

Positive Predictive Value of the Lelli's Test in Diagnosing Anterior Cruciate Ligament Injury taking Arthroscopic Findings as Gold Standard

Muhammad Jawad,¹ Afzal Javid,² Tafseel Ahmad,³ Rana Dawood Ahmad Khan⁴

¹Department of Orthopedics, Services Hospital, Lahore-Pakistan ²Department of Orthopedics, DHQ Hospital, Faisalabad-Pakistan, ³Department of Orthopedics, Jinnah Hospital, Lahore-Pakistan, ⁴Department of Orthopedics, Faisalabad Medical University, Faisalabad-Pakistan

ABSTRACT

Background: Arthroscopic examination is the gold standard for diagnosing ACL injury. However, it is an invasive procedure and is only performed in patients with strong clinical suspicion of ACL injury. Among the various clinical methods for the assessment of ACL injury, Lachman, anterior drawer and pivot shift tests are used in routine practice. But all these tests have their own limitations and have very low positive predictive value. Lelli's test, a recently introduced clinical test has been shown to be superior to these existing tests. It carries a high positive predictive value and can be performed easily in routine clinical setup without any known limitation. However, the available evidence on the positive predictive value of Lelli's test was limited. **Objective:** To determine the positive predictive value of the Lelli's test in diagnosing anterior cruciate ligament injury taking arthroscopic findings as gold standard. **Study Design:** Cross Sectional Study. **Settings:** The study was conducted in Department of Orthopedic Surgery, Services Hospital Lahore. **Duration:** 6 months from approval of this study 11-01-2017 to 10-07-2017. **Methodology:** This study involved 197 patients of both genders aged between 20-45 years suspected of ACL tear and having a positive Lelli's test on clinical examination. Arthroscopy was performed in all these patients to determine the presence or absence of ACL tear. The results of arthroscopy were taken as gold standard. Outcome variable was positive predictive value of Lelli's test which was noted and compared among various age, gender, BMI and duration of symptoms groups. **Results:** Mean age was 32.82 ± 7.61 years. The mean duration of symptoms was 5.03 ± 2.13 weeks while the mean BMI was 27.35 ± 4.24 Kg/m². Arthroscopy confirmed ACL injury in 175 (88.8%) patients. Thus, there were 175 true positive and 22 false positive cases which yielded a positive predictive value of 88.8% for Lelli's test in diagnosing ACL tear taking arthroscopy as gold standard. **Conclusion:** The positive predictive value of Lelli's test was found to be 88.8% in diagnosing ACL tear taking arthroscopy as gold standard. It was not affected by patient's age, gender, BMI and duration of symptoms which make it superior to other clinical tests currently in practice.

Keywords: Anterior Cruciate Ligament Injury, Arthroscopy, Lelli's Test.

Corresponding Author

Dr. Afzal Javid, Senior Registrar, Department of Orthopedics, DHQ Hospital, Faisalabad-Pakistan.

Email: dr_afzaal703@yahoo.com

Submitted for Publication: 19-12-2019

Accepted for Publication: 21-01-2020

Citation: Jawad M, Javid A, Ahmad T, Khan RDA. Positive Predictive Value of the Lelli's Test in Diagnosing Anterior Cruciate Ligament Injury taking Arthroscopic Findings as Gold Standard. APMC 2020;14(2):187-90.

DOI: 10.29054/APMC/2020.817

INTRODUCTION

Anterior cruciate ligament (ACL) rupture occurring after knee trauma is a frequent diagnosis on the emergency orthopedic floor. It needs reconstruction on urgent basis.¹ In the past few decades there is a dramatic increase in the frequency of ACL rupture. Factors of prognostic importance of this type of injury include gender and age. Prevention programs have been started by many sports groups.² Corrections techniques for ACL injuries can end-up into failure, scarring inside the joint, wound dehiscence, nerve damage, tendon injury, peri-ostitis of the tibia, meniscal tears and even pulmonary embolism and septic arthritis.³

Arthroscopic examination is the gold standard for diagnosing and treating ACL injury.⁴ The decision of ACL-Reconstruction (ACLR) timing is the factor controlling the outcome. Most of the reviewers have suggested the repair after at least 3 weeks of trauma and rupture in order to prevent arthrofibrosis.⁵ Thapa et al. in 2015 conducted a study on ACL injury and found that the positive predictive value of Lelli's test in diagnosing ACL injury is 85.71%.⁶

