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Dynamic ultrasonography in the diagnosis of acute anterior cruciate ligament injury – a case report

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Abstract

In the reported case of acute grade 3 anterior cruciate ligament injury, clinical examination and magnetic resonance imaging findings were in conflict, leading to confusion. Ultimately, dynamic ultrasound imaging proved to be the decisive test. The article describes the steps taken to reach the diagnosis. In addition, possible future diagnostic improvements are discussed. Dynamic ultrasound imaging, performed as part of the physical examination, is a valuable supplement to medical documentation. It provides appreciable diagnostic performance for the detection of anterior cruciate ligament insufficiency. Physical examination combined with magnetic resonance imaging, even though they represent the current diagnostic standard, have their limitations.

Introduction

In cases of acute anterior cruciate ligament (ACL) injury, standard diagnostic methods have their limitations. When findings vary, or worse, are contradictory, a clinical problem arises, and decisions about necessary operative treatment might be compromised.

The estimated sensitivity (SE) and specificity (SP) levels of physical examination (PE) and diagnostic tests are as follows: Lachman test 87.1%, 97%; pivot-shift test 49%, 97.5%; anterior drawer test 72.5%, 92.7%⁽¹⁾; magnetic resonance imaging (MRI) 87%, 90%⁽²⁾. Arthroscopy remains the reference standard.

In the reported case of acute grade 3 ACL injury, clinical examination and MRI failed to provide a clear basis for determining the patient's treatment, and the decisive test proved to be dynamic ultrasound (US) imaging.

Case report

A 32-year-old male wrestling athlete presented to the clinic with acute complaints including right knee pain resulting from a traumatic valgus force with a "pop" sensation that occurred the night before. There was no previous medical history. The patient was ambulating on a slightly bent knee

with full-weight-bearing gait. Clinical examination revealed an active range of motion from 10 to 90°, 2 cm of swelling measured at the joint line, and a negative Lachman test. Pain in the knee was too severe to perform the anterior drawer or pivot shift tests. An MRI scan was ordered and performed.

The patient appeared for the follow-up visit on the 11th day after the injury. He reported a decrease in pain and a symptom of "giving way" with weight bearing. The results of the MRI examination stated "ACL in continuity with increased signal strength." (Fig. 1).

The patient's clinical examination revealed an active range of motion from 10 to 100° with passive full extension, 1 cm of swelling measured at the joint line, and a positive Lachman test. Increased muscle defense made it impossible to conduct the anterior drawer and pivot shift tests properly.

Dynamic US examination was performed (Fig. 2). Side-to-side asymmetry was visualized with anterior tibial translation on the affected side. Additionally, the so-called "soft endpoint" sign was elicited^(3,4).

Anterior instability was confirmed, and the patient was referred for surgical treatment. Later, a second radiologist was requested to provide an MRI description, stating grade 3 anterior cruciate ligament injury.



Fig. 1. MRI 8 days after the injury. Sagittal fat-saturated T2-weighted image using PET/MR Biograph – mMR 3T. The anterior cruciate ligament described by a radiology specialist as “in continuity with increased signal strength”. No secondary signs of ACL tear such as tibiofemoral translation or vertical PCL

