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Case Report

How Many Bundles Does the Anterior Cruciate Ligament Consist of? A Case Report

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Abstract

In some cases with anterior cruciate ligament (ACL) injury, physical examination and magnetic resolution imaging cannot clearly identify whether the ACL is intact or partially or completely ruptured. A 40-year-old female patient was admitted to our clinic with complaints of knee pain. After the requested examinations, we could not clearly identify whether the ACL was intact or partially or completely ruptured. Arthroscopic knee surgery was planned for the patient. In diagnostic arthroscopy, it was also determined that there was a multibundle ACL that was not surrounded by the synovium and was tight in the figure 4 position. The surgery was completed by repairing the meniscal tear. It was seen in the current case report that the ACL was a multibundle structure without overlying synovium around. In such cases, it is difficult to evaluate the ACL, and it should be kept in mind that there may also be variations of the ACL.

Keywords: ACL bundles, anterior cruciate ligament, MRI in knee flexion position, multibundle, partial ACL rupture

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The anterior cruciate ligament (ACL) is frequently ruptured, especially after a sports-related injury. Especially in recent years, both the increase in the variety of sportive activities and the ease of accessibility have brought along an increase in the incidence of ACL ruptures.

ACL is an intrasynovial structure. Although ACL has been described as two bundles according to tibial adhesion location,[1] it has been shown that it consists of three bundles in recent studies.[2] These are the anteromedial (AM), posterolateral (PL), and intermediate bundles. However, functionally, ACL is divided into AM and PL bundles. While the AM bundle is tense in flexion and primarily prevents anterior-posterior slippage, the PL bundle is tense in extension and is a structure that prevents the knee's rotational shift.[1] These bundles work synergistically during the knee movement.[3] The intermediate bundle supports the AM and PL bundles to resist rotational forces during the synergies of this movement.[4]

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When the ACL is evaluated by physical examination and imaging methods, it is interpreted as whether intact, partially ruptured, or totally ruptured. If ACL is suspected of being ruptured as a result of physical examination and imaging methods, in some cases, especially in our patient, it was requested to perform magnetic resolution imaging (MRI) with maximum flexion of the knee in the prone position. However, sometimes, the imaging method taken in this special position is not sufficient to decide clearly the status of the ACL.

ACL is normally an intrasynovial structure and has multiple bundles.[5] In this case, the ACL was presented without overlying the synovium around. In addition, it consisted of multiple bundles, and the tension could be examined with the inspection probe in each bundle. Since the ACL was not surrounded by synovium in our patient, the MRI imaging method and the MRI taken in a special position did not guide this patient's situation clearly. The purpose of this case report is to keep in mind a similar anatomical variation while evaluating patients with similar examination findings.

Case Report

The patient is a 40-year-old female patient. The patient complained of pain in the left knee for 1 year and applied to the outpatient clinic with complaints of buckling and giving out sensation in the knee for the past 3 months. In the orthopedic examination of the patient, McMurray was found positive in the lateral of the left knee. In addition, the Lachman test was detected as grade 1, and the anterior drawer test was grade 2. Direct radiography was performed on the patient, and an MRI was requested while the patient was lying in a supine position with full knee extension. Afterward, partial ACL rupture and lateral meniscus tear were detected in the patient's re-examination and MRI examination, but it was not possible to distinguish whether the ACL was intact or totally ruptured (Figs. 1 and 2). In patients with a preliminary diagnosis of suspected partial ACL rupture, an MRI was performed in a special position taken in our clinic by asking the patient to bend the knee with maximum flexion while lying in the prone position (Figs. 3 and 4). The MRI taken in a special position was reported by the radiologist, who is experienced in the musculoskeletal system. As a result of this MRI, the patient was reported to have a partial ACL rupture and a lateral meniscus tear. Even as a result of the MRI taken in a special position, it was not possible to distinguish whether the ACL was intact or not. At this stage, arthroscopic knee surgery was planned because the patient also had a lateral meniscal tear. The ACL reconstruction set and the meniscus repair set were ready during surgery to be used as will be required. The patient was also informed about the current situation, and informed consent from the patient was obtained.