Furthermore, this study shows that the positive predictive value of other tests performed for ACL injury i.e. drawer test, Lachman test and Pivot shift is 80%, 91.42% and 51.42% respectively, still like every test and procedure have limitations, these all also have some limitations; the examiner with small hands will have difficulty in cases with large thigh bulk. For Pivot shift test, the familiarity of the patient with unpleasant phenomenon of pivoting will not allow him to relax his muscles. Additionally, medial collateral ligament and iliotibial band must be intact for proper results. And for anterior drawer test, hemarthrosis and synovitis make the 90° flexion at knee difficult, causing hindrance in proper functioning of the test. As Lelli's test the positive predictive value of 85.71%⁶ on clinical examination, it is by far the most sensitive clinical test in accurately diagnosing ACL tear. No local published data is present on this topic to the best of the candidate's knowledge, and the positive predictive value varies with the prevalence of the disease.

The rationale of this study is to repeat this study in local population as it is least affected by all these phenomena and is easy to perform in knee injuries, which can help in early identification of ACL tear in the local population leading to timely

planning and appropriate management plan for these patients so that the morbidity associated with this condition can be reduced.

METHODOLOGY

Study Design: Cross Sectional Study.

Settings: The study was conducted in Department of Orthopedic Surgery, Services Hospital Lahore.

Duration: 6 months from approval of this study 11-01-2017 to 10-07-2017.

Inclusion Criteria: Patients of both sex groups with ages in the range of 20-45 years suffering ACL injury as per operational definition were included in this study.

Data Collection Procedure: Include patients with: Anterior Cruciate Ligament Injury on Lelli's Test; Patients who heard a popping sound or felt a give-way feeling in the knee joint during activity ≥ 8 weeks of presentation with any one of the following symptoms for ≥ 2 weeks; Pain in the knee and discomfort during walking, limited joint movement due to pain, loss of full range of motion underwent Lelli's test. Patient lying in supine position having the knee joint in full extended position with heel till bed, the clenched fist of consultant was placed below proximal calf and a gentle posterior directed thrust was applied over quadriceps tendon and those with no heel lift-off from bed versus the normal side were labeled as positive.

Anterior Cruciate Ligament Injury on Arthroscopy was performed under general anesthesia. A direct visualization of disruption of $\geq 1/3$ rd fibers of the ligament in diameter (originating from medial and anterior aspect of the tibial plateau) was labeled to have anterior cruciate ligament injury on arthroscopy. Positive Predictive Value of Lelli's Test: It was calculated by the following formula

$$\text{Positive predictive value (PPV)} = \frac{\text{TP}}{\text{TP} + \text{FP}} \times 100$$

True Positive: Patient diagnosed to have ACL injury on Lelli's test and arthroscopy showed ACL disruption. False Positive: Patient diagnosed to have ACL injury on Lelli's test and arthroscopy showed intact ACL. Patients with skin contractures around the knee joint (on clinical examination) and patients with gross quadriceps wasting (on clinical examination), patients with associated fracture of femur or tibia/fibula of the same side and patients with medical conditions making them unfit for anesthesia and operation were excluded from this study. 197 sample size was calculated with 95% confidence interval and 5% margin of error with PPV of Lelli's test to be 85.71% to predict ACL injury and were selected using non-probability, consecutive sampling. Patients having positive Lelli's test underwent arthroscopy with an above knee tourniquet, using standard anteromedial and anterolateral portals. Arthroscopic findings were noted and recorded into the attached proforma along with demographic details of the patient. All the Lelli's test were performed by the same consultant of the orthopedic department and arthroscopies done by the same team involving candidate to remove bias and the confounding variables were controlled by exclusion and stratification.

Data was analyzed through SPSS version 17. Variables like age, BMI and duration of symptoms were presented by mean \pm SD. Variables like gender and ACL injury on arthroscopy have been presented as frequency and percentage. Positive predictive value has been calculated by the formula previously described and has been presented as percentage.

