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ORIGINAL RESEARCH

Identification of Anterior Cruciate Ligament Tunnel Drilling Technique Using X-Ray

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ABSTRACT

Introduction: Anterior cruciate ligament (ACL) reconstruction is commonly performed and surgeons use different techniques to drill the femoral tunnel. Failed ACL reconstruction is most frequently due to tunnel malposition. The ability to identify which tunnel drilling technique was used is important in revision situations. The purpose of our study was to evaluate the utility of radiographs in differentiating between femoral tunnels drilled through the anteromedial portal or the transtibial tunnel.
Methods: Radiographs from 40 patients (20 transtibial tunnel technique and 20 anteromedial portal technique) were presented to 8 different reviewers (4 orthopaedic faculty and 4 trainees), at two separate occasions. We evaluated the overall number of times the correct technique was identified, as well as compared the accuracy of the observers' first and second attempts. The accuracy of faculty surgeons was compared to that of trainees.
Results: The correct technique was identified 591/640 (92.3%) times. There was no difference between the accuracy of faculty members and trainees in identifying the correct technique (93.4% vs 91.2%, respectively. There was no difference in accuracy between the first and second trials (92.5% and 92.2%, respectively). Intraobserver agreement was high, at 92.8% for all trials. 34 of 40 (85%) of radiographs were identified correctly on at least 6 of 8 attempts.
Discussion: Radiographs are a useful tool in distinguishing between femoral tunnels drilled using the transtibial tunnel and anteromedial portal in ACL reconstruction. Faculty and trainees alike are highly accurate in identifying the technique utilized. When the radiographs are unclear, repeat radiographs or additional axial imaging may be necessary in planning revision ACL reconstruction.
Keywords: ACL reconstruction; Anteromedial portal; Transtibial tunnel.

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INTRODUCTION

Anterior cruciate ligament (ACL) tears are often treated surgically with ACL reconstruction. Surgical technique for reconstruction of the ACL involves drilling of tibial and femoral

tunnels to reproduce the ligament's origin and insertion, through which a graft is passed. Various techniques exist for ACL reconstruction, each with their own rationale, advantages, and limitations. Tunnel position is a key determinant in ACL reconstruction, with tunnel malposition cited as a leading cause of graft failure after ACL reconstruction (1).

Independent positioning of the femoral tunnel allows for placement of the femoral tunnel lower on the lateral femoral condyle to more closely reproduce the anatomic position of the ACL's femoral footprint (2,3). A two-incision technique offers the ability to position the femoral tunnel independently without being constrained by the tibial tunnel position. In recent decades, a one-incision arthroscopic technique has become popular and has yielded good clinical results. The femoral tunnel guide pin and reamer are passed through the tibial tunnel to access the lateral femoral condyle in the intercondylar notch to create the tunnel, obviating the need for a separate incision. More recently, femoral tunnel drilling through an anteromedial arthroscopic portal has become much utilized, allowing the surgeon to return to independent tunnel drilling in order to improve the ability to replicate the ACL's femoral footprint without compromising the tibial footprint's position. The anteromedial portal technique for drilling femoral tunnels is reported to achieve a more oblique femoral tunnel position, and typically results in shorter tunnel length than tunnels created with the transtibial technique (4-6).

In cases of revision ACL reconstruction, a clear understanding of previous tunnel position is required for proper surgical planning of revision surgery. The purpose of our study was to evaluate the utility of using radiographs alone in determining whether a femoral ACL reconstruction tunnel was created using the anteromedial portal technique or the transtibial tunnel technique. Our hypothesis was that surgeons would have a high level of accuracy in identifying which technique was used. In addition, we believed that faculty orthopaedic surgeons would more frequently identify the technique correctly compared to trainees.

MATERIALS & METHODS

Approval from our facility's institutional review board was obtained to review patient charts and radiographs for this study. We identified a series of consecutive patients who underwent ACL reconstruction by a single surgeon using either anteromedial portal or transtibial tunnel technique to create the femoral tunnel. Criteria for inclusion in the study included reconstruction using patellar tendon bone-tendon-bone graft and fixation using radiolucent interference screws. Patients were excluded from the study if a different graft type (Achilles tendon, hamstring) was used, or if radio-opaque interference screws were utilized. Patients were also excluded if their initial follow-up radiographs had distinguishable, unique identifiers such as additional visible implants or a brace. The most recent 20 patients from each group were included in the study. Each patient at our center has a radiograph of the knee taken at the initial 2-week postoperative clinic visit. These radiographs were saved for each of the included patients. An anteroposterior and lateral view of the knee was included for each patient. Patient identifiers were removed from the radiographs. The radiographs were presented in random order to eight observers on two separate occasions

separated by at least ten days. Each observer was asked to identify whether they believed the femoral tunnel was created using the anteromedial portal or the transtibial tunnel. Four observers were sports medicine fellowship-trained orthopaedic surgeons, and four observers were orthopaedic surgery trainees (upper-level residents or fellows with prior surgical exposure to ACL reconstruction).

