Comparative Analysis of the Classic Lachman's Test with the Drop Leg Lachman's Test

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ABSTRACT

Objective. The objective of this study is to compare the validity of the Drop Leg Lachman's test (DLLT) with Lachman's test (LT) in appreciating abnormal knee AP laxity using KT-1000, specifically comparing LT and DLLT in terms of sensitivity and specificity.

Methods. A prospective randomized cross-sectional study was used on 36 patients complaining of unilateral knee symptoms from April 2009 to November 2009, 18 to 50 years of age consulting at the UP-PGH Department of Orthopedics Sports Clinic. Descriptive statistics were used to obtain the frequency, percentage, mean, standard deviation and range. Data was analyzed and calculated using the KT-1000 and STATA software.

Results. The subjects included 31 (86%) males and 5 (14%) females. Thirty-six percent were students and the rest were employed. The average age of the subjects was 28 years old with a range from 17 to 50 years. Their average weight was 72 kilograms with a range of 50 to 92 kilograms. Their average height was 170 centimeters with a range of 157-187 centimeters. Twenty eight (78%) complained of knee pain, 7 (17%) of knee instability and 1 (2%) of knee tightness. All of the subjects attribute the current complaint to a previous trauma, 72% were basketball-related. The average duration of onset of symptoms to testing was 22 months. Our study showed identical results of 95.45% sensitivity and 50.0% specificity when DLLT and LT were compared to KT-1000.

Conclusions. The Drop Leg Lachman's test shows no statistical difference with that of Lachman's Test in diagnosing knee instability using the KT-1000 as gold standard. It has an identical sensitivity of 95.45 % and specificity of 50%.

Key Words: instability, sensitive exam, ACL, drop leg

Introduction

The anterior cruciate ligament (ACL) is the most commonly injured ligament of the knee requiring surgical treatment. Its incidence is estimated at 1 case per 3,500 individuals in the USA, resulting in 95,000 new disruptions per year. Although it is uncommon in the general population, it occurs frequently in athletics, with a 4- to 6-fold greater incidence in female athletes when compared to male athletes.[1,2] In the United States alone, conservative estimates of cost per injury, including rehabilitation, range from $17,000 to $25,000, totaling up to $2 billion per annum. At the Sports Clinic of the UP-PGH Department of Orthopedics, the cost of an ACL reconstruction for charity service patients ranges from P35,000 to P75,000, representing more than a month's wages for the majority in this socioeconomic group.

The natural history of an ACL-deficient knee is unknown, but the general consensus among orthopedic surgeons is that this condition leads to immediate functional instability, with possible long-term sequelae of meniscal injury and post-traumatic degenerative arthropathy, thereby increasing the burden of this condition on any healthcare delivery system. Early and adequate detection is therefore necessary to facilitate patient education on the possible consequences of continuing to engage in physical activities with significant cutting and rapid deceleration maneuvers.[3]

Approximately 70% of ACL injuries occur through noncontact mechanisms that involve vigorous cutting, landing or twisting motions. In the acute setting, patients often report hearing or feeling a "popping" sensation coupled with the sudden onset of severe pain.[1,2] Later on, patients are unable to bear weight because of an unstable "giving way" sensation in the knee. The knee usually becomes significantly swollen acutely and range of motion decreases as a result of pain and swelling. Repeated instability episodes, recurrent effusion and a history of locking are commonly reported by patients suffering from chronic ACL injury. Mechanical pain is also a common complaint in this patient population as a result of meniscal tears or early osteoarthritis.[3,4]

Of the options available for the detection of an ACL tear, magnetic resonance imaging (MRI) is an accurate, non-invasive diagnostic tool for ACL injuries with a sensitivity of 82%.[1,2,4] In developed countries with universal healthcare, the cost of the MRI is assumed by the state. In the Philippines, it is an out-of-pocket expense for most patients without private medical insurance. At our institution, it costs P4,500 to P6,500 (plain and contrast, respectively) for the charity patients; additionally, the cost of the MRI often

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results in the depletion of a finite amount determined by the health management organization (HMO) that may otherwise be used for treatment. As a result, the majority of cases in the charity service of the PGH are treated without the aid of an MRI, making history taking and physical examination the primary tool in the screening of ACL injuries.