Data stratified for age, gender BMI and duration of symptoms to address effect modifiers. Post-stratification positive predictive value has been recalculated.

RESULTS

Age ranged from 20 to 45 years with mean 32.82 ± 7.61 years. Majority were between 33-45 years (51.3%), and rest 20-32 years (48.7%); 144 (73.1%) male 53 (26.9%) female patients in the study group with male : female ratio 2.7:1. The duration of symptoms ranged from 2weeks to 9weeks with a mean of 5.03 ± 2.13 weeks while the BMI of these patients ranged from 20.5 Kg/m^2 to 34.9 Kg/m^2 with a mean of $27.35 \pm 4.24 \text{ Kg/m}^2$ as shown in Table 1.

Table 1: Baseline Characteristics of Study Population (n=197)

		Participants
Characteristics	Age (years)	32.82 \pm 7.61
	20-32 years	96 (48.7%)
	33-45 years	101 (51.3%)
Gender	Male	144 (3.1%)
	Female	53 (26.9%)
	Duration of Symptoms (weeks)	5.03 \pm 2.13
	2-5 weeks	108 (54.8%)
	6-9 weeks	89 (45.2%)
	BMI (Kg/m ²)	27.35 \pm 4.24
	20-25 Kg/m ²	71 (36.0%)
	25-30 Kg/m ²	66 (33.5%)
	30-35 Kg/m ²	60 (30.5%)

Arthroscopy confirmed ACL injury in 175 (88.8%) patients as shown in Table 2.

Table 2: Diagnosis of ACL injury on Arthroscopy (n=197)

ACL Injury	Frequency (n)	Percent (%)
Yes (true positive)	175	88.8
No (false positive)	22	11.2
Total	197	100

$$\text{Positive Predictive Value} = \frac{175}{175 + 22} \times 100$$

$$\text{Positive Predictive Value} = 88.8\%$$

Thus, there were 175 true positive and 22 false positive cases which yielded a positive predictive value of 88.8% for Lelli's test in diagnosing ACL tear taking arthroscopy as gold standard. Similar positive predictive value of Lelli's test was seen in various effect modifiers as shown in Tables 3-6 respectively.

Table 3: Positive Predictive Value of Lelli's Test across Age Groups (n=197)

Age	Diagnosis on Arthroscopy		Total	PPV	P value
	True Positive (n=175)	False Positive (n=22)			
20-32 years (n=96)	85	11	96	88.5%	0.899
	88.5%	11.5%	100.0%		
33-45 years (n=101)	90	11	101	89.1%	
	89.1%	10.9%	100.0%		
Total	175	22	197		
	88.8%	11.2%	100.0%		

Chi-square test, observed difference was statistically insignificant, PPV: positive predictive value

Table 4: Positive Predictive Value of Lelli's Test across Gender Groups (n=197)

Gender	Diagnosis on Arthroscopy		Total	PPV	P value
	True Positive (n=175)	False Positive (n=22)			
Male (n=144)	128	16	144	88.9%	0.967
	88.9%	11.1%	100.0%		
Female (n=53)	47	6	53	88.7%	
	88.7%	11.3%	100.0%		
Total	175	22	197		
	88.8%	11.2%	100.0%		

Chi-square test, observed difference was statistically insignificant, PPV: positive predictive value.

Table 5: Positive Predictive Value of Lelli's Test across BMI Groups (n=197)

BMI	Diagnosis on Arthroscopy		Total	PPV	P value
	True Positive (n=175)	False Positive (n=22)			
20-25 Kg/m ² (n=71)	63	8	71	88.7%	0.982
	88.7%	11.3%	100.0%		
25-30 Kg/m ² (n=66)	59	7	66	89.4%	
	89.4%	10.6%	100.0%		
30-35 Kg/m ² (n=60)	53	7	60	88.3%	
	88.3%	11.7%	100.0%		
Total	175	22	197		
	88.8%	11.2%	100.0%		

Chi-square test, observed difference was statistically insignificant, PPV: positive predictive value

Table 1: Positive Predictive Value of Lelli's Test across Duration of Symptoms Groups (n=197)

