

Confidence Levels of Athletic Trainers when Performing The Lachman's Test

By

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ABSTRACT

Proper assessment of an anterior cruciate ligament (ACL) allows athletic trainers to provide proper care and referral. The purpose of this study is to examine the confidence levels of athletic trainers when performing the Lachman's Special test. Participants were recruited using the National Athletic Trainers' Association (NATA) research survey request service to complete a survey through Qualtrics. One hundred and twelve athletic trainers completed the survey and only 76 responders met the required criteria. Participants reported a wide range of perceived limitations when performing the Lachman's Test with 77.8% of participants feeling confident in their ability to accurately assess the integrity of the ACL using the Lachman's Test. Clinician glove size ($X^2_1 = 6.674$, $N=76$, $p= 0.01$) was significantly associated with confidence in doing the Lachman's test. These results suggest that most athletic trainers have confidence in performing the Lachman's Test, but may need modifications to complete an accurate assessment.

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CHAPTER I

INTRODUCTION

The anterior cruciate ligament (ACL) is 1 of 4 major ligaments in the knee that aid in total knee stability. The main function of the ACL is to provide stability against anterior tibial translation and internal rotation (Domnick, 2016). When the knee is fully extended, the ACL has a mean length of 32 mm (about 1.26 in) and 7-12 mm (about 0.47 in) in width (Duthon, 2006). When the ACL is fully intact, it protects the menisci from shearing forces that can occur during various athletic movements, like planting and cutting. Athletic trainers' rely on special tests to determine differential diagnoses. The main special tests used by Athletic Trainers include the Lachman's, Anterior Drawer Test, Pivot Shift Test, and Lelli's or Lever Sign. The Lachman's test is considered the best special test available, but some clinicians may find it difficult to accurately perform due to various anatomical challenges from the athlete and the clinician themselves. Knowledge about the accuracy of special tests and possible anatomical challenges is important for clinicians to know when an ACL injury would be in the differential diagnoses after a knee injury.

ACL injuries at any age can be detrimental to an athlete's mental health and academic performance (LaBella, 2014). Injuries to the ACL are functionally debilitating and predispose the knee to other injuries and early-onset osteoarthritis (Beynon, 2005). Incidences of injuries to the ACL are becoming increasingly common every day, mainly in females (Arendt, 1995). ACL injuries account for 50% of all injuries to the knee (Kaeding, 2017). Athletes with ACL injuries are up to 10 times more likely to develop early-onset knee osteoarthritis. This leads to chronic knee pain and instability (LaBella, 2014). John W. Lachman, MD, was Chair and Professor of Orthopedic Surgery at Temple University in Philadelphia, Pennsylvania, from 1956 to 1989. He

observed early on that some patients with ACL tears had passive anterior subluxation of the tibia about the femur when they were in the supine position. Eventually, he found that ACL instability could be shown quite easily by applying stress to the extended knee joint and that this method was more effective than using the conventional Anterior Drawer test (Makhmalbf, 2013).

Operational Definitions

- **Anterior Cruciate Ligament** – ligament in the center of the knee that prevents anterior translation of the femur on the tibia.
- **Practicing Athletic Trainer** - 50% of your job includes caring for the well-being of athletes.
- **Special Tests** – Tests used during physical examinations by clinicians in orthopedic settings.
- **Selective Tissue Test** - techniques to selectively test ligaments, tendons, and muscles to determine which areas are injured as well as the severity of injury

Purpose of the Study

The purpose of this study is to examine the confidence levels of athletic trainers when performing the Lachman's Special test. Lachman's is the best and first choice for most clinicians who have a knee injury presented to them, but sometimes several factors may prevent an athletic trainer from getting a good result from the test, like small clinician hand size or size of the athlete's lower extremity. Without proper grip from the clinician, an accurate test cannot be achieved, and may prolong the process of ruling in or out different knee pathologies. Some clinicians may find it difficult to get the anterior translation needed to properly assess an end-feel and determine ACL integrity. Some clinicians may use modification to the traditional test in order to feel confident in their ability to perform the test.

Research Questions

Are practicing athletic trainers confident in their ability to effectively perform the Lachman's Test?

Does clinician hand size and athlete size play a role in the effectiveness of the Lachman's test?

Are athletic trainers aware of different modifications to effectively perform the Lachman's test?

Hypothesis

The majority of practicing athletic trainers are not fully confident in their ability to effectively perform a traditional Lachman's test.

Anatomical challenges do play a key role in the effectiveness of the Lachman's test.

Athletic trainers are aware of different modifications to enhance Lachman's effectiveness.

Significance of the Study

The Lachman's test is one of the most widely used special tests for evaluating the integrity of the ACL following potential injury. Differences in hand size may influence the ability of clinicians to accurately perform the test correctly which could affect its clinical value. Bengert et al. (1997) performed a study looking at the influence of hand size, leg size, and clinical experience when performing the Lachman test. Bengert reported that these several factors individually had no clinical effect on a clinician's performance when it comes to accuracy; however, collectively, there was a decrease in effectiveness when all factors are considered together. The study is mainly looking at the athletic trainer's perception of issues that may affect their confidence when performing the test, not just measurements.