The pivot shift test, anterior drawer test and Lachman's test (LT) are among the tests currently being used to screen for possible ACL injury. Of the three, Jonsson T et al. concluded that the pivot shift test and anterior drawer test are the least sensitive.[6] The LT was described by Torg et al. as the most useful clinical examination for acute and chronic ACL tears with a sensitivity and specificity of 85% and 98%.[7] This finding is further bolstered by a study done by Liu Shin when they concluded that no significant difference exist between LT and the KT-1000 arthrometer (Medmetrics, San Diego) in evaluating abnormal anteroposterior (AP) translation.[8] The KT-1000 is a machine used for objectively evaluating AP laxity in the knee used in virtually every study on ACL tears.

The KT-1000 and the LT are currently the gold standard for assessing abnormal AP laxity in the knee. Both tests have proven to be reliable in screening for ACL injury. Both tests, however, are also faced with limitations. The KT-1000 is an expensive tool that costs $4,700 and is widely unavailable in the Philippines; only two tertiary care centers located in Metro Manila have the unit. Difficulty in testing large limbs, adequate control of flexion and rotation of the tibia, and lack of patient relaxation are among the problems with the LT where examination is carried out with the knee in 15-30 degrees of flexion, and external rotation (to relax the iliotibial band): for a right knee, the examiner's right hand grips the inner aspect of the calf and the left hand grasps the outer aspect of the distal thigh. The examiner attempts to quantify the anterior displacement in millimeters (comparing this displacement to the normal side) and an endpoint is described where the end point should be graded as hard or soft. The end point is said to be hard when the ACL abruptly halts the forward motion of the tibia on the femur; the end point is soft when there is no ACL and restraints are the more elastic secondary stabilizers.

The Drop Leg Lachman's test (DLLT) was developed to address these problems concerning the LT. The DLLT is a modification of the LT, performed with the patient supine and the leg to be examined abducted off the side of the table with the hip extended approximately 25^0. The angles of flexion and rotation are maintained by the examiner, who holds the patient's foot between his or her legs. The patient's thigh is stabilized to the table with one of the examiner's hands. The examiner's free hand is then placed behind the patient's leg and is used to apply an anteriorly directed force. According to Adler,[9] the DLLT is physically easier to perform than LT, shows greater tibial translation and is sensitive in demonstrating anterior laxity.

The objective of this study is to compare the validity of the DLLT with LT in appreciating abnormal knee AP laxity using the KT-1000 as the gold standard. Specifically, this study aims to compare the LT and DLLT in terms of sensitivity and specificity, to determine if the DLLT is technically easier to perform than LT, and to determine if the initial results of the DLLT are reproducible in our study population. The hypothesis is that the DLLT will be more sensitive and specific that LT.

Methods

Using Table 1 for the computation of sensitivity and specificity, the sample size was computed based on the results from previous studies.

Using 95% confidence level (and thus Z=1.96), P=sensitivity equal 95% and d=4% N1=114

Using 95% confidence level (and thus Z=1.96), P=specificity equal 85% and d=6% N2=136

However, for everyone who goes for KT1000 assessment, only 40% are true positives and 60% are true negatives, the final sample size will be computed using the following formula:

N final

= Total of true positives and true negatives

= The higher between N1/positivity rate and N2/negativity rate

= 285 knees to be examined by 4 different tests translate to 71 patients

We were not able to realize the computed sample size of 71 from previous studies due to the limited number of patients. However, the methodology of our study is entirely different and may entail reducing the number of required subjects similar to that of an experimental cross-sectional pilot study where at least more than 50% of the subjects were positive to the tests conducted to have a comparison. Taking that into consideration, the sample size was determined to be at least 30 subjects.

Sample Inclusion and Exclusion Criteria

We conducted a prospective randomized cross-sectional study in patients complaining of unilateral knee symptoms from April 2009 to November 2009, 18 to 50 years of age consulting at the UP-PGH Department of Orthopedics Sports Clinic. Both acute and chronic injuries were included. Patients with previous ACL reconstruction or knee surgery and bilateral knee pain were not included in the study. The contralateral knee was used as a control, so patients with bilateral knee injuries or symptoms were excluded.

Study Procedures

Examiners were oriented using workshops, reliability testing, and pretest runs by actual demonstration. Return demonstration of the examiners confirmed the reproducibility of KT-1000 testing and calibration of the KT-1000 machine prior to use standardized the procedure.

