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Original article

CT assessment of femoral tunnel placement after partial ACL reconstruction

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ABSTRACT

Introduction: When one of the anterior cruciate ligament (ACL) bundles is torn, it seems appropriate to preserve the remaining bundle to improve the vascularization and proprioception of the graft, and to reproduce the attachment sites of the torn bundle. After ACL reconstruction, the functional result is worse when the tunnels are positioned further away from the native ACL's isometric attachment points. The goal of this study was to use CT 3D reconstructions to analyse the position of the femoral tunnel following partial ACL reconstruction and to compare it to complete ACL reconstruction cases. We hypothesized that the femoral tunnel positioning was optimal during partial ACL reconstruction.
Methods: In this prospective single-centre study, 16 patients who underwent isolated anteromedial bundle reconstruction were evaluated during the immediate postoperative period using 3D reconstruction of CT images. During this same period, 180 patients who underwent complete ACL reconstruction in the same surgery unit served as a control group.
Results: In the partial ACL reconstruction group, 6 tunnels (37.5%) were in the optimal position and 10 tunnels (62.5%) were not. In the complete ACL reconstruction group, 124 femoral (68.9%) were in the optimal position and 56 (31.1%) were not ($P < 0.05$).
Discussion: Femoral tunnel positioning is not always optimal in patients who undergo partial ACL reconstruction. Three-dimensional CT reconstruction is a good tool to help surgeons detect and learn from their errors.
Level of evidence: III (case-control study).

1. Introduction

Partial anterior cruciate ligament (ACL) ruptures make up 12–28% of all ACL ruptures [1–3]. The anteromedial (AM) bundle is most often injured [1–3]. The anatomy and biomechanics [4,5] of the anteromedial and posterolateral ACL bundles have been extensively studied over the past 15 years. One or both bundles can be stretched or torn when the knee is injured. During ACL reconstruction, preserving macroscopically intact fibres improves the graft's vascularization [6,7] and proprioception [8,9]. These notions have led to partial reconstruction of the remaining fibres being performed during the ACL reconstruction [5,10–13].

After ACL reconstruction, the IKDC score is worse when the tunnels are placed further away from the native ACL's isometric attachment points [14,15]. Partial reconstruction must supplement the role of the spared fibres and must theoretically have its insertion at the footprint of the missing bundle, while preserving the remaining fibres.

Three-dimensional (3D) reconstruction of computed tomography (CT) images is currently the best method to determine whether the ACL graft is positioned correctly [16,17]. In our surgery unit, it has been used in every case of ACL reconstruction surgery since 2012. To our knowledge, there are no published studies on femoral tunnel placement on CT images after partial ACL reconstruction.

Using a series of 3D reconstructed CT images, the objective of this study was to evaluate the position of the femoral tunnel after partial ACL reconstruction and to compare it with the position achieved during complete ACL reconstruction. We hypothesized that femoral tunnel positioning was optimal during partial ACL reconstruction.

2. Materials and methods

This was a prospective, single-centre study performed over a 1-year period by four senior surgeons. The inclusion criterion was

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an isolated anteromedial bundle reconstruction and postoperative evaluation of the reconstruction using 3D CT reconstruction.

The following inclusion criteria were used:

- partial ACL tear involving the AM bundle, with the remaining PL bundle being functional;
- reconstruction of the AM bundle only;
- postoperative evaluation of the reconstruction with 3D CT reconstructions.

Since CT scans have been performed systematically in our surgery since 2012, this was a study of current practices.

Exclusion criteria were a complete ACL tear, full PL bundle tear or full AM tear with non-functional or stretched out PL bundle.

The preoperative diagnostic assessment consisted of a clinical examination, standard X-rays, an MRI and an anterior drawer test (Telos Stress®, Germany, 2010). The final decision to perform selective AM bundle reconstruction was made during arthroscopy. The integrity of the PL bundle was verified during arthroscopy with the leg in Cabot's figure-of-four position [3]. The tension on the remaining bundle was tested using a probe and the anterior drawer test. Although two different techniques were used (depending on the surgeon's preference), the femoral tunnel-positioning objective was the same for both techniques.

The intercondylar notch was debrided with a shaver and small curette (while preserving the PL bundle) until the posterior margin of the lateral condyle was well exposed. The femoral intra-articular positioning objective was the same. The pin's desired exit or entry point was marked with electrocautery tip. The optimal location was within the AM bundle footprint, i.e. 5–6 mm from the posterior side of the lateral condyle. It also should be 4 mm posterior to the lateral intercondylar ridge. For a right knee, it should be between 9:30 and 11:00 o'clock relative to the apex of the intercondylar notch [18–21].