CHAPTER II

REVIEW OF LITERATURE

What is the Anterior Cruciate Ligament

The anterior cruciate ligament (ACL) was first described by Galen, around 170 AD, but its importance as a stabilizing structure preventing anterior translation of the tibia with relation to the femoral condyles was not appreciated until the last century (Katz, 1986). The ACL is a band of dense connective tissue that originates from the medial aspect of the lateral femoral condyle and is inserted at the center of the tibia plateau (Domnick, 2016). The name cruciate comes from two ligaments that cross each other with anterior and posterior tibial attachments. The ACL is a critical stabilizer that prevents anterior translation of the tibia on the femur, posterior translation of the femur on the fixed tibia, internal and external rotation of the tibia on the femur, and hyperextension of the tibia (Decary, 2018). It provides 86% resistance against knee anterior translation.

Prevalence of ACL Injury

An estimated 80,000 to 250,000 ACL injuries occur each year, for athletes between the ages of 15 and 25 (Decary, 2018). ACL injuries continue to be common injuries within orthopedic sports medicine, with non-contact ACL tears among female athletes being the most prevalent (Renstrom, 2008). Female athletes are two to eight times more likely than male athletes to have an ACL injury (Arendt, 1995). Within college athletics, ACL injury rates are 2.5 to 4 times higher for females (LaBella, 2014). Non-contact ACL injuries account for 70% of all injuries in both female and male athletes (Griffen, 2000).

ACL Mechanism of Injury

ACL tears can occur from contact or non-contact planting and cutting, during landing and deceleration maneuvers, flexion movements occur at the hip and knee. Intrinsic factors that can lead to ACL injuries are issues related to the athlete's body. To stabilize the hip and decelerate the horizontal velocity of the body, there is a simultaneous eccentric contraction of the quadriceps. This also aids in the stability of the knee and the hamstrings. The hamstrings neutralize the tendency of the quadriceps to cause anterior tibial translation. If muscles cannot meet the stabilization demand, inert internal tissues are at risk of injury. Therefore, a deficit in eccentric hamstring strength compared to eccentric quadriceps strength could predispose an individual to ACL injuries. A normal hamstring-to-quadriceps hamstring strength ratio is 50% to 80% of knee strength to avoid knee injury (Rosene, 2001). This is important when evaluating and rehabilitating a person's ACL pathology. If there is an imbalance in this ratio, the stability of internal structures and functionality of the extremity can be altered, thus predisposing someone to an ACL pathology (Raus, 2019). Due to the crossing of the cruciate ligaments, there is also a rotational component that can influence injuries when the knee is rotated causing increased stress on the ligaments. There can also be extrinsic factors that can increase the risk of ACL injuries, meaning factors outside the body place the athlete more at risk. Some of those include access to proper facilities, wet or uneven playing surfaces, increased level of competition, and longer cleats (Cimino, 2010).

ACL Diagnosis

There are several different techniques used to diagnose an ACL injury. These methods can include invasive procedures (e.g., arthroscopy) or non-invasive procedures. Non-invasive

procedures can include medical imaging techniques (e.g., MRI) or the use of field-based special tests (e.g., Lachman's, anterior drawer, pivot shift). Each of these different assessment methods has inherent advantages and disadvantages. Accurate diagnosis of ACL ruptures is important because the longer an individual waits, the more swelling and lack of quadriceps activation may be present. This delays the pre-habilitation process and can lead to a slower recovery post-surgical intervention.

Invasive Ways to Diagnose

Arthroscopy is the gold standard used to diagnose ACL ruptures. Arthroscopy is a minimally invasive surgical procedure that orthopedic surgeons use to visualize and treat problems inside a joint (AAOS). Arthroscopies are the gold standard when it comes to diagnosing intra-articular pathologies. Even though it is considered the gold standard and it can visually see the tear and has little room for error, it is an invasive and expensive procedure to undergo, if not already receiving surgical intervention (Patel, 2018). During the procedure, the arthroscope is moved medially to see loose bodies around the tibia. The medial meniscus and medial femoral condyle are inspected when the knee is straightened, and valgus stress is placed on the knee. The knee is then brought to 90 degrees of flexion to inspect the intercondylar notch and examine the ACL and PCL for loose bodies or tears (Ward, 2013).

Non-Invasive Ways to Diagnose

When an ACL injury is suspected, clinicians will always use special tests and imaging to rule out knee pathologies. An MRI (Magnetic Resonance Imaging) is a noninvasive technique used to receive computerized images of internal body tissues. MRI imaging uses radio waves, a strong magnet, and a computer to make a series of detailed pictures (NCI Dictionary).

Clinicians may also use diagnostic ultrasound to aid in orthopedic diagnostics. Devices like this allow clinicians to measure the translation between the femur and the tibia during the clinical examination. This provides the advantage of combining clinical tests with visualization in real-time. The greatest advantage of using diagnostic ultrasound is the ability to assess dynamic range of motion quantitatively (Grzelak, 2015).

Special tests are a clinician's go-to when it comes to evaluating an injury. When evaluating an injury more than one special test will be used. This is to ensure all possible pathologies are checked in the initial evaluation and not overlooked. There are different special tests clinicians can use to rule in or out an ACL pathology. Some of those tests include the Slocum Test with Internal Tibial Rotation, Slocum Test with External Tibial Rotation, Anterior Drawer, Lachman's Test, and Pivot Shift (Konin, 2016), with the most common special tests to determine ACL pathology is Anterior Drawer, Pivot Shift test, Lelli's or lever sign, and Lachman's Test. When performing all these tests, the clinician is looking for translation of the tibia anteriorly on the femur (Malanga, 2003).

