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Research Article

Diagnostic Accuracy of Lelli's Test in Diagnosis of Anterior Cruciate Ligament Tear

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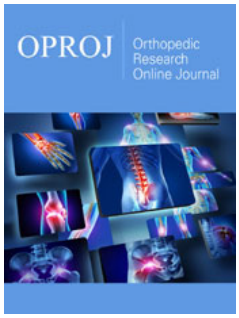

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Abstract

Although anterior cruciate ligament injury is diagnosed clinically, various clinical tests are performed to diagnosed ACL injury but lever sign test has proved superior to the other manual tests, being equally definitive for partial as well as complete tears and additionally being diagnostic even for acute injuries. Objective of the study is to determine the diagnostic accuracy of Lelli test (lever sign test) for diagnosis of anterior cruciate ligament tear taking arthroscopy as gold standard.

Material and methods: This cross section validation study was conducted in department of orthopedics, Hayatabad Medical Complex Peshawar, Pakistan from Jan 2020 to Jan 2022. A total of 254 patients with knee injuries were included in the study. Results of lelli's test (positive/negative) and arthroscopy were recorded.

Results: Mean age was 32.543±6.53 years, age range was 18 to 50 years and mean duration of injury was 18.36±9.61 days. Lelli's test was positive for ACL injury in 110(43.3%) patients while arthroscopically 101(39.8%) patients were confirmed for ACL injury. Lelli's test has shown sensitivity of 91.1%, specificity of 88.2% and diagnostic accuracy of 89%, PPV 83.6% and NPV of 93.7% in the diagnosis of anterior cruciate ligament tear.

Conclusion: lelli's test is easy to perform and superior to other manual tests for clinician in diagnosing ACL injury, even in acute injury as well as in post ACL reconstruction.

Keyword: Anterior cruciate ligament; Lelli's test; Arthroscopy; Diagnostic accuracy

Introduction

Anterior Cruciate Ligament (ACL) is one of the two cruciate ligaments which aid in stabilization of the knee joint [1]. It is strong band made of connective tissue and collagenous fibers that originate from the anteromedial aspect of the intercondylar region of the tibial plateau and extends posterolaterally to attach to the lateral femoral condyle [2]. The anteromedial and posterolateral bundle form the 2 components of the ACL [3]. The ACL and Posterior Cruciate Ligament (PCL) together form a cross (or an"X") within the knee and prevents excessive forward or backward motion of the tibia in relation to the femur during flexion and extension. The ACL additionally provides rotational stability to the knee with varus and valgus stress [3].

Although ACL injury can be diagnosed clinically, imaging with Magnetic Resonance Imaging (MRI) is often utilized to confirm the diagnosis [4]. MRI is the primary modality to diagnose the ACL pathology with a sensitivity of 86% and specificity of 95.5% [5]. Diagnosis may also be made with knee arthroscopy to differentiate complete from partial tears, as well as chronic tears [6].

In 2005, a new physical test called the "Lever Sign Test" (Lelli's test) was conceived of and put into practice. Regardless the types of injury whether it is partial or complete tear of the ACL or the time frame, the Lever Sign test has proved superior to other manual tests, being equally diagnostic even for acute injuries [7]. In a study of Jarbo KA et al. [8] has shown that overall accuracy of the Lelli's test was 77% (63% sensitivity and 90% specificity) in diagnosis of ACL tear. In another study by Thapa SS et al. [9] has shown that Lelli's had

sensitivity of 85.71% and specificity of 91.11% in diagnosis of ACL tear with prevalence of 43.75%. There is limited published data so far regarding validity (specificity and sensitivity) of Lelli's test, so this study has been conducted to evaluate the diagnostic accuracy of Lelli's test in diagnosing ACL tear. Therefore, providing the results of this prospective study may help to generate discussion on physical examination tests for diagnosing ACL injuries.

Material and Methods

This Cross-Sectional Validation Study was conducted in Department of Orthopedics, Hayatabad Medical Complex Peshawar, Pakistan from Jan 2021 to Jan 2022. Sample size was calculated by using sensitivity and specificity calculator, Sensitivity=63% [8], Specificity 90% [8], Prevalence=43.75% [9], Confidence interval=95%, Precision for Sensitivity=9%, for Specificity=9% and Sample size=254. Non-probability consecutive sampling technique was used as sampling technique. Ethical approval was taken from hospital ethical committee.

