



## Research Article

## Section: Orthopedics

### Lelli's Test in ACL Injuries

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#### ABSTRACT

**Introduction:** Anterior cruciate ligament (ACL) injuries are common and impact knee function. Accurate diagnosis is essential, with MRI as a reliable non-invasive method and arthroscopy as the gold standard. Clinical tests like Lachman, anterior drawer, pivot shift, are commonly used for ACL evaluation. Lelli's test is a simple, non-invasive tool, and this study evaluates its sensitivity, specificity, and diagnostic accuracy compared to arthroscopy.

**Objective:** This study aims to assess the sensitivity and specificity of Lelli's test in diagnosing anterior cruciate ligament (ACL) injuries and compares its diagnostic accuracy with that of arthroscopy. **Methods:** This study included 188 patients with suspected ACL injuries presenting at the Department of Orthopaedics, Government Medical College, Kottayam. Each patient underwent standard tests, including the Lachman, anterior drawer, pivot shift, Lelli's test involved applying a posterior force to the quadriceps tendon, with heel liftoff indicating a negative result. Test results were recorded and compared to arthroscopy findings. Sensitivity, specificity, and diagnostic accuracy of each test were calculated. **Results:** The Lachman test had the highest sensitivity (95.09%) and specificity (88%). Lelli's test showed a sensitivity of 91.41% and specificity of 88%, demonstrating good accuracy for diagnosing ACL injuries. The anterior drawer test had a sensitivity of 85.54% and specificity of 88.85%. The pivot shift test showed the lowest sensitivity (65.64%) and specificity (60%). **Conclusion:** Lelli's test is a simple and reliable method for diagnosing ACL injuries, with diagnostic accuracy comparable to other clinical tests. It can be effectively used in both acute and chronic knee injuries but should be combined with other diagnostic tools for comprehensive evaluation.

#### INTRODUCTION

In the emergency room, one of the most frequently encountered diagnoses following knee trauma is an anterior cruciate ligament (ACL) rupture. The ACL, located within the knee, is composed of two bundles: the anteromedial and posterolateral. These bundles are named according to the points where they attach to the tibia and femur, respectively [1]. The ACL plays a crucial role in stabilizing the knee by preventing the tibia from moving too far forward in relation to the femur. Additionally, the ligament serves as a secondary restraint, controlling tibial rotation and limiting excessive varus (inward) or valgus (outward) rotation of the knee joint [2].

A ruptured ACL is often accompanied by visible signs of knee instability and increased laxity. Patients with an ACL tear typically describe a feeling of instability in their knee, particularly during physical activities such as running, jumping, or sudden changes in direction. While clinical signs and patient history are critical for

diagnosis, the most definitive way to confirm an ACL injury is through arthroscopic evaluation [3]. Arthroscopy, a minimally invasive surgical procedure, allows for direct visualization of the ACL and other internal knee structures. However, due to its invasive nature, arthroscopy is typically reserved for cases where there is a strong clinical suspicion of an ACL injury, and non-invasive diagnostic methods have yielded inconclusive results [4].

Early diagnosis of an ACL injury is essential for determining the most effective course of treatment and improving long term outcomes. A delayed or missed diagnosis can lead to further knee damage, including meniscal tears or cartilage degeneration, which may result in chronic knee instability and the early onset of osteoarthritis [5]. Although arthroscopy is considered the gold standard for diagnosing ACL injuries, a comprehensive history and physical examination are usually the first steps in the diagnostic process. This allows the physician to assess the nature of the injury and its impact on the patient's knee function before proceeding to imaging or invasive

There are three primary clinical tests used to diagnose an ACL tear: the anterior drawer test, the Lachman test, and the pivot shift test. Each test assesses different aspects of knee stability, and their combined use increases the accuracy of the diagnosis [7].

The anterior drawer test evaluates the forward movement of the tibia in relation to the femur. The patient lies down with their knee bent at a 90-degree angle, and the examiner pulls the tibia forward while stabilizing the femur. If the tibia moves excessively forward, it may indicate an ACL tear [8]. However, the anterior drawer test is not always sensitive enough to detect acute ACL injuries, particularly if there is significant swelling or muscle guarding. Despite its limitations in acute cases, it can be helpful in diagnosing chronic ACL injuries where the ligament has had time to heal or scar [9].