The Anterior Drawer Test is performed with the patient's hip in 45 degrees of flexion and 90 degrees of knee flexion. The clinician places hands around the proximal tibia with thumbs on the tibial plateau. The clinician will then pull the tibia forward. If the patient's tibia translates forward more than the uninvolved side, this indicates an ACL rupture (Malanga, 2003 & Konin, 2016). Alone, the Anterior Drawer Test has a low sensitivity when determining ACL pathologies but does have a high specificity. The Anterior Drawer Test becomes more sensitive when secondary structures that hold the tibia in place are damaged. Table 1 below lists various sensitivities and specificities for the Anterior Drawer Test.

Table 1

Sensitivity and Specificity of the Anterior Drawer Test

	Sensitivity	Specificity
Zhao et al., 2021	64.2	93.2
Van Eck et al., 2013	38.0	81.0
Katz et al., 1986	40.9	95.2
Makhmalbaf et al., 2013	94.4	96.4
Grzelak et al., 2015	91.0	68-92
Gurpinar et al., 2019	68.8	77.4

The Pivot Shift test was created after a study characterized the knee in anterior subluxation of the lateral plateau in relation to the femoral condyle when the knee reached full extension. This is performed while the patient is lying supine, and the knee is fully extended. The leg will then be flexed and internally rotated while a force is laterally applied on the knee while being moved passively into flexion. Clinicians may find this test hard to perform due to patient guarding and general apprehension when compared to other tests (Konin, 2016 & Malanga, 2003). Table 2 below lists various sensitivities and specificities for the Pivot Shift Test.

Table 2

Sensitivity and Specificity of the Pivot Shift Test

	Sensitivity	Specificity
Zhao et al., 2021	61.5	97.2
Van Eck et al., 2013	28.0	81.0
Katz et al., 1986	81.8	98.4
Grzelak et al., 2015	24-61	98.0
Gurpinar et al., 2019	51.6	93.8

Lelli’s or Lever sign, is a newer test created to make ACL diagnosing easier. This test is performed with the patient lying supine and the clinician standing on the involved knee's side. They then place a closed fist under the proximal third of the calf to increase slight knee flexion. The clinician will use the other hand to apply a downward force on the distal femur. If the patient's ACL is intact, the foot will rise off the table. If the patient's foot does not rise off the table or partially rises, this would indicate a potential ACL pathology (Paessler, 1992). Table 3 below lists various sensitivities and specificities for Lelli’s or lever sign.

Table 3*Sensitivity and Specificity of Lelli's or Lever Sign*

	Sensitivity	Specificity
Thapa S.S et al., 2015	85.7	91.1
Mulligan Ep et al., 2017	38.0	72.0
Fahmy FS et al., 2019	34.0	90.0
Jarbro et al., 2017	63.0	90.0
Litchenberg et al., 2018	93.0	91.0
Lelli et al., 2016	100.0	100.0
Gurpinar et al., 2019	91.9	93.8

The Lachman's test is often considered the highly sensitive clinical test for determining ACL injuries (Torg, 1976). The National Athletic Trainers Association (NATA) has established a subset of skills for Lachman's. These skills include patient position, amount of knee flexion, patient relaxation, hand placement, application of force, translation determination, and end feel determination (Hurley, 2003). The clinician will have the patient lay supine, with the knee flexed about 20 degrees. The clinician will hold the back of the patient's distal femur with one hand, the top third of the patient's tibia, with their thumb on the joint line. The clinician will then proceed to pull the tibia forward while pushing the thigh backward. When pulled, there should be a firm end feel and no give of tibia (Koster, 2018). Table 4 below lists various sensitivities and specificities for the Lachman test.

Table 4*Sensitivity and specificity of the Lachman's Test*

	Sensitivity	Specificity
Whittaker et al., 2020	97.0	95.0
Kostov et al., 2014	84.0	-
Benjaminse et al., 2006	85.0	94.0
Van Eck et al., 2013	81.0	81.0
Mulligan et al., 2017	67.0	97.0
Litchenberg et al., 2018	82.5	87.5
Gurpinar et al., 2019	80.6	62.5
Grzelak et al., 2015	85-98	94.0

Some clinicians find Lachman's difficult to perform on larger athletes. In that case, there are a few variations commonly seen. The first one seen has the patient lying supine with the knee resting on the clinician's knee on the table to gain better leverage. The same translation forces are applied. The next commonly seen variation has the patient's knee slightly off the edge of the table and the foot on the thigh of the clinician. The thigh is used to support the lower leg, which allows the clinician to provide more stability when performing the test (Whitehill, 1994). Some other variations commonly seen include the prone Lachman test, the stabilized Lachman test, and the drop leg Lachman test (Hurley, 2003). The accuracy and reliability of all stress tests may vary depending on the clinician's experience. There are many things that make a clinician immediately think of an ACL pathology when an athlete is being evaluated. Clinicians use special tests to gain an objective evaluation before referring to a physician. Being able to

confidently tell a physician there is an ACL pathology is vital when it comes to quickly treating the patient correctly.

