



# Anomalous insertion of the medial meniscus into a triple bundle anterior cruciate ligament: A rare combination of two anatomical variants

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## ABSTRACT

Rare anatomical variants in the human knee joint include the anomalous insertion of the medial meniscus (AIMM) into the anterior cruciate ligament (ACL) or the presence of a triple bundle ACL. The functional implications of those anomalies have not yet been fully elucidated and might be important in reconstructive surgery of the damaged knee.

We report the case of a 35-year-old female patient with an AIMM into a triple bundle ACL associated with tears of the medial meniscus in both of her knees. Arthroscopic partial meniscectomy was performed on one side, and conservative treatment with physiotherapy was chosen for the other side with good clinical outcomes.

## 1. Introduction

Several anatomical variants of the human meniscus have been described with discoid variants being the most frequent (prevalence of 3–5 %) [1]. Hypoplasia of the anterior horn [2] or complete absence of the meniscus [3,4] have been reported as well. Anomalous insertion of the medial meniscus (AIMM) into the anterior cruciate ligament (ACL) is rare with a prevalence of 1.2–2.3 % [5,6]. The insertion site of the AIMM into the ACL can be classified into three subtypes: type 1 (into the lower portion), type 2 (into the middle portion) and type 3 (into the proximal portion; intercondylar notch), with the lower insertion type being the most common [6]. To this day, it remains unclear whether or not the presence of an AIMM can lead to clinical problems.

The ACL is traditionally considered to anatomically contain two separate bundles, the anteromedial and posterolateral bundle. Arthroscopic and cadaveric studies have postulated the presence of a third intermediate bundle as an anatomic variant of the ACL [7,8]. Only recently, radiological evidence for the triple bundle ACL was presented by MacKay et al. [9] who demonstrated a third ACL bundle in 15 out of 73 human knees (prevalence of 20.5 %). If present, it is believed that the intermediate bundle of the ACL participates to rotatory stability of the knee, especially in flexion angles from 30–45° [8].

Although there have been reports on the AIMM and the triple bundle ACL, the combination of both has not been published so far. We report a case of a patient with an AIMM into a triple bundle ACL in both knees associated with tears of the medial meniscus.