Sample

We conducted a prospective randomized cross-sectional study in patients complaining of unilateral knee symptoms from April 2009 to November 2009, 18 to 50 years of age consulting at the UP-PGH Department of Orthopedics Sports Clinic. A total of 36 patients were studied. The subjects included 31 (86%) males and 5 (14%) females. The average age of the subjects was 28 years old with a range from 17 to 50 years. Their average weight was 72 kilograms with a range of 50 to 92 kilograms. Their average height was 170 centimeters with a range of 157 to 187 centimeters. Twenty-eight (78%) complained of knee pain, 7 (17%) of knee instability and 1 (2%) of knee tightness. The average duration of onset of symptom to testing was 22 months. Both acute and chronic injuries were included. Patients with previous ACL reconstruction or knee surgery and bilateral knee pain were excluded from the study. Patients with bilateral knee injuries or symptoms were excluded, to allow for the contralateral knee to be used as a control.

After explaining the details of the study and obtaining informed consent, each patient was assigned to four examiners who were randomly assigned to perform a specific test (LT/DLLT) to a particular knee (Figures 1 and 2). The examiners were blinded as to which knee was injured or normal. They were able to perform the test without consulting with one another to avoid bias. After physical examination, the patient was subjected to a KT-1000 (Figure 3). We used the KT-1000 arthrometer to quantify the amount of translation with the traditional Lachman's test and the DLLT. The KT-1000 arthrometer is easily adapted to either test.

The KT-1000 arthrometer was used in a fashion described by Malcolm et al. A posterior force was applied until the audiotome signaled, and then the pressure on the handle was released to establish the testing reference position. An anterior force was then applied, and the tibial displacement was read in millimeters to the nearest 0.5 mm when the audiotome signaled that 15-pounds (67 Newtons), 20- pound (89 Newtons), 30-pounds (134 Newtons) and then maximal manual distraction (MMD) forces had been reached. Three consecutive measurements were performed for both the LT and DLLT at each force.

Results were gathered, tabulated and encoded by the co-investigator. After all the tests were performed, information regarding their condition or diagnosis was given. Treatment options as well as alternatives were thoroughly explained. Physical therapy was immediately initiated on the patient as part of the preoperative management of those diagnosed with ACL tears.

Figure 1. Lachman's Test

Figure 2. Drop Leg Lachman's Test

Figure 3. The KT-1000 Arthrometer

Examiner

The examiners were 2nd and 4th year residents of UP-PGH Department of Orthopedics rotating at the Sports Clinic who underwent workshops on how to use the KT-1000 and how to properly perform the LT and the DLLT. Specifically, senior residents were chosen as examiners for they have had at least a year of experience in performing various orthopedic examinations.

Outcome Measures

Anterior-posterior (AP) laxity was assessed as normal in the examined knee if a firm and solid end point after either LT or DLLT was appreciated and with KT-1000 arthrometer readings of less than 3 mm side-to-side difference. Abnormal AP laxity was defined as the absence of a firm end point and a KT-1000 arthrometer reading of greater than 3 mm side-to-side difference.

Statistical Analysis

Descriptive statistics were used to obtain the frequency, percentage, mean, standard deviation and range amongst the 36 patients. Data was analyzed if the results of the DLLT were comparable with LT using the KT-1000 as the gold standard. Using the STATA software (version 10.2), sensitivity and specificity were computed. All data gathered was analyzed using the 2 x 2 tables (Table 2) to determine specificity and sensitivity, and positive and negative predictive value (PPV & NPV)

Table 1. Sample size computation

Screening Test- DLLT or LT	Gold Standard-KT1000		Total
	Positive	Negative	
Positive	A	b	a + b
Negative	C	d	c + d
Total	N1	N2	N

P1=Sensitivity=a/N1
P2=Specificity=d/N2
The formula for the sample size determination is

$N1/N2 = Z^2 PQ/d^2$

Where:
N1 is the number of true positives using the KT1000
N2 is the number of true negatives using the KT1000
Z= normal deviate corresponding to the confidence level
P= the sensitivity or specificity values from related studies (cite here the related study)
Q=1-P
d- Maximum allowable error

Table 2. Statistical analysis of data

Lachmans	KT- 1000 (+)	KT- 1000 (-)	
	A	B	(+)
	C	D	(-)

DLLT	KT- 1000 (+)	KT- 1000 (-)
(+)	A	B
(-)	C	D

[(Sensitivity = a/a + c; Specificity = d/d + d); (PPV= a/a + b; NPV= d/c + d)]

Data and Results

Profile of Subjects

A total of 36 patients were studied. The subjects included 31 (86%) males and 5 (14%) females. Thirty-six percent (36%) of the subjects were students and the rest were employed. The av erage age of the subjects was 28 years old with a range from 17 to 50 years. Their average weight was 72 kilograms with a range of 50 to 92 kilograms. Their average height was 170 centimeters with a range of 157-187 centimeters. Twenty-eight (78%) complained of knee pain, 7 (17%) of knee instability and 1 (2%) of knee tightness. All of the subjects attribute the current complaint to a previous trauma, of which 72% were basketball-related. The average duration of onset of symptoms to testing was 22 months.