Anatomical challenges

Hand grip strength plays a crucial role in the ability for a clinician to perform various special tests accurately. Hand grip strength is a basic evaluation that can provide useful information when it comes to nerve, muscle, joint or bone issues (Liao, 2016). This can also provide information about overall body strength. It is also a critical aspect needed to control various objects (Liao, 2016). There are 35 muscles that are involved in movement of the forearm and hand (Almashqbeh, 2022). Clinicians of all sizes work with athletes of all sizes. This can pose a problem when a smaller clinician needs to do an evaluation of the knee of a larger athlete. Hand size has been shown to correlate with grip strength, meaning the larger the hands a clinician has, the stronger their grip can be compared to clinicians with smaller hands (Bardo, 2021). The average hand length of a male is 7.6 inches and 6.8 inches for females. The average hand circumference for males is 8.6 inches and 7.0 inches in women. The average grip size for an adult is 19.7 inches (Healthline.com). Average quadriceps circumference for males between the ages of 20-29 is 20.8 inches, while their female counterpart averages 21.7 inches (fitnessvolt.com 2022).

The ACL is an important stabilizer for all knee motions. Without the ACL, the knee will not function properly to the level an athlete needs to obtain. Due to the high amount of ACL injuries that occur, it is important for all clinicians to be aware of the different ways to diagnose ACL pathologies, whether that be using special tests or imaging. With special tests being the first step to assessing ligaments before injury, it also emphasizes knowing which tests to use and being able to use them correctly. The Lachman's Test is a highly sensitive clinical test, so the

usage of the test increases, but not all clinicians are able to effectively perform the test due to confidence or anatomical challenges with their own hand size, or the size of the athlete they are working with. No studies were found that assessed athletic trainer confidence in performing the Lachman's special test or an assessment of the appropriate modification. Therefore, this study is unique in its purpose and outcomes.

CHAPTER III

METHODOLOGY

This study examines athletic trainers' perceptions of the influence of anatomical challenges on their ability to perform special tests diagnosing ACL injuries. This chapter will describe the design of the study, participants involved, instruments, procedures, and data analyses.

Design

This study used a cross-sectional survey design involving licensed athletic trainers.

Participants

Participants for this study were recruited using the National Athletic Trainers' Association (NATA) Research Survey Request service. This service is provided to NATA Graduate Student Members free of charge. As part of this service the NATA distributed research surveys to 1000 registered NATA members. Typical survey response rates vary.

Power Analysis

A power analysis was conducted using G*Power (v. 3.1.9.7) to determine the minimum sample size necessary for this study. The power analysis indicated that a minimum sample size of 82 participants is required for this study (Effect Size [ρ] = 0.3; α = 0.05; power = 0.80).

Inclusion/Exclusion Criteria

Inclusion for this study includes 1) practicing for at least 1 year and 2) members of the NATA. Exclusion for this study is comprised of 1) non-certified student members of the NATA and 2) non-practicing athletic trainers. Practice status will be verified through a demographic question asking participants to report the percentage of their workload associated with athletic training duties. Those with less than 50% dedicated workload are considered non-practicing.

Survey Instrument

The survey was developed to include demographic questions (e.g., age, sex, & weight) as well as questions directly related to athletic trainers' perceptions on confidence and knowledge performing various ACL special tests. There are 20 questions, (See appendix B) and took participants an estimate of 10 minutes to complete. They were sent a link that directed them to the Qualtrics database once they agree to participate in the survey. Participants filled out an informed consent at the beginning of the survey (See appendix B).

Data Collection Procedures

The survey was sent out via the NATA service, which is provided to graduate students for free. They will randomly select 1000 NATA members registered in the database. The survey was sent to the NATA after IRB approval (See appendix A). It was available for 1 month once sent out. Data collection will continue for the one-month period or until minimal data has been achieved to reach the desired power analysis of 0.80.

Data Analysis

Descriptive statistics, including measures of central tendency and measures of variation were calculated for all demographic variables. Frequencies and percentages were reported for confidence, effectiveness and modifications used when performing the Lachman's test. To assess the hypotheses, a chi-square statistical test was run. The chi-square test of independence was used to compare confidence and various limitations when performing the Lachman's Test.

CHAPTER IV

RESULTS

This study examines athletic trainers' perceptions of the influence of anatomical challenges on their ability to perform special tests diagnosing ACL injuries. This chapter will discuss the results of this examination.

A total of one hundred and twelve athletic trainers completed the survey from the National Athletic Trainers Association (survey response rate of 11.2%). Twenty-eight athletic trainers were excluded from the analysis for not meeting the criteria of spending at least 50% of their time in clinical work, which resulted in a final sample size of 76 athletic trainers (67.9%). There was a relatively even distribution of responses across sex and clinical setting type from participants (see Table 5).

Athletic trainers reported a wide range in hand sizes and limitations they perceive when performing the Lachman's test. When asked to determine their confidence in performing the Lachman's test, 78.4% of participants expressed feeling confident in performing the test (see Table 6). Hand size, athlete calf size, and athlete thigh size have varying effects on the athletic trainer's confidence in completing the Lachman's test. These values either trended toward significant or were not significantly related to clinicians confidence in completing the Lachman's test (See Tables 6-8). When clinicians were asked if their hand size affected their ability to perform the Lachman's test the results were almost significant. While this result only trended toward significance, 78.4% of clinicians reported that their hand size did affect their ability to perform the Lachman's test. While athlete size was not statistically related to confidence in performing the Lachman's test, 78.1% of athletic trainers expressed this as a limitation to

completing this test. Finally, when clinician glove size was assessed, hand size was significantly related to confidence in performing the Lachman’s test.