The Lachman test is considered the most reliable and sensitive clinical test for diagnosing ACL injuries. During this test, the patient lies on their back with their knee slightly bent (about 20-30 degrees). The examiner stabilizes the femur with one hand while pulling the tibia forward with the other hand. A significant forward movement of the tibia compared to the uninjured knee suggests an ACL rupture. The high sensitivity and specificity of the Lachman test make it the most frequently recommended test for ACL diagnosis [10]. However, the test's accuracy can be influenced by the patient's physical characteristics and the examiner's experience. For example, patients with significant swelling, pain, or muscle guarding may be more difficult to assess accurately [11].

The pivot shift test evaluates the rotational stability of the knee, which is often compromised in the presence of an ACL injury. In this test, the examiner extends the patient's leg while applying a valgus force and internal rotation to the tibia [12]. A positive pivot shift test occurs when the tibia "shifts" or "jumps" during the movement, indicating instability caused by an ACL tear. However, this test is not very sensitive for detecting ACL ruptures, and it can be difficult to perform on patients who are in pain or have significant swelling following an acute injury [13].

To increase the overall sensitivity and specificity of ACL rupture diagnosis, physicians often combine multiple clinical tests. This approach helps mitigate the limitations of individual tests and provides a more comprehensive assessment of knee stability [14]. However, the accuracy of these tests can still be affected by several factors, including the patient's characteristics and the examiner's experience. For example, patients with significant swelling, pain, or protective muscular activity may be more difficult to examine accurately. Additionally, examiners with smaller hands or patients with thick, muscular thighs may find it challenging to perform the Lachman or anterior drawer tests effectively [15].

In the immediate aftermath of an ACL injury, reactive

synovitis, hemarthrosis, and knee swelling are common. These conditions can make patients apprehensive about undergoing a physical examination, as they fear that certain movements may cause discomfort or even lead to knee subluxation (partial dislocation). This hesitancy can hinder the accuracy of clinical tests, especially in cases of partial ACL ruptures [16]. Partial tears may be harder to detect than complete ruptures because the remaining intact fibers of the ACL may continue to provide some degree of knee stability. Moreover, the presence of concomitant injuries, such as a meniscal tear, can further complicate the clinical examination and may mask the signs of an ACL rupture [17].

Diagnosing ACL ruptures in the emergency room requires a combination of clinical tests, patient history, and physical examination. While arthroscopy is the gold standard, non-invasive tests like the Lachman, anterior drawer, and pivot shift tests are essential for assessing knee stability [18]. However, their accuracy may be affected by factors such as patient characteristics and examiner experience. For instance, thick, muscular thighs may hinder the detection of excessive tibial movement, while examiners with smaller hands might struggle to perform these tests on larger patients. Understanding these limitations helps clinicians improve diagnostic accuracy and guide appropriate treatment decisions [19].

This study aims to assess the diagnostic accuracy of Lelli's test by evaluating its sensitivity and specificity for detecting ACL injuries, and comparing its performance against the gold standard, arthroscopy, to determine its reliability in clinical settings.

## MATERIAL AND METHODS

This observational study was conducted over 12 months in the Orthopaedics Department at Government Medical College, Kottayam, focusing on patients with knee symptoms suggestive of ACL injuries. A sample size of 188 patients was determined based on a previous study by Thapa SS et al. (2015), which reported the sensitivity and specificity of Lelli's test as 85.71% and 91.11%, respectively. Arthroscopy was used as the gold standard for diagnosis. Inclusion criteria encompassed patients over 18 years with ACL injuries, including associated ligament injuries and surgical failures. Exclusion criteria included multiligamentous injuries, fractures, infections, stiff knees, and medically unfit patients.

