Tunnel Communication and Increased Graft Signal Intensity on Magnetic Resonance Imaging of Double-Bundle Anterior Cruciate Ligament Reconstruction

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Purpose: This study aimed to evaluate the association between magnetic resonance imaging (MRI) findings of tunnel communication and increased graft signal intensity (SI) and clinical evaluation of knee stability and outcome after double-bundle (DB) anterior cruciate ligament (ACL) reconstruction. **Methods:** Fifty-nine patients were evaluated with 1.5 T MRI and with clinical evaluation 2 years after DB ACL reconstruction. The MRI finding of tunnel communication was defined as the absence of a bony bridge between the anteromedial (AM) and posterolateral (PL) tunnels. The SI of the intra-articular portion of both grafts was analyzed on proton-density (PD)-weighted and T2-weighted images and graded on a scale, with I being a normal SI similar to that of the posterior cruciate ligament, II being $>$ 50% of the graft having a normal SI, and III being $<$ 50% of the graft having a normal SI. The clinical evaluation of knee stability and function included KT-1,000 arthrometric side-to-side difference, pivot shift test, and International Knee Documentation Committee (IKDC) and Lysholm knee evaluation scores. The association between the MRI findings and the clinical findings was calculated using the Fisher exact test and the 2-tailed t test. **Results:** Tunnel communication was seen in the femur in 10% of patients and in the tibia in 27% of patients. Increased graft SI was seen in 15% of the AM grafts and 59% of the PL grafts. No statistically significant association ($P < .05$) between the MRI findings of tunnel communication or increased graft SI and knee laxity was found. **Conclusions:** The MRI findings of tunnel communication or increased graft SI were not associated with knee laxity 2 years after DB ACL reconstruction. Tibial tunnel communication was associated with increased range of movement with flexion, and increased AM graft SI was associated with reduced range of flexion in the knee. **Level of Evidence:** Level IV, therapeutic case series.

The aim of double-bundle (DB) anterior cruciate ligament (ACL) reconstruction is to restore the anatomy of the 2 bundles of the native ACL.[1-3] During reconstruction, 2 bone tunnels are created in both the femur and the tibia. The apertures of the anteromedial (AM) and the posterolateral (PL) tunnels on the lateral femoral condyle and on the tibial footprint are close to each other at the anatomic ligament insertion sites.[4] Intraoperative drilling or bone tunnel widening may lead to tunnel communication.[5,6] Previously, tunnel communication has been seen in 11% to 19% of patients in the femur and in 24% to 29% of patients in the tibia.[5,6]

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Magnetic resonance imaging (MRI) is widely used for the postoperative evaluation of ACL reconstruction. According to the literature, normal DB ACL grafts should be hypointense on proton-density (PD)-weighted and T2-weighted MR images after the revascularization period 1 to 2 years postoperatively.[7,8] Because DB ACL reconstruction is a relatively new technique, the clinical significance of MRI findings of tunnel communication and increased graft signal intensity (SI) seen postoperatively is unclear at the moment.

The association between increased graft SI seen on MRI and knee laxity has been studied in both single-bundle (SB) and DB ACL reconstructions.[9,10] In an SB ACL study, no association between increased graft SI and knee laxity was found 4 to 12 years postoperatively.[9]

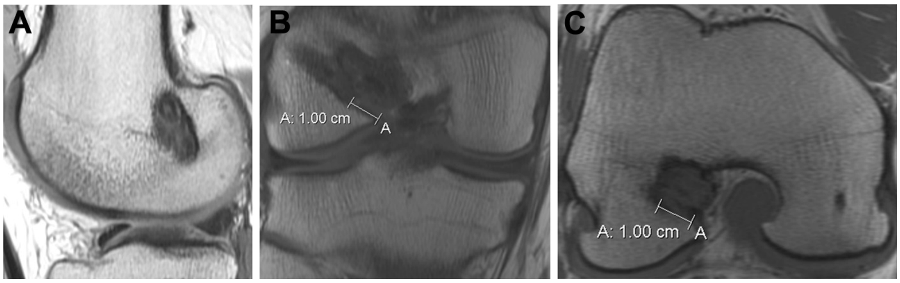

Fig 1. Femoral tunnel communication seen on (A) sagittal proton-density (PD)-weighted MRI of right knee. Both grafts are seen in a common aperture at the lateral femoral condyle.[5] (B) Coronal T1-weighted MRI of right knee. No bony bridge between the tunnels is visible 1 cm from the articular surface.[5] (C) Oblique axial T1-weighted MRI of right knee. No bony bridge between the tunnels is visible 1 cm from the articular surface.[5]