As athletic trainers experience multiple limitations, it is not surprising that 76.5% of athletic trainers report being familiar with and use modifications to the Lachman’s test (See Table 11-14). The most common modification to the Lachman test was the knee propped assessment and drop leg assessment with 81.7% of participants stating that they are using these modifications. The Prone Lachman’s test modification was not used as often as the knee propped and drop leg assessments. Crosstabulations were run to assess confidence and the various Lachman variations used (See tables 8-10).

Table 5

Athletic Trainer Demographics

	M ± SD	N (%)
Age (y)	40.43 ± 10.04	
Height (cm)	173.22 ± 12.59	
Weight (kg)	86.61 ± 22.31	
Sex		
Male		62 (55.4)
Female		48 (42.9)
Degree		
BS or BA		14 (12.5)
MS or MA		81 (72.3)
PhD or DAT or EdD		14 (12.5)
Job setting		
College		39 (34.8)
High School		33 (29.5)
Other		35 (31.3)

Note: M = mean; s = standard deviation; N=72; BS = Bachelor of Science; BA = Bachelor of Arts; MS = Master of Science; MA = Master of Art, PhD = Doctor of Philosophy; DAT = Doctor of Athletic Training; EdD = Doctor of Education Degree

Table 6

Comparing Confidence & Clinician Hand Size

		Clinician Hand Size*					
		Yes		No		Total	
		N	%	N	%	N	%
Do you feel confident in your ability to accurately assess the integrity of the ACL using the Lachman's test	No	2	12.50	14	87.5	16	21.60
	Yes	22	37.93	36	62.07	58	78.40
	Total	24	32.43	50	67.57	74	100.00

Notes: * = Do you feel your hand size effects your confidence when performing the Lachman's test? $X^2_1 = 3.701$, $N=76$, $p = .059$.

Table 7

Comparing Confidence & Athlete Calf Size

		Athlete Calf Size*				Total	
		No		Yes		N	%
		N	%	N	%	N	%
Do you feel confident in your ability to accurately assess the integrity of the ACL using the Lachman's test	No	5	31.25	11	68.75	16	21.60
	Yes	32	55.17	26	44.82	58	78.40
	Total	37	50.00	37	50.00	74	100.00

Notes: * = Do you feel athlete calf size effects your confidence when performing the Lachman's test? $X^2_1 = 2.871$, $N=76$, $p = .09$

Table 8

Comparing Confidence & Athlete Thigh Size

		Athlete Thigh Size*					
		No		Yes		Total	
		N	%	N	%	N	%
Do you feel confident in your ability to accurately assess the integrity of the ACL using the Lachman's test	No	1	6.20	15	93.75	16	21.60
	Yes	7	12.06	51	87.93	58	78.40
	Total	8	10.81	66	89.18	74	100.00

Notes: * = Do you feel athlete thigh size effects your confidence when performing the Lachman's test? $X^2_1 = 0.44$, $N = 76$, $p = .507$

Table 9

Confidence Comparison & Glove Size

		What size surgical glove do you wear?*					
		Small or Medium		Large or Extra Large		Total	
		N	%	N	%	N	%
Do you feel confident in your ability to accurately assess the integrity of the ACL using the Lachman's test	No	13	81.25	3	18.75	16	21.60
	Yes	26	44.82	32	55.17	58	78.40
	Total	39	52.70	35	47.29	74	100.00

Notes: * = $X^2_1 = 6.674$, $N=76$, $p=0.01$

Table 10

Are you familiar with the Lachman's Variations?

	N	%
No	15	19.70
Yes	58	76.50
Missing data	3	3.90

Note: $N = 76$

Table 11

Use of Different Lachman Techniques

	N	%
Prone		
Yes	16	21.10
No	44	57.90
Drop Leg		
Yes	11	14.50
No	49	64.50
Knee Propped		
Yes	49	64.50
No	11	14.50
Other		
Yes	2	2.60
No	57	75.00
Missing Data	16	21.10

Table 12

Confidence and Prone Lachman's Variation

		Lachman's Prone Modification*				Total	
		No		Yes		N	%
		N	%	N	%	N	%
Do you feel confident in your ability to accurately assess the integrity of the ACL using the Lachman's test	No	11	78.57	3	21.42	14	23.30
	Yes	33	71.73	13	28.26	46	76.70
	Total	44	73.33	16	26.67	60	100.00

Notes: * = Does using a Lachman's prone modification effect your confidence when performing the Lachman's test? $\chi^2_1 = 0.256$ $p = .613$

Table 13

Comparison of Confidence & Drop Leg Lachman's Variation

		Lachman's Drop Leg Modification*					
		No		Yes		Total	
		N	%	N	%	N	%
Do you feel confident in your ability to accurately assess the integrity of the ACL using the Lachman's test	No	12	85.71	2	14.28	14	23.30
	Yes	37	80.43	9	19.56	46	76.70
	Total	49	81.67	11	18.33	60	100.00