The first technique was a bone-patellar tendon-bone (BTB) graft in 10 cases. The femoral tunnel was drilled using an outside-in method (Phusis® aimer, Saint-Ismier, France) [22]. The location of the future AM bundle was marked with an electrocautery tip, and then verified by introducing the scope in the anteromedial portal. The femoral fixation as performed by press-fit impaction of the bone ends of the graft.

The second technique was a semitendinosus (ST) graft in 6 cases. The femoral tunnel was drilled using a blind inside-out method (Smith & Nephew® aimer, Andover, MA, USA) [23]. The location of the future AM bundle was marked with an electrocautery tip, and then verified by introducing the scope in the anteromedial portal. The femoral fixation of the graft was performed using the CL endobutton (Smith & Nephew®, Andover, MA, USA).

The method used to mark the femoral tunnel location was the same in both techniques.

2.1. CT scan analysis

A CT scan was performed on postoperative day 1 or 2; a standardised protocol was used to analyse the femoral tunnel position [16]. The patella, tibia and fibula were removed from the 3D reconstruction. The analysis was done using four specific views (Fig. 1).

The images were processed using Centricity® software (GE Medical Systems, 2006). The tunnel was analysed in a blinded manner

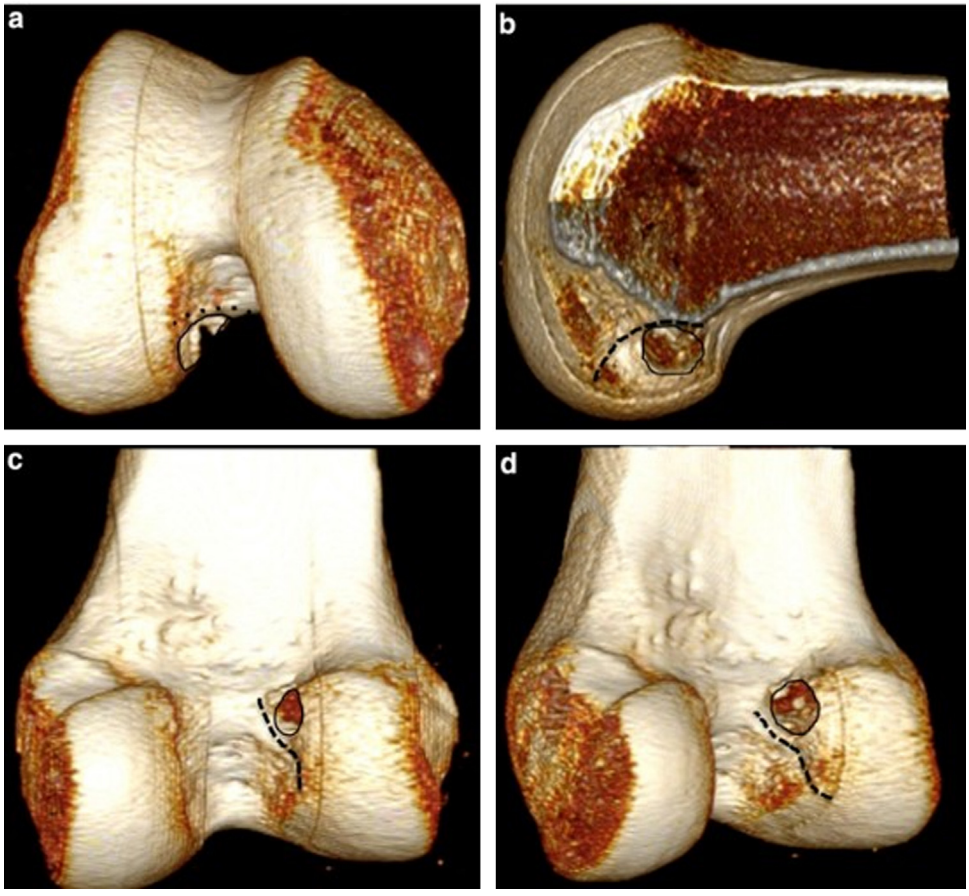

Fig. 1. Right knee CT 3D reconstruction: a: distal view with 20° external rotation; b: medial view of lateral condyle; c: direct posterior view; d: posterior view with 20° internal rotation. Dotted line: the resident's ridge and circle represent the optimal positioning as defined by Hefzy and Grood [15].