Our study showed identical results of 95.45% sensitivity and 50.0% specificity when DLLT and LT were compared to KT-1000 (Tables 3 and 4). We noted the same trend from the previous study of Liu,[9] that the specificity of KT-1000 increases as the force applied increases (from 15 lbs. to MMD), having the result of MMD as the most reliable. An attempt was made to assess BMI as a possible explanation for a difference in the results between the 2 tests; however the obese subjects (BMI > 30) were not as many as anticipated in the study (Tables 5 to 10).

Table 3. DLLT vs. KT-1000

	Sensitivity	Specificity	PPV	NPV
15lbs	100.0	22.9	3.6	100.0
20lbs	100.0	26.7	21.4	100.0
30 lbs	90.9	28.0	35.7	87.5
MMDT	95.45	50.0	75.0	87.5

MMDT- 95.4% of those truly positive for the gold standard KT1000 was diagnosed as positive with DLLT.
PPV of those screened positive under DLLT 75% were found truly positive under the gold standard KT-1000.

Table 4. LT vs. KT1000

	Sensitivity	Specificity	PPV	NPV
15lbs	100	22.9	3.6	100.0
20lbs	100	26.7	22	100.0
30 lbs	100	32	39	61
MMDT	95.45	50	75	87.5

MMDT- 95.4% of those truly positive for the gold standard KT1000 was diagnosed as positive with LT.
PPV of those screened positive under LT 75% were found truly positive under the gold standard

Table 5. (Non-obese) DLLT vs. KT-1000

	Sensitivity	Specificity	PPV	NPV
15lbs	100	21.4	8.33	100
20lbs	100	25	25	100
30 lbs	85.7	25	50	66.7
MMDT	100	50	75	100

Table 6. (Obese) DLLT vs. KT-1000

	Sensitivity	Specificity	PPV	NPV
15lbs	100	33.3	3	100
20lbs	100	42.1	3	100
30 lbs	100	42.9	33.3	100
MMDT	100	85.7	66.7	100

Table 7. (Non–obese) LT vs. KT-1000

	Sensitivity	Specificity	PPV	NPV
15lbs	100	14	7.7	100
20lbs	100	16.7	23	100
30 lbs	100	25	53.9	100
MMDT	100	33.3	69.2	100

Table 8. (Obese) LT vs. KT-1000

	Sensitivity	Specificity	PPV	NPV
15lbs	100	22	3.5	100
20lbs	100	26.6	21.4	100
30 lbs	100	32	39.2	100
MMDT	100	95.45	75	87

Table 9. BMI

VARIABLE	SUBJECTS	MEAN	STD. DEV.	MIN	MAX
BMI	24	25.01001	4.066821	20.02884	35.29555

Table 10. Obese vs. non-obese

SUBJECTS	FREQUENCY	PERCENT
NON-OBESE	15	62.50
OBESE	9	37.50
Total	24	100.00

Discussion

The Lachman's test (LT) is the most sensitive physical exam for determining abnormal knee AP laxity, a hallmark of an ACL-deficient knee. It is more sensitive in both acute and chronic settings than either the anterior drawer or the pivot shift tests, in conscious and anesthetized subjects. Modifications of the Lachman's test have been described. Feagin and Cooke[10] advocated the prone Lachman's test. They believed the prone examination had greater sensitivity. Hip extension acts to stabilize the femur, and gravity to aid anterior tibial translation. Wroble and Lindenfeld[11] advocated the Stabilized Lachman's test, with the patient's thigh supported on the examiner's knee or on a bolster. They stated that a constant flexion angle and fixed tibial rotation would yield an accurate test. The amount of translation is most easily detected at the joint line, and this modification allows the examiner's fingers to be closer to the joint. By stabilizing the thigh, femoral rotation is controlled, which affects the results of the LT. This method was recommended because it is easier to quantify and to perform.