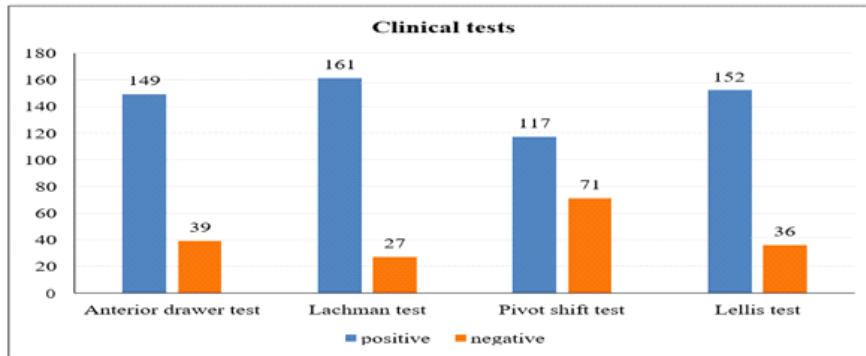
## RESULTS

In this study, the majority of cases (40.96%) fell within the 21–30 year age range, followed by 23.40% in the 31–40-year group. The under 20 group constituted 13.83%, while 14.36% were aged 41–50 years. The 51–60 and 61–70 year groups accounted for 5.32% and 2.13%, respectively. Additionally, gender distribution revealed that 87.23% of the participants were male, while only 12.77% were female, indicating a significant male predominance in the study cohort.

**Table 3: Mode of Injury**

Mode of injury	Cas number	Percent
Sports Injury	114	60.64%
Vehicle Accident	69	36.70%
Assault	5	2.66%

In this study, the most common mode of injury was sport-related, accounting for 60.64% of cases, followed by road traffic accidents at 36.70%. Assault related injuries were the least frequent, comprising 2.66% of the total cases.



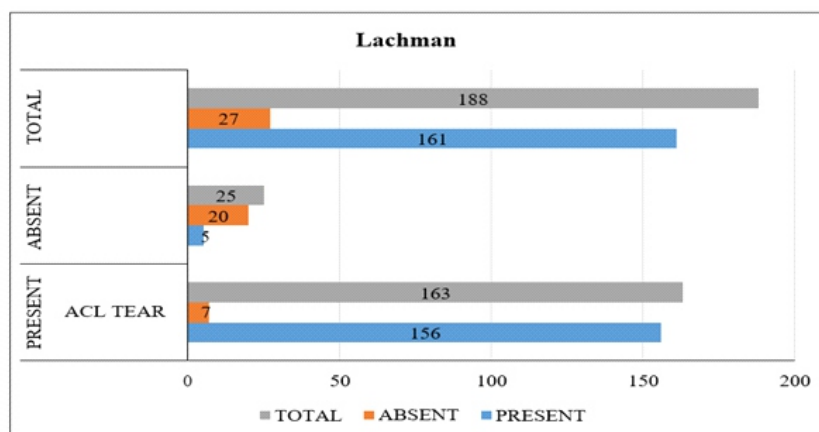
**Graph 4: Clinical Tests**

The Lachman and Lelli's tests show the highest percentage of positive results, indicating greater sensitivity for detecting the condition. In contrast, the anterior drawer test yields fewer positive results compared to Lachman and Lelli's. The pivot shift test produces the fewest positive outcomes, suggesting lower sensitivity or likelihood of detecting the condition.

**Table 5: Pivot Shift Test**

Pivot Shift	ACL Tear			Sensitivity	65.64%
	Present	Absent	Total	Specificity	60.00%
Present	107	10	117	PPV	91.45%
Absent	56	15	71	NPV	21.13%
Total	163	25	188	Accuracy	64.89%

The Pivot Shift test shows low sensitivity (65.64%) and specificity (60.0%) for detecting ACL tears. Its high positive predictive value (91.45%) suggests a strong likelihood of ACL tear with a positive result, but the low negative predictive value (21.13%) indicates a high risk of false negatives.



**Graph 6: Lachman Test**

**Table 7: Lelli's Test**

Lelli's test	ACL Tear			Sensitivity	91.41%
	Present	Absent	Total	Specificity	88.00%
Present	149	3	152	PPV	98.02%
Absent	14	22	36	NPV	61.11%
Total	163	25	188	Accuracy	86.98%

Lelli's test shows 91.41% sensitivity, 88.00% specificity and 86.98% overall accuracy for detecting ACL tears. Its high PPV (98.02%) confirms that a positive result strongly indicates an ACL tear. However, a low NPV (61.11%) suggests it may miss some tears, making it less reliable in ruling out ACL injuries compared to the Lachman test.

