunnel placement. Subsequently, in 1998, Bottini et al.6 inserted the femoral guide through the AM portal, which led to increased use of the AM portal for femoral drill-hole placement. AM drilling of the femoral tunnel gives an increased ability to reach a more anatomical ACL footprint as it enables the surgeon to visualize and position the femoral tunnel independently of the tibial tunnel1. The aim of this review was to discuss femoral tunnel drilling in ACL reconstruction using the AM or TT portal.

Discussion

AM or posterolateral portal?
Silva et al.3 showed that by using the TT technique, the centre of the femoral tunnel was usually in the AM bundle footprint at the height of the femoral condyle. This allows better restoration of the anteroposterior translation but does not restore the rotational stability. Therefore, there is a trend to change the style of surgery from the traditional TT portal technique to the low AM bundle technique. Different studies show a comparison between the results of both techniques3.

Radiographic studies
Pascual-Garrido et al.4 conducted a study aiming to compare the femoral tunnel position after ACL reconstruction by the TT approach versus the AM approach using radiographs from a single surgeon. The postoperative knee radiographs of 50 patients with an ACL reconstruction were studied in two groups according to the tunnel approach. The femoral tunnel was identified radiographically and its coronal and sagittal obliquity was measured and compared among both groups. Drilling the femoral tunnel through the low AM portal (as opposed to the TT technique) resulted in a more oblique femoral tunnel position. However, Hoser et al.10 were not able to determine the position of the

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femoral tunnel by radiographs in 21.6% of their cases during their studies. Therefore, they advocated that evaluation of the bone tunnel is more accurately done using computed tomography (CT) rather than plain radiographs. Silva et al. used the CT in their study to assess the tibial and femoral tunnels. They found that the AM portal technique places the femoral and tibial tunnels more centrally in the ACL footprint compared with the TT technique.

Yau et al. examined the difference in the position of bone tunnels prepared by the transportal technique versus the TT technique using magnetic resonance imaging. The average clock position was 10:18 in the transportal group and 10:54 in the TT group. The tibial tunnel positions along the modified Amis line were 47% and 52%, respectively. This revealed that the transportal technique produced better positions of bone tunnels in the femoral and tibial tunnels.

Clinical studies

In a cadaveric study, Arnold et al. showed that more oblique placement of the femoral tunnel reproduced the normal tension curve of the ACL during passive flexion and extension. In a study conducted by Bedi et al., 18 human cadaveric knees were used. Femoral tunnels for ACL reconstruction were prepared by either a TT or AM portal. This made the preparation of a vertical tunnel possible in TT and AM portal. None of bone tunnels in the femoral and tibial tunnels.

Tomkins et al. evaluated femoral tunnel characteristics in 10 matched pairs of cadaveric knees using the AM portal and TT portal drilling. In this study, the use of the AM portal created more anterior and horizontal tunnels in comparison with the tunnels created by the TT technique.

In another cadaveric study, anatomic and biomechanical outcomes of ACL reconstruction were evaluated with TT versus AM portal drilling of the femoral tunnel. Ten human cadaveric knees (five matched pairs) underwent ACL reconstruction in two groups according to each technique. The AM portal for ACL reconstruction controlled tibial translation more than the TT reconstruction with anterior drawer, Lachman, and pivot shift examination of knee stability. Additionally, the AM allowed more accurate positioning of the femoral socket in the centre of the native ACL footprint.

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In contrast, there was a substantially increased risk of critically short tunnel and posterior tunnel blow-out when a conventional offset was used. Increasing knee flexion with AM portal drilling allowed for greater obliquity of the femoral tunnel, but the higher risk of short tunnel and posterior wall anatomic compromise remained the same.

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Clinical studies

Alentorn-Geli et al. compared functional and clinical outcomes of ACL reconstruction using the TT or the AM portal technique for drilling the femoral tunnel in 47 patients. Blinded assessments of International Knee Documentation Committee (IKDC) score, knee stability and range of motion, one-leg hop test, mid-quadriiceps circumference, visual analog scale (VAS) for satisfaction with surgery, Lysholm scores, and SF-12 questionnaire were obtained for both groups. The AM portal group demonstrated a significantly lower recovery time from surgery to walking without crutches, to return to normal life, and to return to play. Knee stability values were significantly better for the AM portal group compared to the TT group. No differences were found in VAS for satisfaction with surgery.

In a short-term study conducted by Koutras et al., 51 patients were included and data were collected at 3 and 6 months after surgery. The AM approach group had better Lysholm scores at 3 months and better performance in the time movement function tests at 3 and 6 months. No other comparisons were significant.

Ku Kim et al. evaluated the clinical results in 33 patients with ACL rupture who were treated by anatomic ACL reconstruction using the two AM portal technique. The control group included 33 patients with ACL rupture who were treated with the conventional TT non-anatomic method. An objective instability test was performed, both preoperatively and at the final follow-up. The clinical results of both groups were compared using IKDC and Lysholm scores as subjective tests. At the final follow-up, in the group of patients who underwent anatomic reconstruction by the two AM portal techniques, results in the pivot shift showed statistically significant improvement compared to the control group. They concluded that anatomic ACL reconstruction by two AM portals is an effective surgical technique that restores rotational stability with excellent clinical results.