We sought a quantified comparison between a Lachman's modification and the original Lachman's test. Drop Leg Lachman's test (DLLT) offers several advantages over the LT. It is easier to perform, is highly reproducible, and allows bulky legs to be handled easily. Factors that influence the LT include knee flexion angles, joint rotation, and freedom of rotation, displacement force, muscular tone, and soft tissue restraints. All muscle groups that cross the joint can alter measurements of joint laxity. Anterior translation is maximized with external tibial rotation, and internal rotation of the tibia causes tightening of the posterior cruciate ligament and capsular structures, which limit the anterior drawer effect. All of these factors can be controlled by the DLLT, except for muscular tone in conscious subjects and the condition of the secondary restraints.

The effect of the leg position on secondary restraints is not known with certainty. However, the DLLT position is comfortable for the patient and facilitates relaxation, whereas lifting the knee from the table in the standard LT frequently elicits a reflexive muscular tightening. The hip is extended and abducted, the former allowing greater relaxation of the hamstring muscles and fascia lata compared with the mildly flexed position of the LT. The drop leg position allows better stabilization of the femur and better control of tibial rotation and degree of knee flexion. The test is constrained by controlling both femoral and tibial rotation, and there is evidence that minimal restraint provides maximal displacement. Maximal AP displacement is the most sensitive in detecting injuries.[8]

Conclusion

The observation that the DLLT allows for better appreciation of abnormal AP laxity in difficult to handle limbs is derived from clinical and anecdotal experience. Our study showed that the DLLT shows no statistical difference with that of Lachman's Test in diagnosing knee instability using the KT-1000 as gold standard. It has an identical sensitivity of 95.45% and specificity of 50%. We were not able to draw significant results in comparing the ease of performing between the two tests by using the BMI because of the lack of obese patients in our study.

Recommendation

We were not able to prove our hypothesis that the DLLT is more sensitive and more specific than the LT. Our hypothesis is based on the assumption that the DLLT will be more useful because of its ease of use especially in patients with larger limbs in which flexion and rotation of the tibia are hard to control. We therefore recommend a study wherein the population is comprised of subjects with an average BMI of greater than 30 as a surrogate measure for large limbs.

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References

1. Hewett TE, Myer GD, Ford KR. Anterior cruciate ligament injuries in female athletes: Part 1, mechanisms and risk factors. Am J Sports Med. 2006; 34(2):299-311.
2. Hewett TE, Ford KR, Myer GD. Anterior cruciate ligament injuries in female athletes: Part 2, a meta-analysis of neuromuscular interventions aimed at injury prevention. Am J Sports Med. 2006; 34(3):490-8.
3. Woo SL, Vogrin TM, Abramowitch SD. Healing and repair of ligament injuries in the knee. J Am Acad Orthop Surg. 2000; 8(6):364-72.
4. Scholten RJ, Opstelten W, van der Plas CG, Bijl D, Deville WL, Bouter LM. Accuracy of physical diagnostic tests for assessing ruptures of the anterior cruciate ligament: a meta-analysis. J Fam Pract. 2003; 52(9):689-94.
5. Fuchs S, Chylarecki C. Sonographic evaluation of ACL rupture signs compared to arthroscopic findings in acutely injured knees. Ultrasound Med Biol. 2002; 28(2):149-54.
6. Rosenberg TD, Rasmussen GL. The function of the anterior cruciate ligament during anterior drawer and Lachman's testing. An in vivo analysis in normal knees. Am J Sports Med. 1984; 12(4):318-22.
7. Torg JS, Conrad W, Kalen V. Clinical diagnosis of anterior cruciate ligament instability in the athlete. Am J Sports Med. 1976; 4(2):84-93.
8. Liu SH, Osti L, Henry M, Bocchi L. The diagnosis of acute complete tears of the anterior cruciate ligament. Comparison of MRI, arthrometry and clinical examination. J Bone Joint Surg Br. l995; 77(4):586-8.
9. Adler GG, Hoekman RA, Beach DM. Drop leg Lachman test. A new test of anterior knee laxity. Am J Sports Med. 1995; 23(3):320-3.
10. Feagin JA, Cooke TD. Prone examination for anterior cruciate ligament insufficiency. J Bone Joint Surg Br. 1989; 71(5):863.
11. Wroble RR, Lindenfeld TN. The stabilized Lachman test. Clin Orthop Relat Res. 1988; (237):209-12.