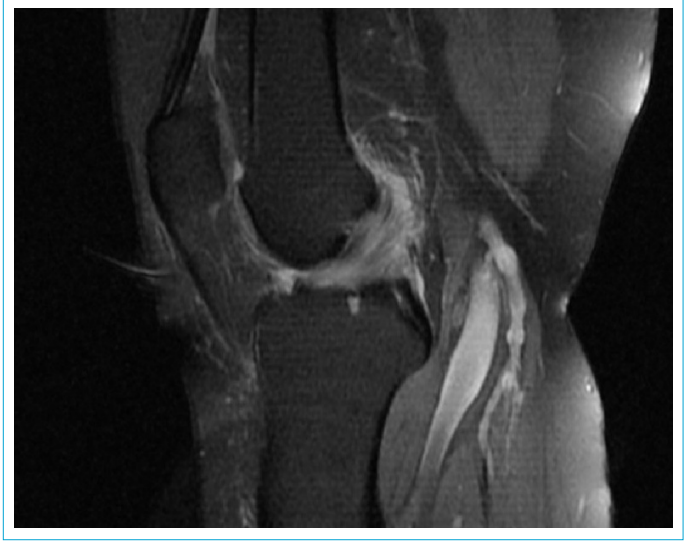

Figure 1. Image of the patient who is considered to have partial rupture in the sagittal section in MRI taken while the patient is in the supine position with the knee 30° flexed.

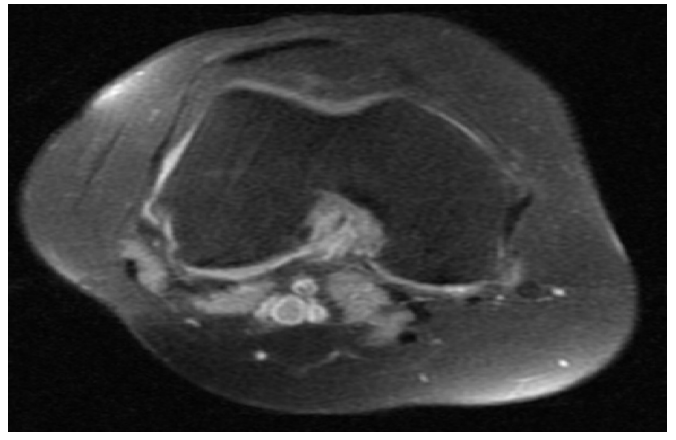

Figure 2. Image of the patient who is considered to have partial rupture in the axial section in fat suppression MRI taken while the patient is in the supine position with the knee 30° flexed.

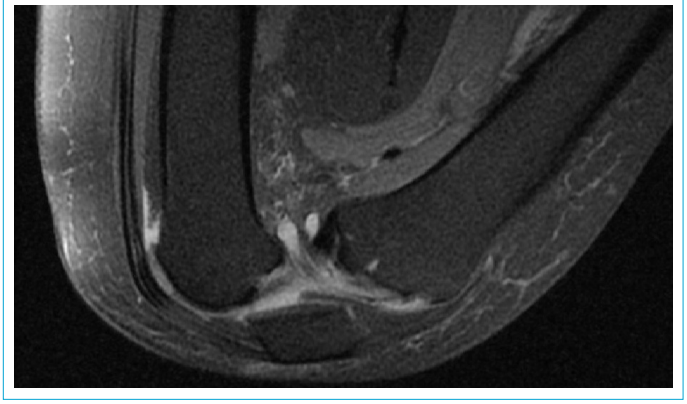

Figure 3. Image of the patient who is considered to have partial rupture in the sagittal section on MRI taken with the patient in the maximum knee flexion position.