Data were collected and evaluated to compare the overall number of times the correct technique was identified. The data were further analyzed using the Student's t-test to determine if there was a statistically significant difference in correct identifications between faculty surgeons and resident surgeons. Similarly, we sought to identify any difference in the number of correct responses between the first and second trial. Intraobserver reliability was also determined.

RESULTS

Overall, 591/640 (92.3%) of the observations resulted in correct identification of femoral tunnel drilling technique. The mean and median numbers of correct responses per observer were 36.9/40 (92.2%) and 37/40 (92.5%), respectively. Faculty observers correctly identified the technique a mean and median of 37.4/40 (93.4%) and 37.5/40 (93.8%) times, respectively, compared to a mean and median of 36.5/40 (91.2%) and 36.5/40 (91.2%) times, respectively, for trainees (p=0.49). The mean numbers of responses correct in the first attempt and second attempt were 37.0/40 (92.5%) and 36.9/40 (92.2%), respectively (p=0.92). 22/40 (55%) of the radiographs were identified correctly on all attempts. 29/40 (72.5%) of the radiographs were identified correctly on at least 7/8 attempts. 34/40 (85%) of the radiographs were identified correctly on at least 6/8 attempts. The intraobserver agreement for all assessments was 92.8%.

DISCUSSION

The purpose of this study was to evaluate the utility of using radiographs alone to determine whether a femoral ACL reconstruction tunnel was created using the anteromedial portal technique or the transtibial tunnel technique. Our hypothesis that surgeons would have a high level of accuracy in identifying which technique was used was shown to be correct. However, our hypothesis that faculty surgeons would have a higher level of accuracy in identification than trainees was incorrect; there was no statistical difference in accuracy between the groups. The ability to differentiate between these two commonly used ACL reconstruction techniques is necessary when evaluating a patient who pre-

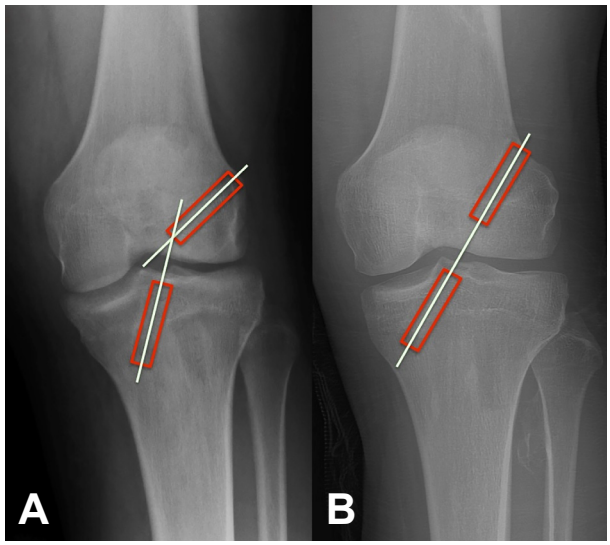

Figure 1. Difference in obliquity of the femoral tunnel using anteromedial portal drilling technique (A) versus the transtibial tunnel drilling technique (B). The tunnels drilled using the transtibial tunnel technique are close to parallel.

viously underwent ACL reconstruction with subsequent graft failure. The surgeon needs an understanding of the technique used for the index procedure in order to adequately plan revision surgery, and to determine whether previous interference screws will need to be removed and their voids filled. Our results show that surgeons are very capable at identifying the femoral tunnel drilling technique by using only radiographs (92.3% accurate). In addition, trainees are statistically just as effective with this task as attending surgeons.

It appears that certain radiographs in our study had a propensity to be incorrectly identified. In 85% of cases, at least 6/8 observations yielded the correct response. This underscores the importance of quality anteroposterior and lateral radiographs in the office setting. To this point, if multiple attempts by different surgeons fail to yield agreement on technique used for femoral tunnel drilling, the provider should consider obtaining new radiographs with improved technique, or an axial imaging study such as MRI or CT.