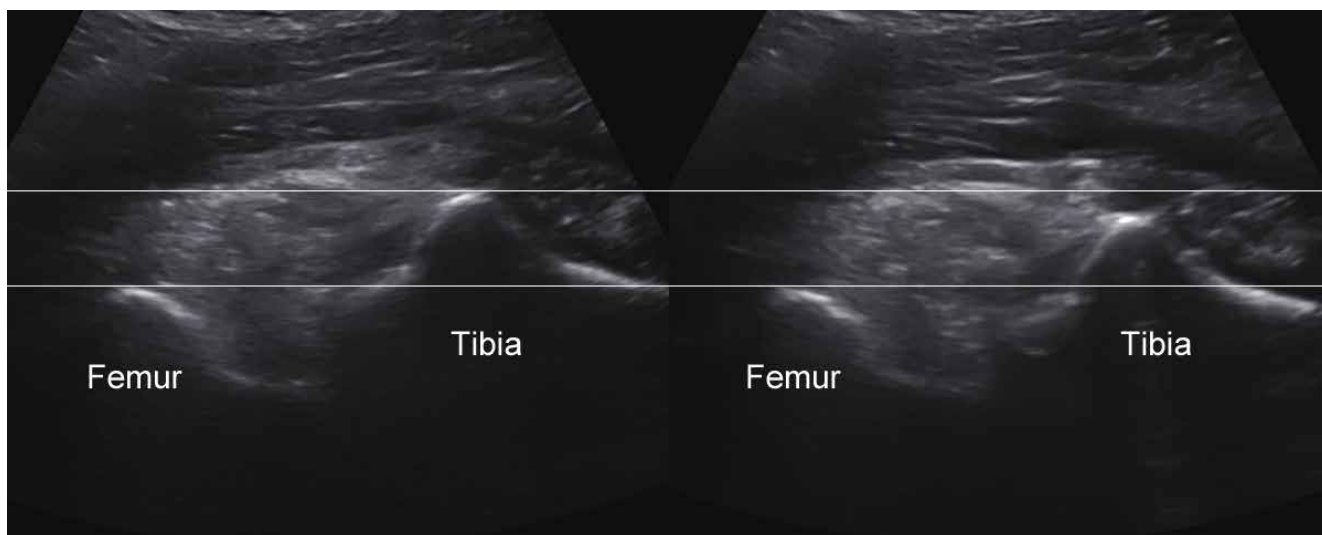


Fig. 2. Dynamic US examination on day 11 after the injury. Sagittal view from the popliteal fossa using convex probe. Probe positioned at the point of insertion of posterior cruciate ligament, parallel to the limb long axis. Patient in prone position, with the knee in 20 degrees of flexion. Pressure applied to the proximal tibia. Anterior tibial translation visible on the affected side

The surgery took place on the 24th day after the injury. Clinical tests were conducted with anesthesia. A positive anterior drawer test (Fig. 3) and positive Lachman and pivot shift tests were obtained. Arthroscopic findings confirmed ACL tearing (Fig. 4).

Discussion

In this case, the orthopedic surgeon found himself in a problematic situation. During the second visit, the PE

and the patient’s history were consistent with anterior knee instability. This condition, in a young, active person routinely engaging in sports, is an indication for surgery. At the same time, however, a radiology specialist left no room for interpretation, stating that the patient’s ACL had a continuity. Luckily, dynamic US could be performed during the patient’s visit. It showed clear symptoms of anterior instability, providing a basis for surgical treatment.

In doubtful cases, dynamic US has a double value. Firstly, It can be easily archived. Secondly, measurements of the

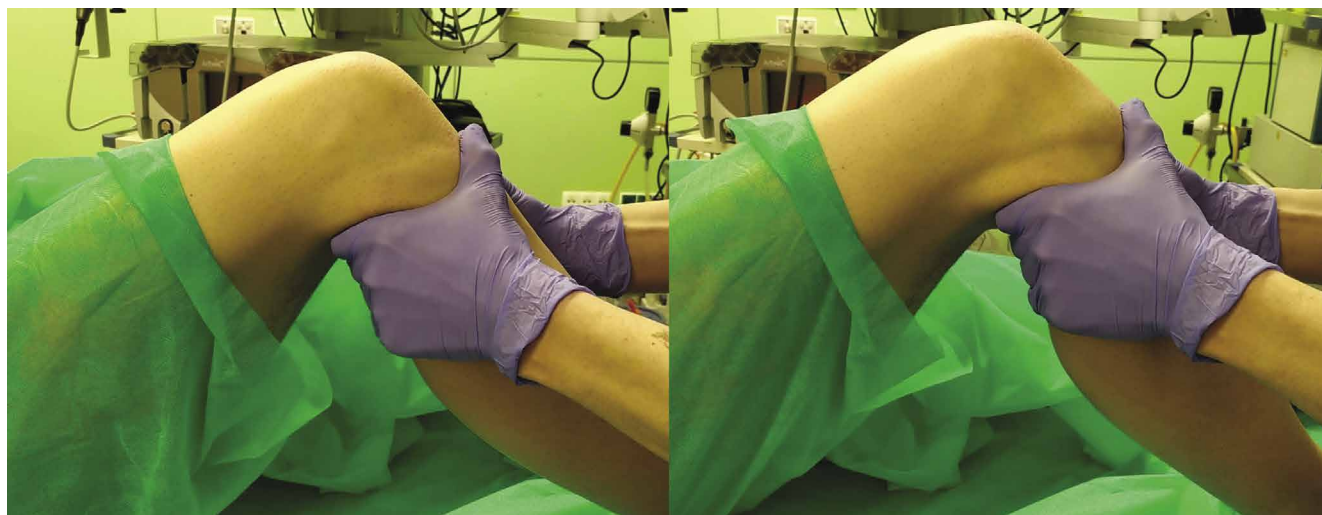


Fig. 3. Positive anterior drawer test conducted under regional anesthesia on the day of the surgery