Mardani-Kivi et al. compared both techniques in 124 cases. Results showed that the AM portal technique significantly accelerates patients’ return to activity. AM portal patients achieved full range of motion much sooner than TT cases. Knee stability was similar in both groups on Lachman test. AM portal group patients (VAS mean score: 9.78 ± 0.4) had greater satisfaction compared to TT group patients (VAS mean score: 9.53 ± 0.5). Nevertheless, Xu et al. showed no clinical difference between both groups in a study that included 72 patients. No studies showed significantly better results with the TT technique.

Tunnel expansion

Enlargement of bony tunnels after ACL reconstruction is a well-described phenomenon. A small degree of tunnel widening occurs immediately, followed by a gradual increase in the size of the femoral tunnel over weeks to months. It is
unclear whether this widening has a correlation with the clinical outcomes of ACL reconstruction. Nevertheless, clearly, the tunnel widening can increase the difficulties in revision ACL surgery.  

Chhabra et al. studied the effect of the two techniques of drilling the femoral tunnel in ACL reconstruction. The TT technique was used in 41 patients while the AM portal was used in 34 patients. Lateral and 45° anteroposterior radiographs were taken for each patient at a minimum of 6 months postoperatively. The study showed that the tibial expansion for ACL reconstruction is significantly lower for the medial portal technique in comparison to the conventional TT procedure.

**Risk of revision surgery**

Rahr-Wagner et al. studied the findings of the Danish knee ligament reconstruction register to ascertain revision rates after ACL reconstruction using the AM technique versus the TT technique. The failure of the two different techniques was determined using revision ACL surgery as a primary endpoint. The pivot shift test, instrumented objective test and pointed patient outcome were used as a secondary endpoint. The cumulative revision rates for ACL reconstruction after 4 years with the AM and TT techniques were 5.16% and 3.20%, respectively. The increased risk of revision ACL surgery with the AM technique was explained by technical failures resulting from the introduction of a new and more complex procedure.

**Surgical difficulties in AM portal technique**

There are various difficulties with the AM portal technique:

- Short femoral tunnels: This could be minimized by hyperflexion of the knee. Additionally, precious tunnel measurement is advisable before final femoral tunnel reaming.

- Back wall blowout: This could happen because, during extreme knee flexion, the socket will be parallel to the true back wall of the intercondylar notch. This could be avoided by conservative selection of appropriate aimer offset. Thus, a guide increment ensuring a substantial back wall should be considered.

- Neurovascular injuries: Distal and/or inferior exit of the Beath pin from the lateral thigh endangers peroneal neurovascular structures. However, this could be avoided or minimized by hyperflexion of the knee.

- Difficulty in visualization: This could be attributed to the hyperflexion position. Additionally, visualization could be further obscured when the fat pad is displaced as the reamer is introduced. Therefore, it is advisable to mark the center of the planned femoral socket before the knee is hyperflexed. This also allows inspection and reviewing of the precise position before reaming; however, this could add an extra step to the surgery, which would be more time consuming. The arthroscopic camera should be positioned superior to the pin-reamer composite looking down. This position and view are relatively easy for an assistant to maintain during the hyperflexion manoeuvre and hyperflexion position.

- Drilling angle: The Beath pin drilling angle determines the angle of the femoral socket. This is important to achieve adequate socket length and to ensure that the pin avoids the neurovascular structures. The reamer can be used as a Beath pin sleeve; this ensures more superiorly angled egress of the Beath pin out of the anterolateral thigh. The drill may be removed from the Beath pin and a power reamer may be changed to an acorn reamer without additional factors.

- Difficulty in determining socket depth: It could be difficult to visualize and read the 5 mm laser-marked depth markings on the acorn reamer. This could be due to a combination of reaming debris and poor flow of arthroscopic fluid, which occurs in the hyperflexion position. A good tip is to read the laser marks by direct visualization as they pass the AM portal at the skin when the arthroscopic view is obscured.

**Surgical modifications in the TT technique**

Some studies have shown that with appropriate modifications of the TT surgical technique, better long-term outcomes and lower failure rates can be achieved. These modifications include the use of an accessory transepiphysial tendon portal for placement of the tibial aiming device; the use of a tibial tunnel starting point at the junction of pesanserinus and medial collateral ligament fibres; and adequate rotation of the 7 mm offset femoral wire aimer. These modifications will improve laterализation and adjustment of the tibial aiming device to achieve 55°–60° of angulation of the tibial tunnel in the coronal plane.

**Conclusion**

The AM portal technique for ACL reconstruction has many advantages. In comparison with the TT procedure, the AM portal technique allows unconstrained femoral socket positioning. We prefer using the AM portal approach in our cases. Our only relative contraindication is in patients with morbid obesity. In general, the AM technique can be more technically demanding and have a steep learning curve. Therefore, careful and meticulous surgical techniques and expert surgeons are indicated for these cases.

References


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