## 2. Case report

### 2.1. Left knee

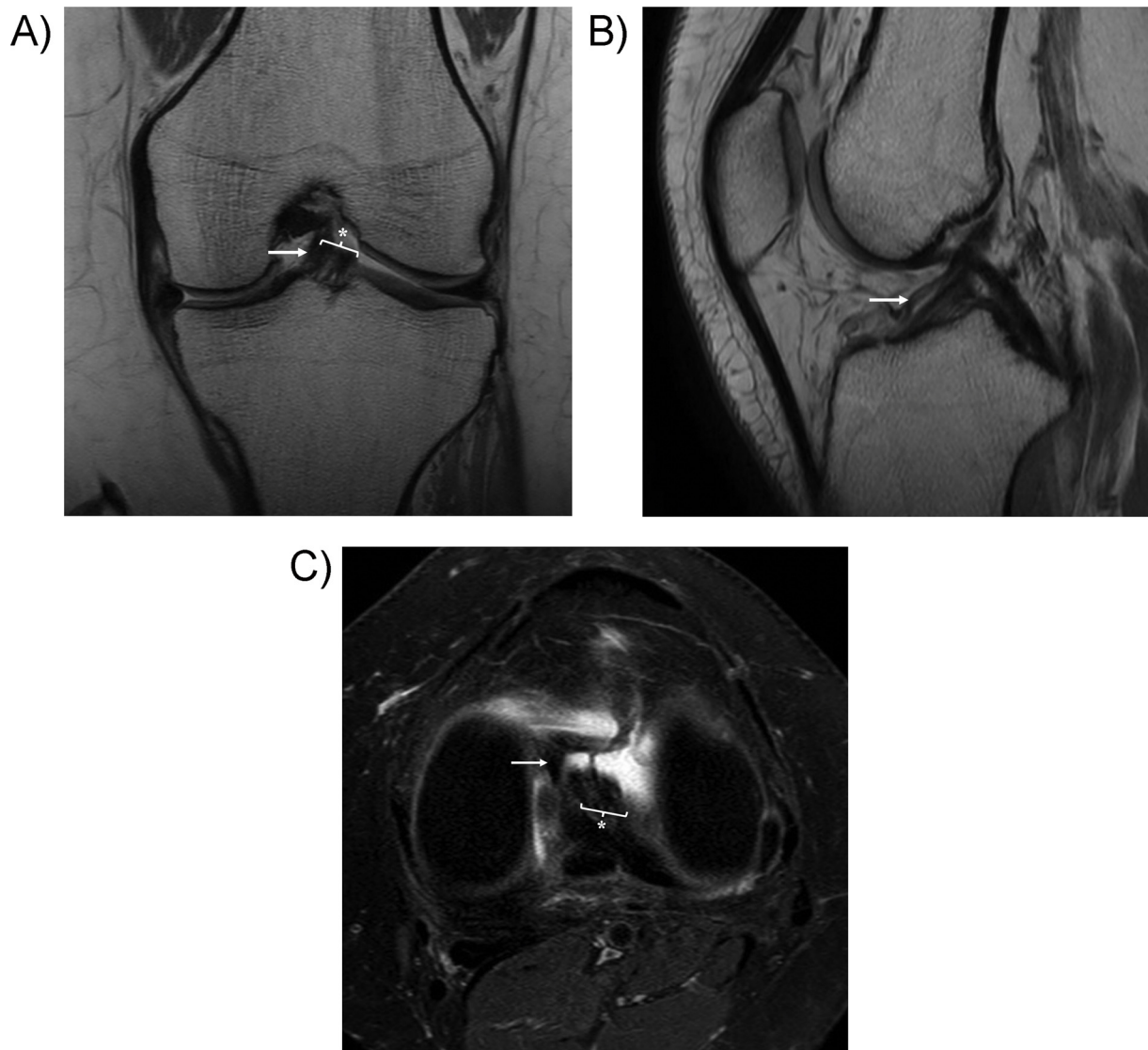
A 35-year-old woman presented to our orthopedic department with left medial knee pain for almost ten years. There was no history of trauma. She reported episodes of blocking of the knee joint, which occurred approximately 1–2 times per month. Conservative treatment with physiotherapy had been unsuccessful over years. On clinical examination, there was pain on palpation of the medial joint space and during functional testing of the medial meniscus. The ACL was normal on clinical examination.

Magnetic resonance imaging (MRI) of the left knee was performed with a 3.0-T scanner (Achieva; Philips Healthcare, Best, Netherlands) by using a dedicated 16-channel knee coil. Intermediate-weighted images were obtained with and without fat saturation in coronal and sagittal planes and with fat saturation in the axial plane (3000 ms / 30 ms repetition time (TR) / echo time (TE) in coronal and sagittal planes, 4469 ms / 30 ms TR / TE in the axial plane; 2.50 mm section thickness in all planes; 768 × 768 matrix in the sagittal plane, 1008 × 1008 matrix in the coronal plane, 640 × 640 matrix in the axial plane; 16 cm field of view (FOV) in the sagittal plane, 15 cm FOV in coronal and axial planes).

MRI of the patient's left knee revealed a large horizontal tear from the anterior to the posterior horn of the medial meniscus with a displaced fragment in the inferior joint recess. In the intercondylar

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**Fig. 1.** (a) Coronal, (b) sagittal and (c) axial intermediate-weighted images of the patient's left knee showing three separate bundles of the anterior cruciate ligament (ACL, asterisks), and insertion of the anterior horn of the medial meniscus into the triple bundle ACL (arrows).

compartment of the knee, three bundles of the ACL (anteromedial, intermediate, and posterolateral) were identified. A ligamentous structure was present, originating from the medial insertion point of the anterior horn of the medial meniscus, partially fusing with the transverse ligament, and inserting into the middle third of the triple bundle ACL (Fig. 1 a–c). The ACL was unremarkable. The lateral compartment of the patient's knee did not show any lesions. There was a discrete chondropathy in the lateral facet of the patella.

