Technical note
A new technique to avoid articular cartilage injury in anterior cruciate ligament reconstruction through far antero-medial portal
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ARTICLE INFO

Article history:
Accepted 17 June 2014

Keywords:
Anterior cruciate ligament reconstruction
Far antero-medial portal technique
Cartilage damage

ABSTRACT
Far antero-medial (FAM) portal technique is usually used in our department in anterior cruciate ligament (ACL) reconstruction when drilling the femoral tunnel. Although the FAM portal technique carries potential risks, such as cartilage injury of the lateral femoral condyle, peroneal nerve injury and blow out of the lateral femoral condyle’s posterior wall, these problems were resolved in a cadaveric study, in which 110 – 120° knee flexion was recommended when drilling the femoral tunnel. However, there is a potential risk of injuring the cartilage of the medial femoral condyle especially when drilling the postero-lateral bundle. A new method is proposed to ensure that the femoral tunnel drilling does not damage the cartilage of the medial femoral condyle.

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1. Introduction

The anterior cruciate ligament (ACL) reconstruction technique improved with the advancement of an anatomical study and of surgical instruments, enabling reconstruction of an authentic anatomical ACL footprint. Thus, a number of comparatively excellent clinical results have been reported, and its basic procedure is established with stable results [1–5]. ACL augmentation procedure preserving ACL remnant was reported for the first time by Adachi et al. in 2000 [6], and then, many reports have been published showing good clinical results [7–10]. In case of ACL remnants, an augmentation procedure is usually performed with the far antero-medial (FAM) portal technique; the incision of the FAM portal is made as medial as possible, especially in selective PL bundle reconstruction because it is not necessary to create the AM tunnel [7]. In such cases, the cartilage injury of the medial femoral condyle is an issue due to the large diameter of the burr. Actually, we experienced a case of the drill potentially injuring the cartilage of the medial femoral condyle. Therefore, Ochi developed a new procedural technique with the FAM portal involving overdrilling, which is performed when insertion of the guide wire may interfere with the medial femoral condyle, rendering linear access impossible at the time of creating a femoral tunnel.

2. Technique

2.1. Creation of a far antero-medial portal

Since 2011, computed tomography (CT) at 120° of knee flexion and reconstructed three dimensional (3D) knee models using the volume rendering technique have been taken to investigate the appropriate insertion point of the FAM portal. At first, the anatomical footprint on the sagittal plane is marked and decides the direction of the guide pin so as not to damage the cartilage of the medial femoral condyle. Then, the intersection of skin and guide pin is defined as the FAM portal position. Using 3D-CT, the length from the medial border of the patellar tendon to the FAM position is measured, in order to make a FAM portal (Fig. 1a and b). After confirming that a 23-Gauge Cathelin needle can access the foot print of the femoral ACL attachment from the defined FAM position under anterolateral arthroscopic view (Fig. 2a and b), an approximately 10 mm longitudinal skin incision is made.

2.2. Creation of a femoral tunnel

The passing pin is inserted at the anatomical position of the femoral ACL attachment, and the tip of the pin is advanced through the femoral skin. Then overdrill is performed using the 4.5 mm Endobutton drill with the passing pin as the guide. However, there is a risk of malposition of the FAM and the tip of the drill may injure the cartilage of the femoral medial condyle (Fig. 3). In such a risk scenario, it is necessary to pull out the terminal of the pin towards the center, and advance it up to the position of 5–10 mm projecting...
from the femoral attachment (Fig. 4). The skin incision is shifted inward utilizing the extensible property of the skin, insert the drill into the joint with its tip outward, then gradually turn the direction inward, and advance carefully, so as not to interfere with the cartilage of the medial femoral condyle. After interdigitating the tip of the drill with the terminal of the pin (Fig. 5), the drill is aligned against the pin, and the pin is pushed back into the drill hollow hole until the bone tunnel is created. After confirming that the pin is placed sufficiently deeply into the drill hollow hole, a femoral tunnel is created with overdrilling. In order to pull the drill out from the articular joint cavity, the pin is pulled back, the drill tip is then moving freely, and pulled out slowly turning the direction of the drill tip outward not to injure the cartilage of the medial condyle. By performing the same procedures repeatedly, it is possible to create tunnels for the AM and PL bundles in double-bundle reconstruction.

Fig. 1. a: the anatomical footprint of the PL bundle is marked on the sagittal plane; b: the direction of the guide pin is determined, so as not to damage the cartilage of the medial femoral condyle. The intersection of the skin and guide pin is defined as the far antero-medial portal position (arrowhead). (Dotted line: the length from the medial border of the patellar tendon (arrow) to the FAM position).

3. Discussion

Three ACL reconstruction femoral drilling methods include: far antero-medial portal technique, transtibial technique and outside-in technique [11]. Each procedure has been reported to have some disadvantages [12–15]. The transtibial technique is technically demanding when creating the femoral tunnel, especially in double bundle ACL reconstruction because the position of the femoral tunnel is dependent on the position and angle of the tibial tunnel [13]. The outside-in technique is a more invasive procedure because it is necessary to make an additional incision on the lateral side of the distal end of the femur. The FAM portal technique carries the potential risks of injuring the cartilage of the lateral femoral condyle of causing blowout of the posterior wall, of damaging the attachment of the lateral collateral ligament and of damaging the peroneal nerve. However, the mechanism of risks of the FAM portal technique has been solved and it is now possible to create the femoral tunnel safely [14,15]. Nakamura et al. and Zantop et al. recommend a high knee flexion position of more than 110° to prevent peroneal nerve injury, cartilage damage of the lateral femoral condyle and injury to the attachment of the lateral collateral ligament [14,16]. Nakamae et al. recommend a knee flexion angle of between 110° and 120° to avoid damage of the lateral collateral...
ligament and cartilage injury of the lateral femoral condyle when drilling the PL tunnel [15].

For the above reasons, the FAM portal technique is used in our department when creating the femoral tunnel. The FAM portal is made as far away as possible from the medial border of the patellar tendon, in order to prevent the risks associated with the FAM portal technique, but there is a possibility of injury to the cartilage of the femoral condyle, especially with narrow intercondylar notch cases and in creating the PL bundle. There have been no reports that indicate the risks of cartilage injury of the medial femoral condyle when drilling the femoral tunnel. As mentioned above, we experienced a case where the drill would have injured the cartilage of the medial femoral condyle. Therefore, Ochi developed new method to make the femoral tunnel, so as not to injure the cartilage of the medial femoral condyle. It is vital not to injure cartilage when inserting a 2.4-mm guide pin, but the passing pin might pass through at the exactly the intersection with cartilage when drilling the femoral tunnel at the anatomical position. This method will be useful in such cases as there is a high risk to injure the cartilage in overdrilling.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References