Original Article With Video Illustration

Critical Analysis of the Lever Test for Diagnosis of Anterior Cruciate Ligament Insufficiency

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Purpose: To critically analyze the "lever test" in detecting anterior cruciate ligament (ACL) tears and to compare its accuracy with the Lachman, anterior drawer (AD), and pivot shift tests. **Methods:** From June 2014 to June 2015, 91 subjects were analyzed. Inclusion criteria were subjects aged 16 to 60 years, presenting after a knee injury with subjective swelling, or an objective effusion and an uninjured normal contralateral knee for comparison. Exclusion criteria included previous knee ligamentous reconstruction, fracture of the distal femur or proximal tibia, bilateral knee injuries, or known cruciate ligament tear. The Lachman, AD, pivot shift, and lever tests were performed in the office by 2 board-certified orthopaedic surgeons with patient awake. Examiners were blinded to the presence or absence of ACL injury. Magnetic resonance imaging was used to determine injury. Sensitivity, specificity, and accuracy were evaluated for all 4 tests. Accuracy was compared using χ-square and receiver operator curves. **Results:** Average subject age was 28 ± 11 years (61 males, 30 females). Seventy-one (79%) had ACL tears diagnosed by magnetic resonance imaging. The sensitivity, specificity, and accuracy of the lever test were 83%, 80%, and 82%, respectively. Accuracy was not statistically different from the Lachman, AD, and pivot shift tests ($P = .78$, .99, .07, respectively). Subanalyses were performed based on the presence of another ligament tear, timing of injury, and the presence of a meniscus tear. Although the groups were smaller and thus underpowered, the results were reported. Neither the presence of another ligament tear nor the timing of the injury affected accuracy ($P = .62$ and $P = .47$); however, the presence of a meniscus tear decreased its accuracy ($P = .003$). **Conclusions:** The lever test showed high sensitivity, specificity, and overall accuracy in the detection of ACL tears. The accuracy of the lever test was not significantly different from the Lachman, AD, or pivot shift tests. **Level of Evidence:** Level II, prospective comparative study.

Accurate clinical diagnosis of anterior cruciate ligament (ACL) tears requires a skilled physical examination.[1-4] Current physical examination tests to detect ACL tears were developed nearly 50 years ago. Galway et al.[5] described the pivot shift test in 1972 and Torg et al.[6] described the Lachman test in 1976. Several meta-analyses have shown that the Lachman test consistently had the highest sensitivity (85% to 96%) and the pivot shift test consistently had the highest specificity (97% to 99%).[2,7-9] It should be noted though that in most previous studies the examiners were not blinded to the presence or absence of an ACL tear in the patient.[2,7-9]

The Lachman and pivot shift tests may be difficult to perform on patients in acute settings because of pain and guarding.[10-12] The Lachman and pivot shift have shown lower accuracy when performed by a physical therapist or nonorthopaedic physician compared with an orthopaedic surgeon.[12,13] An ideal test would have both a high sensitivity and specificity and be easily reproducible. Having a simple, reproducible, dichotomous test may be very helpful to those practitioners in the emergency room, office, sideline, or training room. Recently, a physical examination called the "lever test" has been described to test for ACL insufficiency.[14] The key unique feature of this test is that it is dichotomous, which you can visualize, rather than a graded test based on the examiner's feel or proprioception.

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The purpose of this study was to critically analyze the lever test to detect ACL tears and to compare its accuracy with the Lachman, anterior drawer (AD), and pivot shift tests. The hypothesis was that the lever test would have a high sensitivity, specificity, and overall accuracy comparable to that of the Lachman, AD, and pivot shift tests.