Because of the dislocated meniscal fragment causing pain and recurrent blockings of the knee joint, arthroscopic partial meniscectomy was performed. After surgery, full weight bearing was allowed. On the first follow-up six weeks after surgery, the patient was free of pain, and the clinical examination was normal. At the last follow-up seven months after surgery, the patient was still satisfied with the result. The left medial knee pain did not reoccur.

## 2.2. Right knee

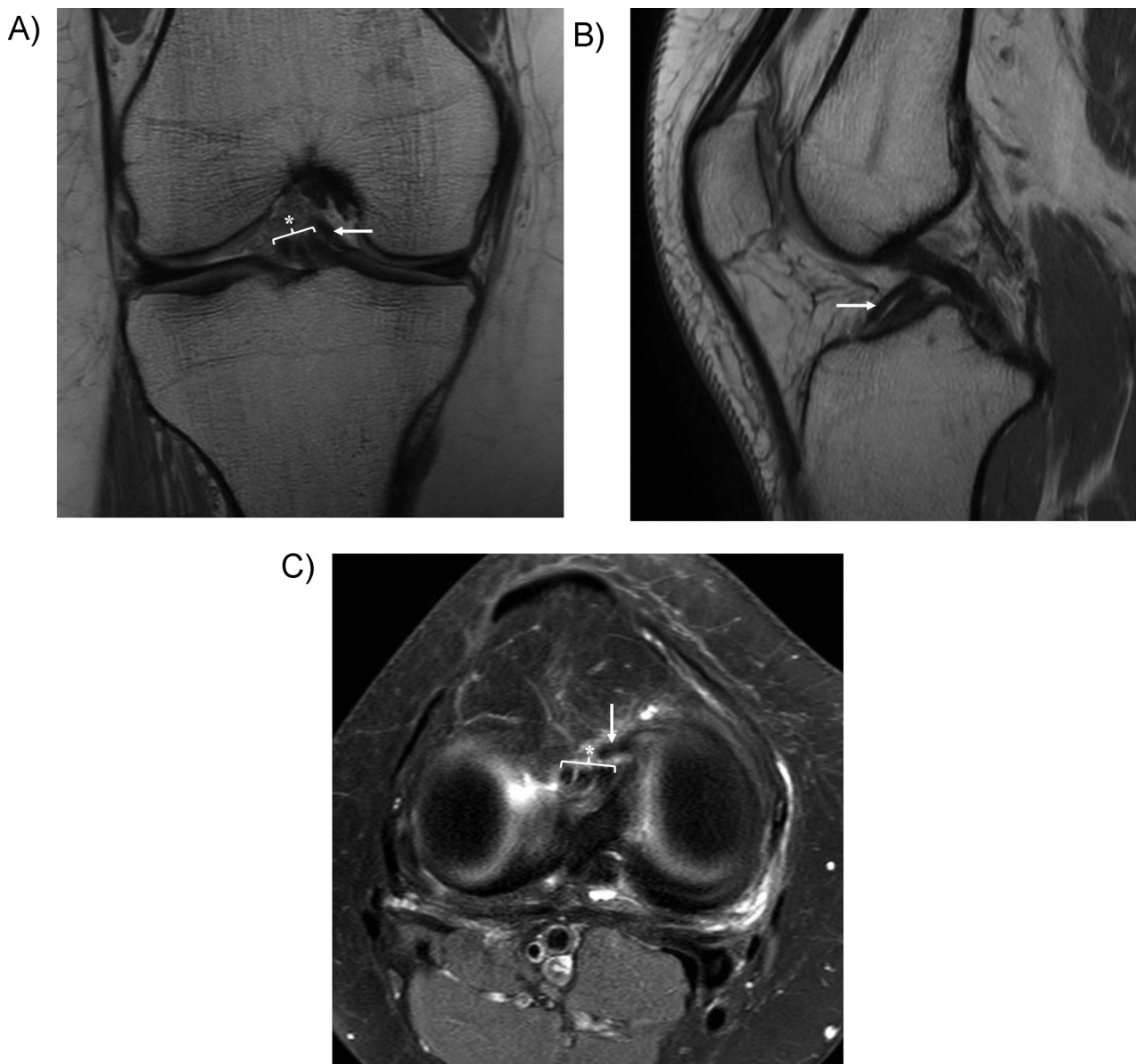
One year after the initial presentation, the same patient consulted the orthopedics' department this time with right medial knee pain without a history of trauma. The left knee was asymptomatic. The clinical examination of the right knee revealed pain on palpation of the