Inclusion criteria

Age 18 to 50 years

Both genders

Patient with knee injuries irrespective of duration of injuries (both acute and chronic)

Exclusion criteria

History of previous knee surgery

Patient with generalized hyperaxity

History of muscular, skeletal deformity or malignancy

Patient with open wound at knee on physical examination

Data collection procedure

Patient fulfilling our inclusion criteria were admitted, base line demographic information of patients (age, gender, duration of injury) was recoded. Informed consent was taken from each patient. Patient was placed supine with knees fully extended on examination table. The examiner stands at the side of the patient and place a closed fist under the proximal third of the calf. This causes the knee to flex slightly. With his other hand, he applied moderate downward force to the distal third of the quadriceps. With this configuration, the patient's will act as Lever over fulcrum- the clinician's fist. There were two downward forces on the patient's leg that was considered: the force of the clinician's hand on the quadriceps and the force of gravity on the foot and lower leg. In an intact knee, the creation of complete lever by the ACL allowed the downward force on the quadriceps to more than the offset, the force of gravity, the knee joint move into full extension and the heel rise up off the examination table. With a partial or completely rupture ACL, the ability to offset the force of gravity on the lower leg was compromised and the tibial plateau slides anteriorly with respect to the femoral condyles. In this case, the gravity pulled the heel down to the examination table. All patients then underwent knee arthroscopy, status of the ACL confirmed and needful procedure by an experienced arthroscopic surgeon was performed under regional or general anesthesia with tourniquet applied, using standard anteromedial and anterolateral portals.

Results of Lelli's test (positive/negative) and arthroscopic findings (positive/negative) were noted, and diagnostic accuracy was recorded.

Data Analysis

Data was entered and analyzed through IBM-SPSS version 23. Mean±St Deviation was calculated for all quantitative variables like age and duration of injury. For qualitative variables like gender frequency and percentage were calculated. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy for Lelli's against arthroscopic finding was calculated using 2 X2 models.

Sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV) and accuracy value were calculated as follows: Sensitivity = true positive/(true positive + false negative); Specificity = true negative/(true negative + false positive); PPV = true positive/(true positives + false positives); NPV = true negative/(true negatives + false negatives); Accuracy = (true positives + true negatives)/(true positives + false positives + true negatives + false negatives).

Effect modifiers like age, gender and duration of injury were controlled by stratification. Post stratification using diagnostic accuracy was calculated, $p \leq 0.05$ was considered statistically significant.

Results

254 patients were included in the study, Age range was 18-50 years with mean age of 32.54±6.53 years, 192(75.6%) were male and 62(24.4%) were female and mean duration of injury was 118.36±9.61 days. Lelli's test was positive for ACL injury in 110(43.3%) patients while on arthroscopy 101(39.8%) was diagnosed with ACL tear (Table 1). Lelli's test has shown Sensitivity of 91.1%, Specificity of 88.2% and Diagnostic accuracy of 89%, Positive Predictive Value (PPV) 83.6% and Negative Predictive Value 93.7% in diagnosing ACL tear. True positive (TP) were 92, False positive (FP) 110, False Negative (FN) 9 and True negative (TN) 144 (Table 2).

Stratification with respect to age, gender and duration of injury of Lelli's test versus arthroscopy finding are shown in Tables 3-8 respectively.

Table 1: Lelli's test and arthroscopic finding in diagnosis in ACL tear.

Anterior Cruciate Ligament Tear	Lelli's Test	Arthroscopy Findings
Positive	110 (43.3%)	101 (39.8%)
Negative	144 (56.7%)	153 (60.2%)
	254 (100%)	254 (100%)

Table 2: Comparison of Lelli's test versus arthroscopy finding for diagnosis of anterior cruciate ligament tear.

Lelli's Test	Arthroscopic Findings		Total
	Positive	Negative	
Positive	92(TP)	18(FP)	110
Negative	9 (FN)	135(TN)	144
Total	101	153	

Chi square=155.92 P value=0.000.

Table 3: Stratification with respect to age (18-30 years) of Lelli's test versus arthroscopy finding.

Lelli's Test	Arthroscopic Finding		Total	p Value
	Positive	Negative		
Positive	48 (TP)	8 (FP)	56	0.000
Negative	3 (FN)	73 (TN)	76	
	51	81	132	

Sensitivity: 94.1%, Specificity: 90%, DA= 92%, PPV= 85.7%, NPV= 96%.

Table 4: Stratification with respect to age (31-50 years) of Lelli's test versus arthroscopy finding.

Lelli's Test	Arthroscopic Finding		Total	p Value
	Positive	Negative		
Positive	44 (TP)	10 (FP)	54	0.000
Negative	6 (FN)	62 (TN)	68	
	50	72	122	

Sensitivity: 88%, Specificity: 86.1%, DA= 87%, PPV= 81.5%, NPV= 91.2%.

Table 5: Stratification with respect to Gender (Male) of Lelli's test versus arthroscopy finding.

Lelli's Test	Arthroscopic Finding		Total	p Value
	Positive	Negative		
Positive	78 (TP)	13 (FP)	91	0.000
Negative	5 (FN)	96 (TN)	101	
	83	109	192	

Sensitivity: 93.9%, Specificity: 88%, DA= 91%, PPV= 85.7%, NPV= 95%.

Table 6: Stratification with respect to gender (female)) of Lelli's test vs arthroscopy finding.

Lelli's Test	Arthroscopic Finding		Total	p Value
	Positive	Negative		
Positive	14 (TP)	5 (FP)	19	0.000
Negative	4 (FN)	39 (TN)	43	
	18	44	62	

Sensitivity: 77.7%, Specificity: 88.6%, DA= 85%, PPV= 73.7%, NPV= 90.7%.