Methods

This prospective comparative study was performed during the study period from June 2014 to June 2015, after approval from the hospital institutional review board. The inclusion criteria for this study were subjects aged 16 to 60 years, presenting after a noncontact or contact knee injury with subjective swelling, or an objective effusion, and uninjured normal contralateral knee for comparison (no previous injury or surgery). The status of the ACL was unknown to the examiner. The exclusion criteria were previous knee ligamentous reconstruction, any fracture of the distal femur or proximal tibia, bilateral knee injuries, or a known cruciate ligament tear. Patients with a concomitant meniscus tear or collateral ligament injury were eligible for inclusion in the study. Ninety-one subjects met final inclusion criteria for this study. The examiners were blinded to the presence or absence of an ACL tear (if known). If a magnetic resonance imaging (MRI) was available, the examiner did not review it until after the physical examination was performed and data recorded in a standardized data collection sheet. The examiners also obtained a history including the mechanism of injury before the examination.

The date of the injury and the date of the examination were recorded. If the injury was less than or equal to 2 weeks from the date of the examination, it was designated "acute." If the injury was greater than 2 weeks from the date of the examination, it was marked as "chronic." The "acute" 2-week time frame was used based on previous investigations and their accuracy of the physical examination for ACL tears.[11]

In eligible subjects, both the uninjured and injured knees were examined for comparison. The uninjured normal knee results were analyzed as a control. The physical examination was performed before obtaining or reviewing the MRI. The uninjured knee was examined first followed by the injured knee. The examination was performed in the following order: lever test, Lachman, AD, pivot shift. The physical examinations were performed by 2 board-certified orthopaedic surgeons with sports medicine fellowship training and the data were recorded on a standardized sheet. Each knee was examined by only 1 examiner, so interobserver and intraobserver reliability were not calculated. No aspirations were performed before examination.

Description of Ligament Testing

For the lever test, the examination was performed as follows: the patient was placed supine on a flat hard surface (Video 1, available at www.arthroscopyjournal.org). It is important to note that when trying different surfaces, it was found that the test did not work well with soft surfaces such as a cushioned examination table. The test depends on the examiner's fist acting as a fulcrum for the foot to lever up. When using a soft cushioned surface, the examiner's fist presses into the cushion without acting as a fulcrum. To standardize this, all patients had a plastic slide board placed under them that measured 1.5 × 3 feet and a quarter inch thick. For a right knee, the examiner's right hand was placed in a fist under the patient's tibia just distal to the most proximal aspect of the tibial tubercle (Fig 1A). The tibial tubercle was chosen as a landmark for fist placement, because it is an easily reproducible landmark regardless of body habitus and a consistent proportional length down the tibia.[15,16] Next the examiner's left hand pushes from anterior to posterior on the supracondylar region of the femur, 10 cm cephalad or proximal to the patella. If the patient's foot passively raised off the table any observable distance (loss of contact with the table), this was marked as a negative test (Fig 1B). It is believed that with this maneuver, the heel raises off the table as the tibia levers via the ACL linkage to the femur.[14] If the foot did not raise passively (contact of the heel still on the table) (Fig 1C), this was marked as a positive test.

When the foot does not raise with this maneuver, it is thought that the femur is translated posteriorly without moving the tibia via the ACL linkage.[14] In addition, the height of the heel displacement during this test with both the injured and uninjured knee was measured with a ruler (centimeters) and recorded. The AD, Lachman, and pivot shift tests were performed using standard techniques.[17] The results of all 4 ACL tests from both the injured and uninjured knees were recorded as either positive or negative. The Lachman test was considered positive if it was a grade 2B or above when compared with a stable contralateral knee, and the pivot shift was considered positive if it was grade 1 or above.

All MRIs were performed using a 1.5 Tesla magnet and reviewed by a board-certified musculoskeletal radiologist. An orthopaedic surgeon reviewed all MRIs and agreed with the radiologist's interpretation on all of the subjects. Subsequent MRI showing an ACL tear was used as the gold standard for diagnosis of an ACL tear. An intact ACL was recorded when both the orthopaedic surgeon and musculoskeletal radiologist agreed that the ACL was intact.

Additional data on the timing of the injury and date of examination, demographic information, mechanism of injury, and other concomitant injuries were recorded.