medial joint space and during functional testing of the medial meniscus. The ACL was normal. A degenerative lesion of the medial meniscus was suspected, and MRI of the right knee was performed.

All images were acquired with a 3.0-T scanner (Achieva; Philips Healthcare, Best, Netherlands) by using a dedicated 16-channel knee coil. The same MR protocol, as described above, was used.

MRI of the patient's right knee revealed a transverse tear in the anterior horn of the medial meniscus as well as a horizontal tear in the posterior horn of the medial meniscus. As on the left side, three bundles of the ACL were visible. A part of the anterior horn of the medial meniscus inserted into the middle portion of the intermediate bundle of the ACL (Fig. 2 a–c). There was no tear in the ACL. A few small parameniscal ganglion cysts were present posteromedially, adjacent to the posterior horn of the torn medial meniscus. The lateral compartment did not show any lesions. There was a discrete retropatellar chondropathy.

As symptoms were not always present and quality of life was still acceptable, the patient did not undergo surgery so far and chose to have a conservative treatment with physiotherapy to strengthen the muscles around the knee joint. On follow-up three months after the initial consultation, the medial knee pain was significantly reduced, and the patient was satisfied with the current situation.



**Fig. 2.** (a) Coronal, (b) sagittal and (c) axial intermediate-weighted images of the patient’s right knee showing three separate bundles of the anterior cruciate ligament (ACL, asterisks), and insertion of the anterior horn of the medial meniscus into the triple bundle ACL (arrows).

**3. Discussion**

To our knowledge, this case report is the first description of an AIMM into a triple bundle ACL. In both knees, this anatomical variant was associated with tears in the medial meniscus. The patient did not present any other proven risk factors for developing degenerative meniscal tears such as age above 60, male gender, or work-related kneeling and squatting [10]. Potentially, the presence of an AIMM might be an additional risk factor for developing meniscal tears as the forces acting upon the meniscus might be higher if there is a connection with the ACL, leading to microtraumas and tears eventually. However, there are no biomechanical studies to support this hypothesis so far.

It remains unclear whether the sole presence of an AIMM can lead to clinical symptoms. Kim et al. [11] reported a case series where 4 out of 77 patients had a discoid lateral meniscus with an anomalous insertion of the anterior horn of the medial meniscus into the ACL. The discoid lateral meniscus was reshaped in the four knees, which led to good clinical outcomes. The authors concluded that the AIMM was not related to the patients’ symptoms. Cha et al. [6] analyzed 30 knees with

AIMM, in which four arthroscopic excisions of the AIMM were performed. Upon post-operative evaluation, there was no difference in terms of recurrent knee pain or limitation in the range of motion in any of the patients in either the excision or non-excision groups. On the other hand, Santi and Richardson [12] reported a case where anterior medial knee pain disappeared after excision of the AIMM. In our patient, it is highly probable that the meniscal tears were responsible for the patient’s symptoms as pain decreased after partial meniscectomy on the left side.

The clinical value of this case report lies in the description of the coexistence of the AIMM and the triple bundle ACL. Especially when performing reconstructive surgery of the knee, the orthopedic surgeon should be aware of the possible existence of these anomalies. Further clinical studies are needed in order to improve our understanding of this anatomical constellation and its influence on the development of medial meniscal tears, as current evidence is limited to single cases.

## Declaration of competing interest

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