Table 7: Stratification with respect to duration of injury (1-20 days) of Lelli's test versus arthroscopy finding.

Lelli's Test	Arthroscopic Finding		Total	p Value
	Positive	Negative		
Positive	14 (TP)	5 (FP)	19	0.000
Negative	4 (FN)	39 (TN)	43	
	18	44	62	

Sensitivity: 77.7%, Specificity: 88.6%, DA= 85%, PPV= 73.7%, NPV= 90.7%.

Table 8: Stratification with respect to duration of injury (>20 days) of Lelli's test versus arthroscopy finding.

Lelli's Test	Arthroscopic Finding		Total	p Value
	Positive	Negative		
Positive	78 (TP)	13 (FP)	91	0.000
Negative	5 (FN)	96 (TN)	101	
	83	109	192	

Sensitivity: 93.97%, Specificity: 88%, DA= 90.6%, PPV= 85.7%, NPV= 95%.

Discussion

Lever sign test is highly sensitive and specific for diagnosing ACL injury and can be easily performed in both acute and chronic period after injury with high inter-observer reliability. Importantly, this test is more sensitive in acute injuries than other clinical tests, which are considered, the sensitive tests for diagnosing ACL injury [10,11]. In our study, we investigated the diagnostic accuracy of the lever sign test in diagnosing ACL injuries.

The lever sign test was introduced by Lelli's et al. [12] to overcome the lower sensitivity of previously described tests, particular for acute ACL injuies. Acute ACL injuries are generally considered difficult to diagnose due to pain, reactive synovitis, haemarthrosis and swelling [13,14]. In his own study, Lelli's claimed that the lever sign test has 100% sensitivity for acute ACL inuries [12]. Nevertheless, only two studies after Lelli have investigated the sensitivity of the lever sign test in acute ACL injuries. Massey et al. [15] found the sensitivity of the lever sign test in acute injuries to be 90% and specificity of 77%. However, Jarbo et al. [8,16] found the sensitivity of 63% and specificity of 90%. Wang et al. [17] showed, the joint aspiration can raise the sensitivity of physical examination for diagnosing ACL injury. In our study, we found the patient in acute injury group (<20 days) has the Sensitivity of 77.7% and Specificity of 88.6% as compared to the group of patients with chronic injuries (>20 days) has the Sensitivity of 93.97% and Specificity of 88%. Gender can have statistically insignificant impact on sensitivity and specificity of lever sign test in our study. The sensitivity and specificity of lever sign test was 93.9% and 88% in male and 77.7% and 88.6% female respectively.

External factors such as pain, patient resistance, haemarthrosis, swelling or duration injury have minimal or no effect on the sensitivity of the lever sign test, but alter the sensitivity of other tests. In addition, in pre and post anaesthesia, the sensitivity of Lever sign test was slightly higher than Lachman test. Regardless of the time after injury, patient resistance is another factor that can alter the sensitivity of the tests. It is known that the sensitivity of the pivot shift test and anterior drawer test can be very different in pre and post anaesthesia [18]. In a Meta-analysis, it has been reported that the sensitivity of the anterior drawer test and pivot shift test increased from 38 to 63% and 28 to 73% respectively after anesthesia [19]. Therefore, Lever sign test can be easily performed regardless of patient resistance, distinguishing Lever sign test among other tests, because the sensitivity of all other tests improved after induction of anaesthesia.

The Lever sign test is newer test and the ability to learn and perform the test has not been evaluated. All authors mentioned that the test is easy to perform and has a higher sensitivity, but they found different results in similar patient population [20,21]. Before starting this study, we assessed our ability on patients with proven ACL ruptures. One of the technical points we found is the rigidity of the examination table. The examination tables are not all standardized and some don't support the fist in a similar manner as the fulcrum on the Lever sign test. When posterior force is applied to the femur on softer examination table, the fist can be embedded and therefore does not work as fulcrum and heel does not rise. This can cause false negativity of test and important factor to be considered. To avoid this, Massey et al.15 used a flat hard surface under the leg before examination. Besides, this test can be easily performed without making the patient uncomfortable.

Meniscal tear is another factor that can affect the accuracy of ACL clinical test [15,22,23]. Massey et al. [15] also found the statistically significant decrease in the accuracy of lever sign from 89% to 74% when meniscal tear was present Spang et al. [22]. In a biomechanical study found a significant increase in anterior tibial translation relative to femur after medial menisectomy. Meniscal tear can increase the knee instability and it has been shown that menisci are secondary restraints of anterior tibial translation.

There are some limitations to our study. The sample size for female gender was too low. Lever sign test was not compared to the other clinical tests and post ACL reconstruction in our study. The effect of meniscal injury and haemarthrosis on lever sign test was not considered. The testers were not blinded to the patient history and therefore they looked for instability but didn't know the results of MRI. This study does not include results from MRI or arthroscopy of contralateral uninjured knee.

Conclusion

The ideal test for diagnosing ACL integrity should be easy to perform, causing less pain to the patient and has high sensitivity and specificity. The lelli's test fulfill the criteria required for test that can aid in the diagnosis of acute, chronic ACL injuries.

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