Original Research Article

Clinical and radiological evaluation of multiple ligament injury of knee

Shreerang Joshi[1], Bharati Deokar-Sharma[2*], Kalpit Dhotkar[3], Rohan Nagare[4], Suyash Ingale[5], Akshay Bondar[6], Piyush Gaikwad[7]

[1]Professor and HOD, [2]Associate Professor, [3]Senior Resident, [4,5,6,7]Junior Resident. B.K.L. Walawalkar Rural Medical College and Hospital, Sawarde, Ratnagiri, INDIA.
Email: bharatideokar@gmail.com

Abstract

Background: The multiple ligament-injured knee is a complex problem in orthopedic surgery. The knee is one of the most frequently injured joints because of its anatomical structure, its exposure to external forces and the functional demands placed on it. Knee ligaments are often injured due to direct trauma as in RTA or indirectly as in sport injuries. **Objective:** To study various patterns of knee ligament injuries, to study the efficacy of clinical and radiological -findings of multiple ligament injuries and to grade them. **Materials and Methods:** 30 patients of multiple ligament knee injury were evaluated by means of clinical examination and radiological investigations. Findings on the basis of sex, side involvment, mode of injury, efficacy of clinical compared to MRI. **Observation:** we in our study observed that most common age group for Multiple ligament knee injury was <30 (43.33%) years with a mean age of 34 years, males (80%) were more commonly affected and left side (60%) was involved in majority of cases. Rta was the most frequent mode (43.33%). Most common pattern of injury was type Ill ACL + posterolateral complex with 11 cases (36%). On comparing with MRI Lachman's test is more sensitive than Anterior drawer for ACL tear, For PCL injury posterior drawer was more sensitive than Posterior sag test. Varus test for LCL and McMurray's test for Medial meniscus were more sensitive than their counterparts. **Conclusion:** Each ligament of the knee has separate diagnostic clinical tests which have high sensitivity and specificity. But when one encounters a knee with combination of multiple ligament injury the sensitivity and specificity decreases for each test. Thus, we concludes that MRI is better non-invasive diagnostic tool for multiple ligament knee injuries than clinical examination which provides with the information of ligaments involved, grade of involvement and is cost effective

***Address for Correspondence:**
Dr Bharati Deokar-Sharma, Associate Professor, Department of Orthopaedics, B.K.L. Walawalkar Rural Medical College and Hospital, Sawarde, Ratnagiri, INDIA.
Email: bharatideokar@gmail.com.
Received Date: 08/07/2021 Revised Date: 18/08/2021 Accepted Date: 24/09/2021
DOI: https://doi.org/10.26611/1032014
This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Access this article online	
Quick Response Code:	Website: www.medpulse.in
	Accessed Date: 17 October 2021

INTRODUCTION

The multiple ligament-injured knee is a complex problem in orthopedic surgery. The knee is one of the most frequently injured joints because of its anatomical structure, its exposure to external forces and the functional demands placed on it.[1]The knee joint is the largest and probably the most complex joint within the human body its vital importance in support and locomotion of our bipedal existence. Its position between the two longest lever arms of the skeleton makes it vulnerable to injury, damage to its major components results in much discomfort and disability.[2] Knee ligaments are often injured in contact athletic activities such as football, skiing, ice hockey, wrestling and gymnastics can produce enough stress to disrupt knee ligaments. Motor vehicle accidents, especially those involving motorcycles, are common causes of knee ligament disruptions. Sudden severe loading or twisting injury without a fall or contact, like deceleration of a running athlete can also cause ligament disruption.[1] Knee with a combination of instabilities is very difficult to restore to a completely stable condition. The ligamentous

How to site this article: Shreerang Joshi *et al.* Clinical and radiological evaluation of multiple ligament injury of knee. *MedPulse International Journal of Orthopedics.* October 2021; 20(1): 13-19. https://www.medpulse.in/Orthopedies/