**Table 8: Anterior Drawer Test**

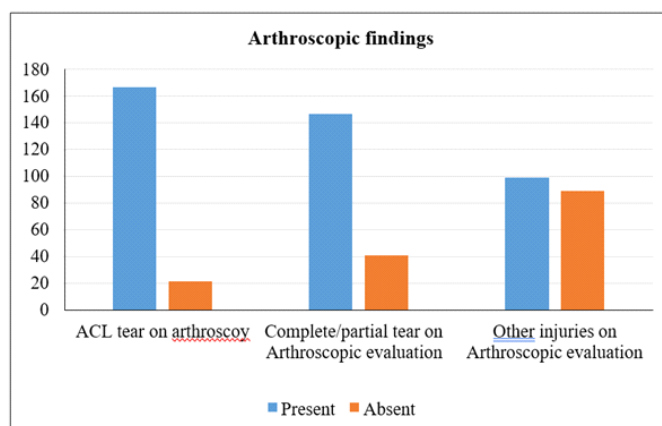
Anterior drawer test	ACL tear			Sensitivity	85.54%
	Present	Absent	Total	Specificity	88.85%
Present	142	7	149	PPV	83.42%
Absent	21	18	39	NPV	96.60%
Total	163	25	188	Accuracy	85.43%

The Anterior Drawer test demonstrates high specificity (88.85%) and sensitivity (85.54%), making it reliable in ruling out ACL tears with a high NPV (96.60%). A positive result reasonably indicates an ACL tear (PPV 83.42%). Its total accuracy (85.43%) suggests it is a reliable diagnostic tool for detecting ACL rupture.

**Table 9: ACL Tear on MRI**

MRI findings	Present	Absent	Present	Absent
ACL tear on MRI	173	15	92.02%	7.98%
Complete/partial tear on MRI	148	40	78.72%	21.28%
Other injuries on MRI	107	81	56.91%	43.09%

Complete ACL tears account for 148 cases (78.72%) and typically require surgery for optimal recovery. No ACL injuries make up 15 cases (7.98%) and may involve other knee conditions. Partial ACL tears represent 25 cases (13.30%) and involve partial ligament damage requiring varying treatments based on severity. Other injuries, such as meniscal or collateral damage, are present in 107 cases (56.91%), comprising non-ACL knee injuries.



**Graph 10: Arthroscopic Findings**

In this study, 167 cases involved ACL tears, with 147 being full tears, typically requiring arthroscopic reconstruction for optimal outcomes. Twenty cases had partial tears, which may or may not need surgery; the decision for repair or conservative management is made intraoperatively. Ninety-nine patients fell under the "other injuries" category, including PCL, MCL, LCL, or meniscus injuries, which often require surgery for improved outcomes.

## DISCUSSION

The anterior cruciate ligament (ACL) is the most frequently injured component of the knee joint. Patients with ACL injuries often present with symptoms of knee laxity and instability. Commonly used tests for diagnosing ACL tears include the anterior drawer, Lachman, and pivot shift tests. The Lelli's test evaluates ACL integrity by restricting anterior tibial translation when the ACL is intact. Applying a posterior force to the distal femur causes the heel to lift if the ACL is functional. Lelli's test can detect both acute and chronic ACL injuries and is unaffected by concurrent MCL injuries or patellar tendon ruptures [20].

Dr. Alessandro Lelli, an Italian orthopaedic knee surgeon, introduced the Lelli's test in 2005 as a novel diagnostic tool for detecting anterior cruciate ligament (ACL) injuries. His research claimed near perfect sensitivity and specificity (almost 100%) for this test, though these results may be somewhat inflated. Lelli's test can identify both acute and chronic ACL injuries, as well as partial and complete tears [21].

In our study, Lelli's test showed a sensitivity of 91.41% and specificity of 88.00%, indicating strong accuracy in detecting ACL tears. Its high positive predictive value (95.51%) suggests that a positive result reliably indicates an ACL injury. However, with a negative predictive value of 61.11%, the test may have a high rate of false negatives, making it less reliable in ruling out ACL tears. Compared to other tests, Lachman demonstrated 95.09% sensitivity, the anterior drawer test had 85.54% sensitivity, and the pivot shift test had 65.64% sensitivity. The specificity for these tests was 88.00%, 88.85%, and 60.00%, respectively. Interestingly, previous studies suggest the pivot shift test's specificity can reach 100% when performed under anesthesia, though in this study, the tests were not done under anesthesia [21].