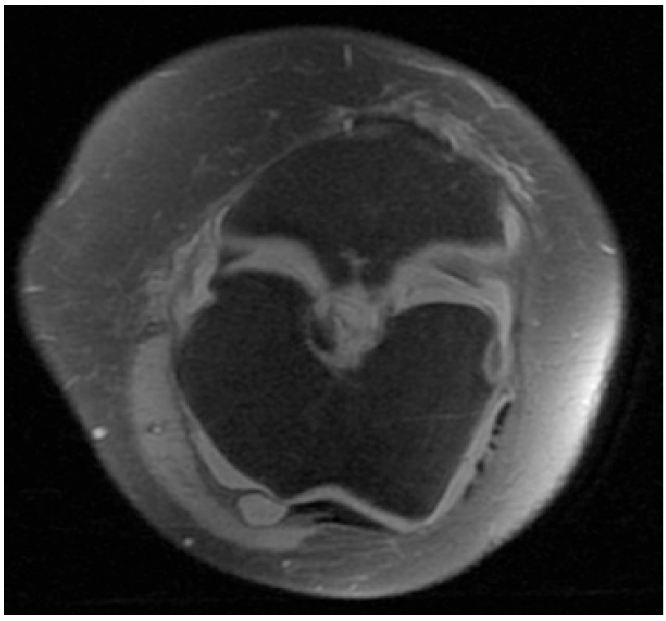

Figure 4. Image of the patient who is considered to have partial rupture in the axial section on fat suppression MRI taken with the patient in the maximum knee flexion position.

Cefazolin sodium 1 g (Cefazol) prophylactic antibiotic treatment was applied to the patient half an hour before surgery. The patient was lying in a supine position after spinal anesthesia. Afterward, the tourniquet was inflated. The patient was re-examined under anesthesia before surgery. The patient's Lachman test was found to be grade 1, the anterior drawer test was grade 2, and the pivot shift test was grade 1. The patient's knee was flexed 90° on the operating table, and the anterolateral portal was opened. While viewing obtained from this portal with the camera, the AM portal was opened through a spinal needle. An examination probe was applied through the AM portal. First, ACL fibers were examined. It was observed that the ACL was tense but consisted of the multibundle without overlying the synovium around (Figs. 5). The tension of each band was evaluated with the examination probe, and it was also seen that the bundles were tense one by one. The ACL fibers were assessed by taking the patient to the figure 4 position (Fig. 6). The patient's knee was flexed to 90°. Afterward, anterior and posterior drawer examinations were performed. Meanwhile, the tension of the ACL ligament was visually confirmed. After deciding that the ACL was intact, other knee structures were started to be evaluated. The medial meniscus was found to be stable by probe examination. After the knee was taken to the figure 4 position, the lateral meniscus was examined with the probe. A horizontal tear was detected in the lateral meniscus corpus. The meniscus tear was reduced with the probe, and two Fast-Fix 360 (Smith and Nephew Endoscopy, Andover, MA) sutures were applied to the tear. The lateral meniscus was examined through the probe and found to be stable. The inside of the knee was irrigated. The incisions were sutured. A Hemovac drain was not applied. The dressing was applied, and after that, an elastic bandage was applied.

Ice application was started in the early period after surgery, at 15 min per hour. The patient was discharged on the 1st day after surgery. During the post-operative period, the patient was suggested to use a knee brace, and she was first allowed to move to 0–60° of knee flexion. Outpatient follow-up of the patient was performed for 1 year. In the first 6 weeks, it was performed weekly and once every 2 weeks for 1½ months afterward. At the end of 3 months, the patient is followed up monthly for 3 months and once every 3 months after 6 months. In the outpatient follow-up, ROM was gradually increased, allowing knee movement. Isometric quadriceps and hamstring exercises were started on the 1st post-operative day, and the patient was mobilized immediately without weight-bearing for 1 month on the extremity, which was a meniscus repair performed for 1 month. For the next 1 month, partial, and after 2 months, full weight bearing is allowed. In the 1st year of follow-up of the patient, it was found that the patient had a full range of motion. At 1st-year outpatient follow-up, the orthopedic examination Mc-Murray test of the left knee was negative. In addition, the Lachman test was detected as grade 1, and the anterior drawer test was grade 2.