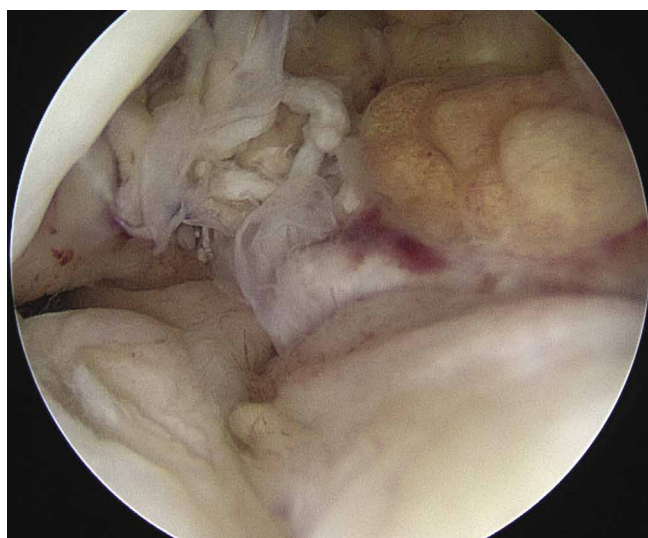


Fig. 4. Arthroscopic findings. Intercondylar notch view on the day of the surgery, day 24 after the injury. Visible remains of the ACL, no continuity

image can be taken. In cases where important therapeutic decisions must be made, such as surgical treatment, it is a valuable supplement to medical documentation.

On the day of surgery, the Lachman and anterior drawer tests performed in the patient under regional anesthesia were positive. Arthroscopy confirmed a complete ACL tear.

PE performed under anesthesia⁽⁵⁾ and arthroscopy are precise diagnostic tools. However, they are mostly unavailable in outpatient practice, relatively expensive, and invasive.

MRI is a noninvasive technique that remains the physician's first choice for the clinical diagnosis of ACL injury. The diagnostic accuracy of MRI for ACL injury compared with arthroscopy SE and SP are 87% and 90%. Still, the objectivity of MRI-based diagnosis, as determined by a single radiologist, remains both observer-dependent and

experience-related⁽²⁾. Improvements in imaging technology including sequences, specific knee coils, scanning technique as well as the radiologist's familiarity with MRI over time will result in even greater accuracy⁽⁶⁾. One of such improvements seems to be using oblique-sagittal MRI in addition to the orthogonal MRI protocol⁽⁷⁾. Also, flexion imaging of the ACL is useful to distinguish between a high-grade tear and complete tear⁽⁸⁾. There is no good evidence that higher magnetic field intensity results in better diagnostic accuracy^(2,9). Some future advancement may be also possible due to Machine-Learning-Assisted Detection. Weight-bearing⁽¹⁰⁾ and dynamic MRI⁽¹¹⁾ are potentially useful options as well.

Dynamic US imaging seems to be a valuable imaging point-of-care test. Unlike the PE, it can be easily archived, and reevaluated, if needed. It is characterized by good accessibility and low cost, and allows dynamic testing with quantitative measurements and real-time comparison between the traumatic and nontraumatic sites⁽¹²⁾. Dynamic examination seems to have an advantage in the diagnosis of ACL insufficiency over MRI⁽¹³⁾.

Dynamic US imaging for ACL tears has SE of 88%, and SP of over 82%^(14,15).

However, further research is required to establish the most accurate signs, preferably based on quantitative measurements⁽¹⁵⁾.

Also, new alternative diagnostic tools arise, such as needle arthroscopy⁽¹⁶⁾.

Conclusions

Physical examination with MRI is the current standard in the diagnostic work-up of acute ACL tears. There is limited room for further improvements of SE and SP levels in PE. Advancements in technology and clinical techniques will undoubtedly change the way MRI is used in the future.

For the time being, dynamic US performed as part of the physical examination is accessible, inexpensive and non-invasive, and offers a valuable supplement to medical documentation.

In conclusion, DU is able to provide appreciable diagnostic performance for the detection of ACL injury, ensuring high SE and SP levels.

Conflict of interest

The author does not report any financial or personal connections with other persons or organizations which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

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