Thapa et al. reported a sensitivity of 85.71% and specificity of 91.11%, while Tahsin Gurpinar et al. achieved both sensitivity and specificity at 91.9%. Patrick A. Masset et al. observed lower sensitivity (83%) and specificity (80%). Dhakal et al. reported high values with 87.5% sensitivity and 93.2% specificity. The current study demonstrates high diagnostic performance, with a sensitivity of 91.41% and specificity of 88%. Overall, these results highlight strong efficacy in diagnosing ACL tears across studies.[22,23, 24,25]

In this study the specificity of Lelli's test was lower than expected particularly in patients with partial ACL tears. The

test was negative in some cases of partial injury due to the anatomical structure of the ACL. Normally, the ACL fans out when it inserts into the tibia, allowing it to tuck under the intercondylar notch, with anterior fibers wrapping around during full extension a process known as physiological impingement. In partial tears (involving one bundle) the heel often failed to lift off the table, leading to false negative results and reduced accuracy in detecting partial ACL injuries[21].

Common ACL diagnostic tests like the Lachman, pivot shift, and anterior drawer tests have limitations. Smaller hands, defensive muscle activation, and conditions like hemarthrosis can hinder accuracy. Lelli's test, however, is less impacted by these factors, making it easier to perform with similar sensitivity and specificity. It's particularly effective for detecting complete ACL tears but less reliable for partial tears. As a non-invasive, passive test, Lelli's test isn't influenced by age, sex, or BMI. Though valuable, it should be combined with other diagnostic methods for a comprehensive evaluation of ACL injuries and effective treatment planning [21]

## CONCLUSION

In conclusion, the Lelli's test demonstrates strong diagnostic performance with a sensitivity of 91.41% and specificity of 88.00%, effectively identifying ACL and non ACL tear cases. A positive result is highly indicative of an ACL tear, given its high PPV (98.02%). However, the low NPV (61.11%) suggests the test may miss some ACL tears, leading to false negatives. With an overall accuracy of 86.98%, it is a reliable tool, though not as dependable as the Lachman test. Given its simplicity and comparable sensitivity, Lelli's test can be routinely used to assess ACL function in both acute and chronic injuries.

## REFERENCES

1. Parwaiz H, Teo AQ, Servant C. Anterior cruciate ligament injury: a persistently difficult diagnosis. *The Knee*. 2016 Jan 1;23(1):116-20.
2. Marieswaran M, Jain I, Garg B, Sharma V, Kalyanasundaram D. A review on biomechanics of anterior cruciate ligament and materials for reconstruction. *Applied bionics and biomechanics*. 2018;2018(1):-4657824.
3. LaBella CR, Hennrikus W, Hewett TE, Council on Sports Medicine and Fitness, and Section on Orthopaedics, Brenner JS, Brookes MA, Demorest RA, Halstead ME, Kelly AK, Koutoures CG, LaBella CR. Anterior cruciate ligament injuries: diagnosis, treatment and prevention. *Pediatrics*. 2014 May 1;133(5):-e1437-50.
4. Imada AO, Ellis HB, Tompkins M. Diagnostic knee arthroscopy and arthroscopic anatomy. In *MRI-Arthroscopy Correlations: A Case-Based Atlas of the Knee, Shoulder, Elbow, Hip and Ankle* 2022 May 17 (pp.

