Comparative study of sensitivity and specificity of MRI versus GNRB to
detect ACL complete and partial tears

Anterior cruciate ligament (ACL) tears are difficult to diagnose and treat (DeFranco). The preoperative clinical diagnosis of such injuries poses difficulties even in the hands of experienced surgeons. The importance of grading clinical laxity tests has been reported and the proper interpretation of the Lachman test could support the diagnosis of ACL tears. However, clinical examination is examiner dependent, and the inability to produce consistent and comparable results raises the need to use objective instrumented laxity methods and to quantify the amount of laxity, especially for diagnosis, carrying out postoperative follow-up, and comparing the efficacy of surgical procedures.

The additional use of instruments (KT1000, Rolimeter, X-rays under stress) to measure knee laxity in cases of total and partial ACL tears is not new. (Daniel, Beldame). But the efficacy of these devices in the differential diagnosis of complete versus incomplete ACL tears has been questioned (DeFranco). Furthermore, the use of magnetic resonance imaging (MRI), seems to be insufficient to describe the exact pattern of an ACL injury when used alone, mainly because of the many patterns of partial tears and the frequent similarity of partial tears to complete tears or even to mucoid degeneration of the ACL (Umans, Van Dyck). Both instrumented laxity and MRI need to be used in combination with proper clinical evaluation to possibly acquire a greater diagnostic value.

The purpose of the study was to investigate if different arthroscopically confirmed ACL injury patterns have distinctive preoperative findings in a robotic laximeter (GNRB), and MRI.

We tested the hypothesis that complete and partial ACL tears demonstrate different patterns in instrumented laxity tests and MRI.

Methods

This is a prospective, single operator study in which all consecutive cases of adult patients scheduled for primary ACL reconstruction during a 6-month period were included. Inclusion and exclusion criteria are listed in Table 1. 50 cases are suitable for the study.

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<th>Inclusion criteria:</th>
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<td>isolated and acute ACL tear (&lt; 6 months)</td>
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<td>adult &gt; 18 years</td>
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<th>Exclusion criteria:</th>
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<td>contro-lateral knee injury</td>
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<td>previous contro-lateral knee reconstruction</td>
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Table 1.
The GNRB.

The GNRB, used to measure anterior translation of the anterior tibial tuberosity in millimetres (mm), under a pressure of 0–250 newtons (N) has been described elsewhere and we will summarise only the essential elements [Robert].

Registrations are done in the absence of pain, by a trained operator, according to a strict installation protocol. The patient lies on a standard examination table in the supine position, with each knee tested comparatively, the healthy knee is recorded first. The lower limb is placed on a composite thermoformed support, adaptable in length, with the knee placed at 0° rotation. The knee is positioned so that the inferior pole of the patella corresponds to the lower edge of the patellar support. The joint line is palpated and is located between the support and the jack. An electric jack is used to exert a force of 67, 89, 134, 150 or 250 N on the postero-superior part of the calf. A motion sensor (0.1 mm precision) records the relative displacement of the anterior tibial tuberosity with respect to the femur. Motion data obtained by the displacement transducer are used to create a force/displacement curve, the slope of which determines the elasticity of the ACL. Tightening of the patella (pressure in newtons) and the heel-support distances (mm) are symmetric on both knees. Motion data obtained by the displacement transducer are used to create a force/displacement curve, the slope of which determines the elasticity of the ACL. A laxity file is built up for each patient including measurement conditions (pressure applied to the patella, forces) and results (ligament elasticity curve, side-to-side laxity and slope).

MRI.

Standard MRI on a 1.5 T magnet was performed preoperatively in all cases. Dual turbo spin echo or fast spin echo T1-weighted sagittal views were selected. Oblique axial, coronal and sagittal views in the ACL plane are more informative about the type of ACL injury than standard views (Steckel).

A independent radiologist classified ACL morphologic processes according to 3 different patterns based on previously published data (Van Dyck): (1) presence of a wavy contour of the ligament; (2) hyperintense signal within the ACL substance, fibers disorganized but with the presence of any visible straight lines from the femoral to the tibial insertion of the ACL, or clear fiber disruption in the anteromedial (AM) or posterolateral (PL) bundle; and (3) ACL fibers falling on the posterior cruciate ligament (PCL) or the notch. Time from injury to operation was recorded in all cases.

Arthroscopic surgery

In every case, ACL surgery was performed within a maximum of 30 days from the time of office consultation. Arthroscopic evaluation of the ACL rupture included confirmation of the tear by direct vision and palpation with a probe. When the ACL was totally absent, the tear was classified as complete (Fig 1). When there was an isolated rupture of the AM bundle and the integrity of the PL bundle was verified visually and with the use of a probe in the
“figure-of-4“ position (Sonnery Cottet) the tear was classified as PL intact (Fig 2). In the case of an isolated PL bundle rupture, the tear was classified as AM intact (Fig 3), and when the ligamentous stump of the ACL was found to be healing on the PCL, the tear was classified as PCL or notch healing (Fig 4 and 5) (Bach, Colombet).

Figure 1. Arthroscopic view of a complete ACL tear, in which all ligament attachments have disappeared from the femoral notch (left knee, view from anteromedial portal).

Figure 2. Arthroscopic view of a partial PL-intact tear (right knee, view from anteromedial portal). (AM, anteromedial; PL, posterolateral.)
Figure 3. Arthroscopic view of a partial AM-intact tear (left knee, view from anteromedial portal). (AM, anteromedial; PL, posterolateral.)

Figure 4. Arthroscopic views of different cases of the PCL-healing type of partial tear. The femoral attachments have clearly disappeared from the notch, but the ligamentous stump “heals” on the PCL (all cases right knee, view from anteromedial portal).
Figure 5. Arthroscopic views of the ACL stump healing on the notch. (right knee, view from anteromedial portal).

**Statistical Analysis**

The \( \chi^2 \) test was used for comparison of 2 qualitative variables. The Spearman correlation test and the Pearson test were used for comparison of 2 quantitative variables. Results from qualitative versus quantitative variables were compared using the Mann-Whitney and Kruskal-Wallis tests. The sensitivity measured the percentage of knees that tested positive (positive screening with the GNRB® or MRI) among all knees undergoing surgery. The specificity measured the percentage of knees that tested negative among all knees. ROC curves were used with differential laxity and differential slope to define a threshold value with maximal sensitivity and specificity. Level of statistical significance was set as \( P \) less than .05.

**References**


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February 10, 2014