Notes: * = Does using a Lachman's drop leg modification effect your confidence when performing the Lachman's test? $X^2_1 = 0.2$ $p = .655$

Table 14

Comparison of Confidence & Knee Propped Lachman's Variation

		Lachman's Knee Propped Modification*					
		No		Yes		Total	
		N	%	N	%	N	%
Do you feel confident in your ability to accurately assess the integrity of the ACL using the Lachman's test	No	3	21.42	11	78.57	14	23.30
	Yes	8	17.39	38	82.60	46	76.70
	Total	11	18.33	49	81.67	60	100.00

Notes: * = Does using a Lachman's knee propped modification effect your confidence when performing the Lachman's test? $X^2_1 = 0.117$ $p = .732$

CHAPTER V

DISCUSSION

This study examines athletic trainers' perceptions of the influence of anatomical challenges on their ability to perform special tests diagnosing ACL injuries. This chapter will discuss the study results, literature comparisons, A mechanism of action, limitations and a conclusion statement.

Knee trauma, particularly when caused by a high-energy mechanism, can result in other capsuloligamentous injuries in addition to the ACL issue. Consequently, if clinician's have decreased confidence, these kinds of mechanisms of injury can cause clinicians to misdiagnose injuries when just using special tests (Dawod, 2023). The gold standard of ACL diagnosis is magnetic resonance imaging (MRI); however, before reaching a definitive diagnosis, before an MRI can be completed, a series of special tests have been described to assess the integrity of the ACL. An evaluation of the ACL should ideally be structured, easy to perform, clinically reproducible, and have a high sensitivity and specificity. Each of the special tests assessed in this study matched this description.

While the study hypothesized that the majority of athletic trainers would not be confident in competing the Lachman's special test, this study shows that 78.4% percent of athletic trainers were confident. However, hand size, as assessed by surgical glove size, significantly affected athletic trainers' confidence levels when performing the test. To improve the athletic trainer's diagnostic accuracy most athletic trainers use multiple variations of the Lachman's special test.

The current studies first outcome looked at confidence in completing the Lachman's test. Khan, et al., (2019) assessed the use of orthopedic special tests to diagnose low extremity pathologies via clinical examinations performed by physical therapy students. Students were

asked to self-report their clinical confidence with lower extremity special tests. Khan, et al., (2019) reported that physical therapy students showed high confidence in basic more well-known tests like Anterior Drawer, and McMurray's test; however, students were less confident with the more complex special tests such as the Lachman's and scouring tests. This is similar to the confidence levels of athletic trainers when it comes to performing the Lachman's test and may explain why so many athletic trainers using modifications use different special tests.

Peeler et al., (2010) reported data that suggests multiple examiner-related variables like level of experience, degree of specialization, and favoritism in ACL test selection, may adversely impact the acuity of ACL injury assessments. Unreliable or inaccurate clinical examination confounds the clinician's ability to make informed decisions regarding appropriate patient referral and treatment. Peeler et al., further states that confidence within all tests, may also be lower than the literature portrays.

To improve the accuracy of the Lachman's test, the NATA established subset skills for the Lachman's special test as (1) patient positioning, (2) amount of knee flexion, (3) patient relaxation, (4) hand placement, (5) application of force, (6) translation determination, and (7) end-feel determination. The general "rule of thumb" for interpretation of manual stress testing is that final determination is based on end-point distinctiveness rather than laxity. Clinicians need to consider that during the physical examination, knee motion occurs simultaneously in 2 planes (i.e. sagittal and transverse) but has the greatest sagittal plane motion (Hurley, 2003).

The second outcome of the current study looked at how clinician and athlete anatomy's effects clinician confidence in performing the Lachman's test. While no studies were found assessing the relationship between clinician and athlete body size and confidence in performing special tests, several articles compared anatomical size to special test accuracy. For instance,

Benger, et al., (1997), examined if hand size, leg size, and clinical experience influenced accuracy when performing the Lachman test. Benger, et al., (1997) reported that the interpretation and performance of the Lachman's test is significantly affected by athlete size, clinical experience, and hand size of the clinician. Unlike the present study, the Benger, et al., (1997), did not identify differences in diagnostic accuracy between clinicians with large or small hand sizes. Draper, et al., (1995) found that the Lachman's Test is considered the most accurate special test to determine ACL integrity, yet it can be challenging for clinicians to perform on larger patients, especially when the clinician has smaller hands. Different variations of the Lachman's test have been successfully used by clinicians who struggle with the traditional Lachman's test. The difference in findings may be partially explained by the context of each study. While Benger, et al., (1997), examined diagnostic accuracy of the test, the focus of the current study was on the athletic trainer confidence. Benger, et al., (1997) also reported that there was a trend of the Lachman's test becoming less sensitive with increasing thigh size, but this relationship was not statistical significance.

The current study found that surgical glove size and anatomical challenges (i.e. athlete's thigh size and calf size) plays a role in the confidence of the athletic trainer performing the test. Another possible explanation for the difference in findings may be associated with the respective study populations. In the present study the target population was athletic trainers who reported at least 50% of their job responsibility associated with clinical responsibilities. Meanwhile, medical students were the target population in the Benger, et al., (1997) study. The use of athletic training participants allows a better sample of clinicians who perform the test more regularly when doing evaluations. This study is unique as to the best of our knowledge there are no other studies that

assessed athletic trainer confidence in performing the Lachman's special test or an assessment of the appropriate modifications.