Duration of Symptoms	Diagnosis on Arthroscopy		Total	PPV	P value
	True Positive (n=175)	False Positive (n=22)			
2-5 weeks (n=108)	96	12	108	88.9%	0.978
	88.9%	11.1%	100.0%		
6-9 weeks (n=89)	79	10	89	88.8%	
	88.8%	11.2%	100.0%		
Total	175	22	197		
	88.8%	11.2%	100.0%		

Chi-square test, observed difference was statistically insignificant, PPV: positive predictive value

DISCUSSION

Arthroscopic examination is the gold standard for diagnosing and treating ACL injury.⁴ However, it is an invasive procedure and is only performed in patients with strong clinical suspicion of ACL injury.^{4,5} Among the various clinical methods for the assessment of ACL injury, Lachman, anterior drawer and pivot shift tests are used in routine practice.^{4,6} But all these tests have their own limitations and therefore carry very low positive predictive value⁶ Lelli's test, a recently introduced clinical test has been shown to be superior to these existing tests. It carries a high positive predictive value and can be performed easily in routine clinical setup without any known limitation.⁶ However, the available evidence on the positive predictive value of Lelli's test was limited.

Aim was to determine the positive predictive value of the Lelli's test in diagnosing anterior cruciate ligament injury taking arthroscopic findings as gold standard. In the present study, mean age was 32.82±7.61 years, similar 30.28±5.6 years was reported by Yasin et al. (2006) undergoing knee arthroscopy at Combined Military Hospital Rawalpindi.⁷ Iqbal et al. (2009) reported similar mean age of 33.0 years in such patients at Hayatabad Medical Complex, Peshawar⁸ while Khan et al. (2015) reported it to be 35.02±12.0 years in such patients undergoing arthroscopic ACL reconstruction at Allied Hospital, Faisalabad.⁹ Abd Razak et al. (2015) observed similar mean age of 32.3 years in Singapore¹³ while Gupta et al. (2014) reported it to be 30.35 years in Indian such patients.¹⁰

We observed that there were 144 (73.1%) male and 53 (26.9%) female patients with a male female ratio 2.7:1. Male predominance with ACL injury was observed by Iqbal et al. (2009) who reported a male female ratio of 2:1 in local population.⁸ Shah et al. (2017) reported much higher male predominance among such patients presenting at Mayo Hospital and Gurki Trust Hospital, Lahore with a male to female ratio of 5.1:1.¹¹ A similar male predominance (M:F, 1.5:1) among Indian such patients has been reported by Gupta et al. in 2014.¹⁰ Lopes et al. (2016) reported a male to female ratio of 4.6:1 in Brazilian such patients¹² while Abd Razak et al. reported it to be 4.9:1 in Singapore.¹³

In the present study, the mean BMI of the patients was 27.35 ± 4.24 Kg/m². Abd Razak et al. also observed similar mean BMI of 25.3 ± 2.1 Kg/m² among such patients in Singapore.¹³ A relatively younger mean age (32.82 ± 7.61 years), male predominance (2.7:1) and slight overweight (27.35 ± 4.24 kg/m²) observed in the present study is in line with the mechanism of injury of ACL as it usually involves younger males involved in sports where slight unbalanced movement restrained by body weight causes abnormal movement of the bones at knee joint leading to ligamentous injury.¹

We selected 197 patients with a positive Lelli's test. Arthroscopy confirmed ACL injury in 175 (88.8%) patients which yielded a positive predictive value of 88.8% for Lelli's test in diagnosing ACL tear. Our results are similar to the previously published study by Thapa et al. (2015) who found the positive predictive value of Lelli's test in diagnosing ACL injury to be 85.71%.⁶ Furthermore, their study showed that the positive predictive value (PPV) of other tests performed for ACL injury i.e. anterior drawer test and Pivot shift test to be 80%, and 51.42% respectively which is quite lower compared to PPV of Lelli's test. Moreover, there are certain limitations to these tests like for Lachman test; the examiner with small hands will face difficulty on patients with large thigh bulk. For Pivot shift test, the familiarity of the patient with unpleasant phenomenon of pivoting will not allow him to relax his muscles. Additionally, medial collateral ligament and iliotibial band must be intact for proper results. And for anterior drawer test, hemarthrosis and synovitis make the 90° flexion at knee difficult, causing hindrance in proper functioning of the test.^{1,6}

We didn't observe any significant difference in the positive predictive value of Lelli's test across age, gender, BMI and duration of symptoms which confirm that it doesn't have any such limitation. In the light of this evidence it can be advocated that in future practice Lelli's test should be used for clinical evaluation of patients with suspected ACL injury.