- 19-30). Cham: Springer International Publishing.
5. International Olympic Committee Pediatric ACL Injury Consensus Group, Ardern CL, Ekås G, Grindem H, Moksnes H, Anderson AF, Chotel F, Cohen M, Forssblad M, Ganley TJ, Feller JA. 2018 International Olympic Committee consensus statement on prevention, diagnosis and management of pediatric anterior cruciate ligament injuries. *Orthopaedic journal of sports medicine*. 2018 Mar 16;6(3):2325967118759953.
  6. Felli L, Garlaschi G, Muda A, Tagliafico A, Formica M, Zanirato A, Alessio-Mazzola M. Comparison of clinical, MRI and arthroscopic assessments of chronic ACL injuries, meniscal tears and cartilage defects. *Musculoskeletal surgery*. 2016 Dec;100-:231-8.
  7. Kuroda R, Hoshino Y, Kubo S, Araki D, Oka S, Nagamune K, Kurosaka M. Similarities and differences of diagnostic manual tests for anterior cruciate ligament insufficiency: a global survey and kinematics assessment. *The American journal of sports medicine*. 2012 Jan;40(1):91-9.
  8. Krick JD. Anterior Cruciate Ligament Injuries In Athletes.
  9. Swain MS, Henschke N, Kamper SJ, Downie AS, Koes BW, Maher CG. Accuracy of clinical tests in the diagnosis of anterior cruciate ligament injury: a systematic review. *Chiropractic & manual therapies*. 2014 Dec;22:1-0.
  10. Sosulska A, Ankowska D, Szczurowska B, Jekielek M, Mańko G. Comparison of selected clinical tests for the assessment of ACL injury with respect to sensitivity and specificity a review paper. *Physiotherapy Review*. 2022;26(3):23-32.
  11. Sibbald M, Panisko D, Cavalcanti RB. Role of clinical context in residents' physical examination diagnostic accuracy. *Medical education*. 2011 Apr;45(4):415-21.
  12. McLeod KC, Barber FA. Pivot shift syndrome of the knee. *Sports Medicine and Arthroscopy Review*. 2023 Jun 1;31(2):34-40.
  13. Boeth H. Evaluation and characterization of knee joint instability in ACL deficient patients.
  14. Décarry S, Fallaha M, Belzile S, Martel-Pelletier J, Pelletier JP, Feldman D, Sylvestre MP, Vendittoli PA, Desmeules F. Clinical diagnosis of partial or complete anterior cruciate ligament tears using patients' history elements and physical examination tests. *PLoS One*. 2018 Jun 12;13(6):e0198797.
  15. Musso G, Gambino R, Cassader M, Pagano G. Meta-analysis: natural history of non-alcoholic fatty liver disease (NAFLD) and diagnostic accuracy of non-invasive tests for liver disease severity. *Annals of medicine*. 2011 Dec 1;43(8):617-49.
  16. Eagles K, Stevenson H. ACL INJURY. *The 5-Minute Clinical Consult Premium* 2015. 2014 May 6;41(1):10.
  17. Sonnery Cottet B, Colombet P. Partial tears of the anterior cruciate ligament. *Orthopaedics & Traumatology Surgery & Research*. 2016 Feb 1;102(1):S59-67.
  18. Leblanc MC, Kowalczyk M, Andruszkiewicz N, Simunovic N, Farrokhyar F, Turnbull TL, Debski RE, Ayeni OR. Diagnostic accuracy of physical examination for anterior knee instability: a systematic review. *Knee Surgery, Sports Traumatology Arthroscopy*. 2015 Oct;23:2805-13.
  19. White S. The diagnostic accuracy of the clinical examination of the hip (Doctoral dissertation, Auckland University of Technology).
  20. Musahl V, Rahnama-Azar AA, Costello J, Arner JW, Fu FH, Hoshino Y, Lopomo N, Samuelsson K, Irrgang JJ. The influence of meniscal and anterolateral capsular injury on knee laxity in patients with anterior cruciate ligament injuries. *The American journal of sports medicine*. 2016 Dec;44(12):3126-31.
  21. Lelli A, Di Turi RP, Spenciner DB, Dòmini M. The "Lever Sign": a new clinical test for the diagnosis of anterior cruciate ligament rupture. *Knee Surg Sports Traumatol Arthrosc*. 2016 Sep;24(9):2794-2797. doi: 10.1007/s00167-014-3490-7. Epub 2014 Dec 25. PMID: 25536951
  22. Thapa, Sunil & Lamichhane, Arjun. (2015). Accuracy of Lelli Test For Anterior Cruciate Ligament Tear. *Journal of the Institute of Medicine*. 37. 91-94.
  23. Gürpınar T, Polat B, Polat AE, Çarkçı E, Öztürkmen Y. Diagnostic Accuracy of Lever Sign Test in Acute, Chronic, and Postreconstructive ACL Injuries. *Biomed Res Int*. 2019 Jun 9;2019:3639693. doi: 10.1155/2019/3639693. PMID: 31281835; PMCID: PMC6590604.
  24. Massey PA, Harris JD, Winston LA, Lintner DM, Delgado DA, McCulloch PC. Critical Analysis of the Lever Test for Diagnosis of Anterior Cruciate Ligament Insufficiency. *Arthroscopy*. 2017 Aug;33(8):1560-1566. doi: 10.1016/j.arthro-2017.03.007. Epub 2017 May 9. PMID: 28499922.
  25. Dhakal, Binit, et al. "Efficacy of Lelli Test for Detecting Anterior Cruciate Ligament Tear." *Nepal Orthopaedic Association Journal*, vol. 7, no. 1, 1 June 2020, pp. 31–36, nepjol.info/index.php/NOAJ/article/view/58336.

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