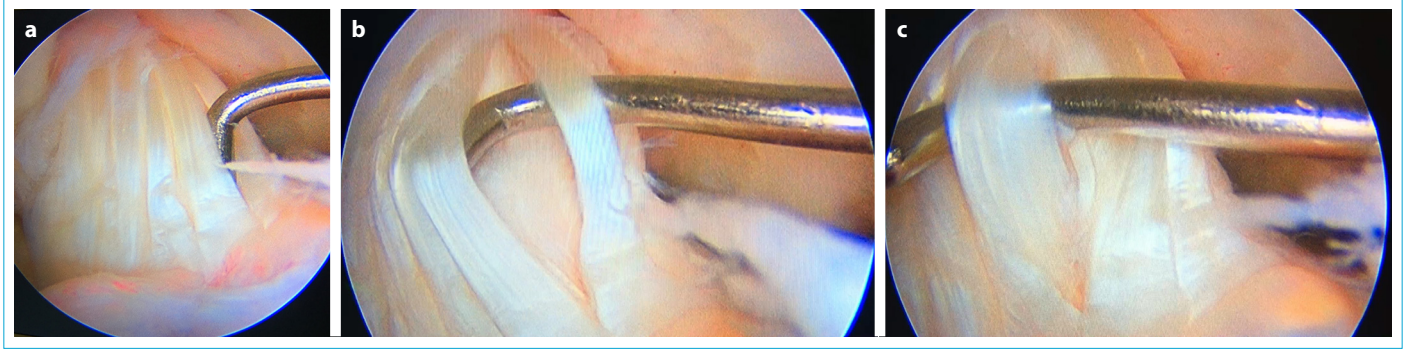

Figure 5. (a-c) Arthroscopic image of probe examination showing that the anterior cruciate ligament consists of multibundle.

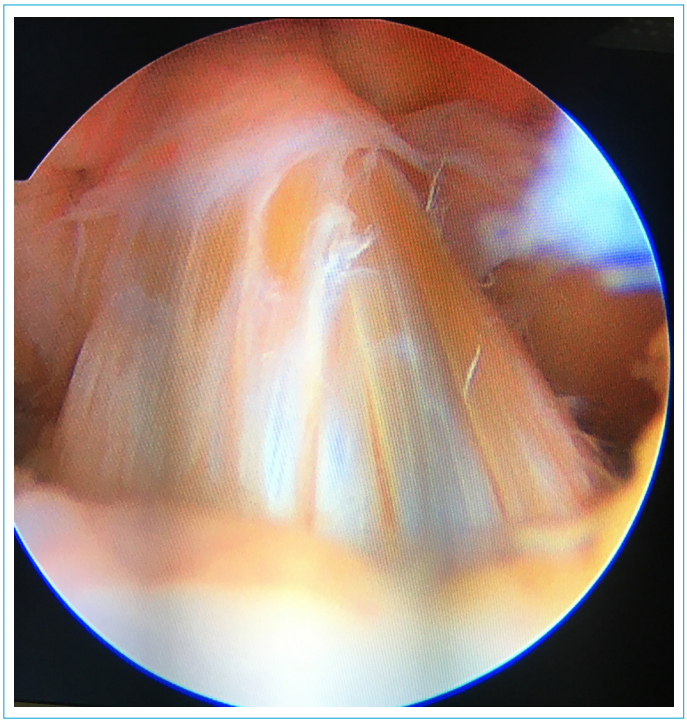

Figure 6. Arthroscopy image of the patient whose anterior cruciate ligament has been shown to be composed of multibundle during the positioning of the knee into figure 4.

Discussion

Although ACL has been described as two bundled – AM and PL – according to the tibial adhesion location,[1] it has been reported that the intermediate bundle is also found and that the ACL consists of 3 bundles.[2] In fact, in a study by Sapega et al.,[6] it was stated that ACL was divided into 4: anterolateral, AM, central, and posterior.

ACL is normally an intrasynovial structure. After the overlying synovium and ligament membrane around the ACL were removed to expose the whole structure, ACL bundles could be evaluated. Our patient had an ACL without overlying the synovium around. This situation is a variation and cannot be seen commonly. When the ACL variations are evaluated, it is seen that the bundles of the ACL are evaluated according to the tibial and femoral attachment sites. It was stated in a study by Hara et al.[5] that the ACL consists of many small bundles. However, in our case, although the ACL consists of many small bundles, it is not covered by a synovial structure. This situation makes it difficult to evaluate ACL in an MRI and causes misdiagnosis.