CONCLUSION

The positive predictive value of Lelli's test was found to be 88.8% in diagnosing ACL tear taking arthroscopy as gold standard. It was not affected by patient's age, gender, BMI and duration which make it superior to other clinical tests currently in practice.

LIMITATIONS

Patient's age group less than 20 years and above 40 years are not covered in this article. Moreover, associated injuries such as PCL injury and menisci injuries are not addressed in this article.

SUGGESTIONS / RECOMMENDATIONS

Lelli's test should be used instead of Lachman test or anterior drawer test for diagnosing ACL injury due to its high positive predictive value.

CONFLICT OF INTEREST / DISCLOSURE

None.

ACKNOWLEDGEMENTS

We acknowledge Dr. Fida Hussain, Dr. Muhammad Umar and Dr. Sajid Hussain for helping us in collecting the data and counseling of the patients.

REFERENCES

1. Kiapour AM, Murray MM Basic science of anterior cruciate ligament injury and repair. *Bone Joint Res.* 2014;3(2):20-31.
2. Quisquater L, Bollars P, Vanlommel I, Claes S, Corten K, Bellemans J, et al. The incidence of knee and anterior cruciate ligament injuries over one decade in the Belgian Soccer League. *Acta Orthop Belg.* 2013;79(5):541-6.
3. Mohtadi N, Barber R, Chan D, Paolucci HO Complications and adverse events of a randomized clinical trial comparing 3 graft types for ACL Reconstruction. *Clin J Sport Med.* 2016;26(3):182-9.
4. Fanelli GC, Edson CJ Surgical treatment of combined PCI. ACL medial and lateral side injuries (global laxity): surgical technique and 2- to 18-year results. *J Knee Surg.* 2012;25(4):307-16.
5. Evans S, Shaginaw J, Bartolozzi A ACL Reconstruction - It's All About Timing. *Int J Sports Phys Ther.* 2014;9(2):268-73.
6. Thapa SS, Lamichhane AP, Mahara DP Accuracy of lelli test for anterior cruciate ligament tear. *J Inst Med.* 2015;37(2):91-4.
7. Yasin B, Kazi WA comparison of intra-articular pethidine and neostigmine for postoperative analgesia in patients undergoing knee arthroscopy. *Pak Armed Forces Med J.* 2006;56(3):1-3.
8. Iqbal MJ, Inam M Patient satisfaction with knee arthroscopy under local anaesthesia. *J Pak Med Inst.* 2009;23(2):193-7.
9. Khan RD, Tayyab SM, Saeed UB, Yasin A Postoperative range of motion and stability after anterior cruciate ligament reconstruction using quadrupled hamstring autograft. *J Pak Med Assoc.* 2015;65(11):215-9.
10. Gupta MK, Rauniyar RK, Karn NK, Sah PL, Dhungel K, Ahmad K, et al. MRI evaluation of knee injury with arthroscopic correlation. *J Nepal Health Res Council.* 2014;12(26):63-7.
11. Shah F, Riaz MU, Hassan D, Abbas Z Factors contributing to anterior cruciate ligament injury and pattern of presentations. *Rawal Med J.* 2017;42(2):223-5.
12. Lopes TJ, Simic M, Pappas E. Epidemiology of anterior cruciate ligament reconstruction in Brazil's public health system. *Rev Bras Med Esporte.* 2016;22(4):297-301.
13. Abd Razak HR, Sayampanathan AA, Koh T-HB, Tan H-CA. Diagnosis of ligamentous and meniscal pathologies in patients with anterior cruciate ligament injury: comparison of magnetic resonance imaging and arthroscopic findings. *Ann Transl Med.* 2015;3(17):243.

AUTHORSHIP CONTRIBUTION

Muhammad Jawad	Principal Investigator
Afzal Javid	Proof Reading & Analysis of Paper
Tafseel Ahmad	Data Collection & Discussion Writing
Rana Dawood Ahmad Khan	Supervision