This study also found that many clinicians did report having issues with hand size and it effecting their ability to perform the test. Clinicians who reported a surgical glove size of small or medium did have an issue when performing the test, but glove sizes of large or extra-large did not have an issue. This is similar to the findings of the Bengert, et al., (1997) study that found that surgical glove size accurately standardizes and assesses clinician hand size leading to significant results in both Bengert et al., (1997) study and the current study.

A limitation of the current study was the non-inclusion of clinician's strength. Clinician strength may influence the confidence level of an athletic trainer to complete the Lachman's test; however, as this study was a questionnaire, clinician strength was difficult to assess. Hand size has been shown to correlate with grip strength, meaning the larger the hands a clinician has, the stronger their grip can be compared to clinicians with smaller hands (Bardo, 2021). As this was not assessed, future studies should assess if the clinician's grip strength affects their confidence in completing the Lachman's test.

Even though Lachman's test is considered the best special test for ACL injuries, 5.4% of participants stated that they do not use the test at all. The Lachman's test is considered the best special test to determine ACL integrity with many athletic trainers not struggling with this traditional test. There are three main modifications athletic trainers use when performing the Lachman's test: the prone, knee propped and drop leg tests. These modifications allow the athletic trainer to accurately assess the integrity of the knee even when they are not able to or confident in their ability to perform an accurate Lachman's test. There is very little data published regarding different factors that can influence the outcome of these modifications.

Future studies should be considered in this area to determine if the use of modifications significantly alters clinician confidence or the diagnostic accuracy of these assessments.

Other special tests such as Lelli's or Lever Sign test and the Pivot Shift test were not used as often by clinicians. This may be due to a variety of factors. The Lever sign test is a relatively new test with limited research. Because of the novelty of the test many athletic trainers may not have learned about this test during their clinical education experiences. If they are not actively staying up-to-date and following evidence-based practices they might not be as familiar with the test. Furthermore, with the Pivot Shift test it has been identified that muscle guarding is a significant problem that limits potential application of the test. Original studies conducted on the diagnostic accuracy of the Pivot Shift test were conducted on patients under anesthesia to test the integrity of the surgical repair of the ACL by surgeons (Konin, et al., 2016). This suggests that this test may not be a useful clinical diagnostic test for athletic trainers because of the difficulty in getting the patient to fully relax their muscles during testing. The traditional Lachman, modified Lachman, or Anterior Drawer tests are used more by athletic trainers. This may be due to the ease of use, familiarity, or other factors. Future research should explore factors, such as confidence and content knowledge, related to the use of other special tests not explored in the present study.

Clinical diagnosis of ACL injuries is based upon physical examination findings confirmed by MRI or arthroscopy. Many special tests have aided in the diagnosis of ACL injuries. A popping sound, swelling, and instability after trauma along with a positive Lachman's, Anterior Drawer, or Pivot shift is the most common method of diagnosis. It is important to mention that athletic trainers' should not rely on one singular special test to diagnosis a suspected injury (Swain, 2014). The Lachman's test has the highest sensitivity, while

the Lever Sign and Pivot Shift tests have the highest specificity (Krakowski et al., 2019). Therefore, a combination of these tests would be the most appropriate to detect ACL injury.

Conclusion

The current data suggests that hand size plays a role in an athletic trainer's confidence when performing the Lachman's test. Other variables like athlete thigh or calf size were not significantly related to an athletic trainer's confidence in performing the Lachman's test. Although variables related to the athlete's body size did not show significance, many athletic trainers (i.e. 78.4%) indicated that athlete size does affect their confidence in accurately performing this test. With 21.4% of athletic trainers not knowing the different Lachman's variations, continuing education on special tests would be beneficial. Future research should 1) assess these variations and assess if their limitations impact the athletic trainer's confidence and accuracy when completing the test, 2) assess if there is a modified gold standard that exists for best practices and 3) reassess the Benger, et al., (1997) study methods for accuracy in different populations.

The current study has shown that a combination of circumstances can influence the confidence of an athletic trainer's ability to perform the Lachman's test. The findings of this study, such as hand size and confidence, should be considered when athletic trainers evaluate and question the integrity of the ACL. Modifications can be used to increase confidence if clinicians do not feel they are getting an accurate assessment with the traditional Lachman's test.

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APPENDIX

Appendix A: IRB Letter of Approval

Date: 4-16-2024

IRB #: IRB-FY2024-130
Title: The practicality of the Lachman's special test for athletic trainers.
Creation Date: 12-17-2023
End Date:
Status: Approved
Principal Investigator: Kelli Hurt
Review Board: MTSU Institutional Review Board
Sponsor:

Study History

Submission Type	Initial	Review Type	Exempt	Decision	Exempt
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Key Study Contacts

Member Vaughn Barry	Role Co-Principal Investigator	Contact vaughn.barry@mtsu.edu
Member Helen Binkley	Role Co-Principal Investigator	Contact helen.binkley@mtsu.edu
Member James Farnsworth	Role Co-Principal Investigator	Contact jim.farnsworth@mtsu.edu
Member Kelli Hurt	Role Principal Investigator	Contact kgh3c@mtmail.mtsu.edu
Member Kelli Hurt	Role Primary Contact	Contact kgh3c@mtmail.mtsu.edu

Hurt Kelli Survey

Start of Block: Consent Statement

Q24 Study Title: The practicality of the Lachman's special test for athletic trainers. Protocol Number: IRB – FY2024-130

Approval Date: TBD

Principal Investigator: Kelli Hurt LAT, ATC

Institution: Middle Tennessee State University

You are being asked to participate in a research project. The following information is provided to inform you about the research project and your participation in it.