Total ACL rupture was not considered in the anterior drawer, and Lachman tests were performed on the patient since the ACL of the patient was not covered with a synovial structure and consisted of multiple bundles, and the ACL bundles were intact and stretched in individual examinations. A partial ACL rupture was suspected, but arthroscopic surgery confirmed that the patient's ACL was intact. The patient had a multibundle ACL, and the ACL was completely intact. The tibia and femoral attachment sites of the ACL were arthroscopically in normal localization.[6] The ACL was in normal appearance with knee flexion and extension.[5] Although partial ACL rupture is defined as at least one of the bundles being intact while other bundles are ruptured,[7] there is no consensus on the definition of partial ACL rupture.[8] Noyes et al.[9] described the rupture of 50–75% of the ACL diameter as a partial rupture. A partial ACL rupture is difficult to detect by physical examination and additional measurements, and it is not easy to diagnose a partial rupture by MRI taken in the neutral position.[10] The ratio of partial ACL rupture in all ACL tears was determined to be 10–35%.[11]

DeFranco and Bach find it difficult to diagnose partial rupture, and they emphasized that decisions should be made according to clinical evaluation, knee laxity, and arthroscopic evaluation of the ACL.[11-12] Noyes et al.[9] defined the partial ACL rupture as ¼, ½, ¾ according to the amount of ruptured ACL detected in the arthroscopic evaluation. Partial ACL rupture proceeds to total rupture in 38% of the patients,[9] so there are those who recommend surgery.[13,14] However, publications are stating that there are good-to-perfect functional results with conservative treatment.[9,15]

In a study conducted by Umans et al.,[16] it was stated that MRI has 55% sensitivity and 75% specificity in detecting partial ruptures.[16]

MRI shows total ACL rupture with 83% sensitivity at full knee extension, 83% at 30° knee flexion, and 93% at 55° knee flexion. Partial ruptures were shown at 50% when the knee was in full extension, 63% when at 30° knee flexion, and 63% when at 55° knee flexion.[17]

A study by Alioto et al.[18] revealed that orthopedic surgical intervention plans have changed as a result of findings found in MRI in 18% of patients.

Muhle et al.[17] explained in a publication that MRI, which was taken on flexion, displayed the ACL lesions better, and they suggested the reasons for this. In this study, it was stated that as the knee flexion increased, the femoral adhesion of the ACL took a more horizontal position and that the AM bundle was tenser as the flexion increased.

They emphasized that with increased flexion in the knee, the ACL is moving away from the intercondylar roof at the femoral adhesion region, so that the rupture in this region can be detected better, especially in sagittal MRI scans.[17] In addition, it was stated that the shape of the ACL is cylindrical with knee flexion, and in this way, the ACL rupture can be detected better with knee flexion.[17] In a recent study,

unlike previous publications, it was found that increasing the degree of flexion at the level of hyperflexion can better evaluate ACL lesions.[19] However, it was not possible to discriminate whether the ACL was intact or torn with an MRI taken while the patient was lying prone and her knee was in hyperflexion. In addition, if it was ruptured, a partial or total rupture was not distinguished.

In a study by Sonnery-Cottet and Colombet, as a result of all the evaluations of the patients, they showed that the findings led the surgeon to suspect a partial tear. However, they emphasized that diagnostic arthroscopy made a definitive diagnosis as to whether the rupture was total or partial.[8]

Diagnostic arthroscopy involves the examination of ACL fibers when the knee is flexed from extension and also in the figure 4 position.[8] This patient was evaluated by diagnostic arthroscopy, and the ACL was found to be intact in the figure 4 position. During cyclic exercise movements, similar movements are performed in which the knee is brought to hyperflexion and extension, which has been shown to have a positive effect on functional scores with single bundle reconstruction.[20] However, the superiority of double bundle usage over single bundle usage has also been shown.[21]

Conclusion

It was seen in the current case presentation that the ACL was a multibundle without overlying synovium, and each bundle was tense. As in our case, if it is not possible to distinguish between intact or ruptured ACL with physical examination and radiological evaluations, it is obvious that care should be taken during the evaluation of patients. We must bear in mind that there may also be structural variations of the ACL.

At the same time, it is obvious that it will make an additional contribution to the studies and research on ACL bundles in recent years. There is a need for further studies on this subject, and we think that this case will give a different perspective to this issue.

Disclosures

Informed consent: Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – B.G., C.S.; Design – B.G., T.I.K.O.; Supervision – B.G., M.O., M.U.C.; Materials – M.O., O.T.E.; Data collection &/ or processing – B.G. E.C.; Analysis and/or interpretation – C.S., M.O.; Literature search – B.G., O.T.E.; Writing – B.G., E.C.; Critical review – B.G., M.U.C.

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