Conversely, in a previous DB ACL study, an increased AM graft SI was associated with anterior laxity and an increased PL graft SI was associated with rotational instability at 1 year postoperatively.[10]

The purpose of our study was to evaluate the association between the MRI findings of tunnel communication and increased graft SI and the clinical evaluation of knee stability and function, which included KT-1,000 arthrometric side-to-side difference, pivot shift test, and International Knee Documentation Committee (IKDC) and Lysholm knee evaluation scores 2 years after DB ACL reconstruction. Our hypothesis was that tunnel communication is associated with knee laxity and that increased graft SI is not associated with knee laxity.

Methods

Patients

The prospective study population comprised 59 nonconsecutive patients who had undergone DB ACL reconstruction carried out by an experienced orthopaedic surgeon (T.J.) between 2004 and 2008. The inclusion criteria were primary ACL reconstruction, closed growth plates, and the absence of associated ligament injury to the index knee and the absence of ligament injury to the contralateral knee. The study was approved by the Medical Ethics Committee at Tampere University Hospital. Written consent was required.

The preinjury activity level of the patients was as follows: 22% participated in competitive sports, 62% participated in recreational sports, and 10% participated in no sports activities. The sporting activities of the patients were soccer, floor ball, baseball, downhill skiing, judo, track and field, squash, volleyball, kickboxing, snowboarding, ice hockey, cross-country skiing, orienteering, badminton, capoeira, jujutsu, and football.

Surgical Technique

The DB technique used in this study has previously been described in detail.[4] In brief, the torn ACL remnant was debrided, but the tibial ACL footprint was left intact. The femoral tunnels were drilled using an AM portal, and a free-hand technique was used for the anatomic insertions of the AM and PL bundles of the ACL. The tibial tunnels were drilled at the anatomic insertion sites of the ACL bundles at the tibial footprint with a tibial guide. The bony wall between the AM and PL tunnels was at least 1 to 2 mm on both femoral and tibial sides. Notching of each tunnel was performed. In the femur, the notcher was driven into the tunnel

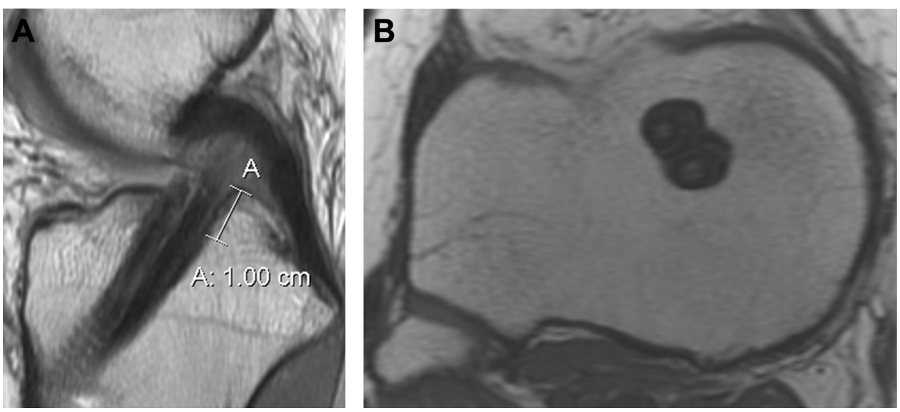

Fig 2. Tibial tunnel communication seen in (A) sagittal proton-density (PD)-weighted MRI of right knee. No bony bridge between the tunnels is visible 1 cm from the articular surface.[5] (B) Oblique axial T1-weighted MRI of right knee. Both grafts are seen in a common aperture in the tibia.[5]