An estimated 10,000 to 20,000 revision ACL reconstructions are performed annually (7). Preoperative workup in each of these cases usually involves clinical examination, radiographs, and often some type of axial imaging for evaluation of the graft, the position of tibial and femoral tunnels, and hardware.

The Multicenter ACL Revision Study (MARS) found that in 276/460 (60%) cases of revision ACL reconstruction "technical cause of failure" was cited as a reason for revision surgery. Of these, in 210 (47.6% overall) femoral tunnel malposition was cited as a cause of failure, and in 117 (25.4% overall) cases it was the only identified cause of failure. The majority of malpositioned femoral tunnels were too anterior, too vertical, or a combination of both. The majority of revision cases (82.1%) involved the drilling of entirely new femoral tunnels (1).

If the initial graft and hardware will interfere with proper revision graft positioning, they can be removed with the remaining voids filled with either bone graft or bioabsorbable screws. Alternatively, the hardware can be left in place if it will not interfere with optimal tunnel positioning for the revision. It is important for the treating surgeon to understand the various tunnel drilling techniques and be able to identify this technique by using imaging. An understanding of tunnel position and graft obliquity is important in order to correct any shortcomings of the initial surgery. Tunnel position can be evaluated using radiographs, CT, and MRI. CT and MRI are more costly, but offer a three-dimensional view of the tunnels. A CT-based classification has been developed for femoral tunnel location (8). CT exposes the patient to an increased level of radiation. The ability to determine which femoral tunnel drilling technique was used using radiographs alone would be cost-effective and expose the patient to less radiation than CT.

Biomechanical and clinical data supports the use of anteromedial portal technique in ACL reconstruction. Biomechanical studies have examined the advantage of anteromedial portal drilling in recreating the anatomy of the femoral ACL footprint (9-13). Given that the technique is gaining popularity, it can be expected that a certain proportion of failed ACL reconstructions will have femoral tunnels drilled using anteromedial portal technique.

Femoral tunnels are shorter, and more oblique when created using antero-

medial portal technique compared to transtibial tunnel technique (4,5,14). Knowledge of these differences can be helpful when attempting to determine which technique was used by radiographs or coronal CT or MRI. Our observers noted that the obliquity of the femoral tunnel compared to the tibial tunnel on the anteroposterior radiograph was one of the most easily recognized factors helping them differentiate between tunnels drilled using anteromedial portal and transtibial tunnel technique. Femoral tunnels created with transtibial tunnel technique appear to be parallel to the tibial tunnel, which is intuitive given that the femoral tunnel was created with a reamer that was constrained by the tibial tunnel. Figure 1A shows the outline of tunnels created using the anteromedial portal; Figure 1B shows the outline of tunnels created using the transtibial tunnel technique.

Radiographs have been used for many years for evaluation of bone tunnel and interference screw position after ACL reconstruction. A comparative study by Lemos et al. (15) in 1993 compared tunnel position in 50 patients who had undergone ACL reconstruction using either a two-incision technique or transtibial tunnel technique. The study used anteroposterior and lateral radiographs alone to identify differences between tunnel and screw positions and angles. They noted that the anteroposterior and lateral screw angles were different using each technique. Over twenty years later, the two-incision technique is performed less frequently. The advent of the anteromedial portal drilling technique in large part represents a desire to return to a femoral tunnel that is created independently from the tibial tunnel. Independently drilled femoral tunnels centered at the anatomic footprint of the ACL are of similar obliquity, whether created using inside-out (anteromedial portal technique) or outside-in (two-incision technique) methods. It should thus stand that the differences in tunnel position and obliquity noted by Lemos et al. (15) should be recognizable to radiograph observers today.

Limitations of our study include the quality of postoperative images obtained. Multiple observers identified certain studies incorrectly, suggesting that radiograph quality may have contributed to the ability to identify tunnels. A controlled situation was created in which the observers were given two techniques to choose from, thus simplifying the identification process. In reality, more than two techniques exist to create the femoral tunnel. Our study evaluated patients in whom bioabsorbable interference screws were used. This makes tunnel/screw identification much more difficult than if metal screws were used.

CONCLUSIONS

We conclude that radiographs are a useful tool in distinguishing between femoral tunnels drilled using the transtibial tunnel and anteromedial portal in ACL reconstruction. Orthopaedic sports medicine fellowship-trained faculty and senior trainees alike were highly accurate in determining which tunnel drilling technique was utilized. When findings are unclear, repeat radiographs or additional axial imaging may be necessary in planning revision ACL reconstruction.

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