1. Purpose of the study: The purpose of this study is to examine the practicality of the Lachman's special test for athletic trainers.
2. Description of procedures to be followed and approximate duration of the study: A survey developed including demographic questions as well as questions related to athletic trainers' perceptions on confidence and knowledge performing various ACL special tests. The survey is 23 questions and estimated to take 10 minutes to complete.
3. Compensation for participation: There is no compensation for participation in this study.

Here are your rights as a participant: a) Your participation in this research is voluntary. b)

You may skip any item that you don't want to answer, and you may stop the research at any time. Note that if you leave an item blank, you will be warned that you missed one, just in case it was an accident. You can still click that you don't want to answer. Some items may be required in order to accurately present the study. c) There are no risks associated with your participation besides possible discomfort with some of the questions. d) There are no real benefits to you from participating besides possibly learning something about the research. e)

You will NOT be asked to provide any identifiable personal information. f) All efforts, within reason, will be made to keep the personal information in your research record private, but total privacy cannot be promised. Your information may be shared with people at MTSU (such as the MTSU Institutional Review Board) or other agencies (such as the Federal Government Office for Human Research Protection) if you or someone else is in danger or if we are required to do so by law.

To receive the outcomes of this study, we invite you to reach out to the [principle](#) investigator using the contact information below.

Contact Information: If you should have any questions about this research study please contact:

Principal Investigator: Kelli Hurt LAT, ATC

Contact Information: Kgh3c@mtmail.mtsu.edu

Faculty Advisor: Dr. Vaughn Barry
Contact Information: Vaughn.Barry@mtsu.edu

For additional information about giving consent or your rights as a participant in this study, please contact the Middle Tennessee State University (MTSU) Office of Compliance at 615-494-8918 or via email at irb_information@mtsu.edu. (<http://www.mtsu.edu/irb>) If you're ready to get started, please make your choice below before clicking the arrow button. Thanks again for volunteering your time to this project! I have read the information above. I am at least 18 years old. I believe I understand the purpose, risks, and benefits of the research, and I know what I will be expected to do as a study participant.

I consent to participate

I decline to participate

I agree to participate (1)

I decline to participate (2)

Skip To: End of Survey If Q24 = I decline to participate

End of Block: Consent Statement

Start of Block: Default Question Block

Q1 How old are you?

Q3 What is your biological sex?

Male (1)

Female (2)

Intersex (3)

Prefer not to say (4)

Q4 What is your height?

Q5 What is your weight?

Q6 Please select the size of latex surgical glove you use.

- Extra Small (1)
- Small (2)
- Medium (3)
- Large (4)
- Extra Large (5)
- Do not know (6)

Q8 Please state your highest level of education.

Q9 Please select the percentage of clinical work you do on a daily basis

0 10 20 30 40 50 60 70 80 90 100

Click to write Choice 1 ()



Q10 How long have you been practicing as an athletic trainer?

Q11 What setting do you currently practice in?

End of Block: Default Question Block

Start of Block: Block 1

Q12 Select all that apply: In patients with a suspected anterior cruciate ligament (ACL) injury; which ACL-specific special tests do you include as part of your regular evaluation?

- ~~Lelli's~~ or lever sign (1)
 - Lachman's (2)
 - Anterior Drawer (3)
 - Pivot Shift (4)
 - Other (5)
-

Q14 Select all that apply: Of the tests listed below, which tests did you learn in school?

- ~~Lelli's~~ or lever sign (1)
 - Traditional Lachman's (2)
 - Modified Lachman's (3)
 - Anterior Drawer (4)
 - Pivot Shift (5)
 - Other (6)
-

Q15 What test are you most confident will help you diagnose ACL pathologies?

Q16 Select all that apply: Do you feel any of the following factors affect your ability to perform the Lachman's test?

- Hand size (1)
 - Athlete thigh size (2)
 - Athlete calf size (3)
 - Other (4)
-
-

Q17 Do you feel like you have gained confidence with the Lachman's Test over time during your career?

- Yes (1)
 - No (2)
-

Q18 Do you feel that your hand size limits your ability to perform the Lachman's test effectively with your patients?

- Yes (1)
 - No (2)
-

Q19 Do you feel that you have difficulty performing the Lachman's test on larger athletes?

- Yes (1)
 - No (2)
-

Q20 Do you feel confident in your ability to accurately assess an ACL's integrity using the Lachman's test?

- Yes (1)
 - No (2)
-

Q21 Are you familiar with the Lachman's variations?

- Yes (1)
- No (2)

Q22

Select all that apply: Which modifications do you use?

- Prone
 - Drop Leg Lachman's Test
 - Knee propped Lachman's Test
 - Other
-
-

Q23

Do you feel these modifications effect the accuracy of the Lachman's Test?

- Yes
- No