structure of the knee is a functional unit. Laxity in any of the planes of the knee motion can produce increased stretching and stress to the structures, which help to provide stability in the other planes.[3]Multiple ligament injuries of the knee basically concern the rupture of at least two of the main ligaments of the knee crutiate, collaterals, and are associated with meniscus ruptures, cartilage injuries and osseous fractures.[4]The most common mechanism of injury of multiple ligament injury of knee is Abduction, flexion, and internal rotation of femur on tibia. In this medial structures, MCL and medial capsular ligament are first to injured, followed by ACL tear. Adduction, flexion, and external rotation is less common and produces primary lateral disruption. Hyperextension force usually injures the ACL. If the force is severe, stretching and disruption of posterior capsule and PCL can occur. Anteroposterior forces, such as a tibia striking a dashboard can cause injuries to either ACL or PCL, depending on the direction of tibial displacement.[1] Orthopedic surgeons relied completely on clinical examination in the late 1960 and early 70's till numerous reports suggested the role of arthroscopy in diagnosis and treatment of various knee disorders.[5] Since the introduction of MRI for clinical use in the mid 1980's, the role of MRI in the diagnosis of knee lesions has been well established. MRI has proved reliable, safe and offers advantages over diagnostic arthroscopy, which is currently regarded[6] as the reference standard for the diagnosis of internal derangements of knee. MRI has several advantages, It is non-invasive, poses minimal risk, produces minimal patient discomfort [7] and a highly sensitive tool of investigation, early and subtle changes in the soft tissues often are picked up by MRI. Arthroscopy being highly sensitive and specific procedure is both diagnostic and therapeutic, but is invasive. [8] Aside from routine radiography, no imaging method has as great an effect on the current practice of orthopaedics as MRI. MRI provides unsurpassed soft tissue contrast and multiplanar capability with spatial resolution that approaches that of CT. Consequently, MRI has superseded older imaging methods, such as myelography, arthrography, and angiography. MRI has become a powerful diagnostic tool, helping the surgeon to evaluate structures that are otherwise invisible to noninvasive techniques. As an evolving technology, the ultimate role of MRI in orthopaedics is still to be determined. Continued improvements in hardware and software undoubtedly will expand the role of MRI in orthopaedics and in other fields of medicine. In the acute phase of knee injury, the indication of MR imaging depends upon severity of pain and/or swelling of knee joint. Although clinical examination is important for the diagnosis of ligament injury, painful stress examinations are not always accurate in the acute phase of injury. For that reason MR imaging is indicated for early diagnosis of the acutely injured knee.[5] Diagnosis and treatment of multiple ligament injuries of the knee remain real challenges for most surgeons and Magnetic resonance imaging (MRI) is an essential tool to assist in the diagnosis of the Multiple Ligament Knee Injuries and assists in the formulation of the treatment plan.[9] In the present study selected patients will be evaluated clinically and radiologically on x-ray and magnetic resonance imaging as it can help us in diagnose the various patterns and grading of multiple ligament injury which will help in the treatment of lesion in a better way.

AIM: Clinical and Radiological evaluation of multiple ligament injuries of knee.

OBJECTIVES: To study various patterns of knee ligament injuries. To study the efficacy of clinical and radiological -findings of multiple ligament injuries. Grading of various ligament injuries on the basis of clinical tests and Magnetic Resonance Imaging.

MATERIALS AND METHODS

Type of Study: Prospective study.

Place of study: BKL WALAWALKAR RURAL MEDICAL COLLEGE DERVAN CHIPLUN RATNAGIRI.

Period of study: August 2020 to July 2021

Sample size: 30 cases

Period of data collection: 1 year

The study was approved by the Hospital ethical committee and the patients gave their informed consent to participate.

INCLUSION CRITERIA: Patients of both sexes and age groups 17 years to 60 years will be included. Patients with clinical signs and symptoms after injury. No previous surgery performed on the affected knee. No previous cruciate or collateral ligament damage sustained in the affected knee.

EXCLUSION CRITERIA: Single ligament injury. Patients with generalized ligament laxity. Patients with fractures and compound injuries. Patients who are uncooperative and unwilling for clinical examination.

During the period from August 2020- July 2021, all the patients diagnosed for knee injuries at Out Patient Department (OPD) — Orthopedics were screened using the inclusion and exclusion criteria. 30 patients were selected after The inclusion and exclusion criteria. Institutional ethical clearance was obtained before the start of the study.

RESULTS

We evaluated total 30 of cases of multiple ligament knee injuries clinically and radiologically during the period of August 2020 to July 2021. Observation and analysis of results was done in relationship to age, sex, side of involvement, mode of injury, various clinical tests and MRI in detail as follows.

STATISTICAL ANALYSIS

Data analysis was done using the SPSS (statistical package for the social science) version 17 for windows. The demographic variables, other variables were calculated with number and percentage.

To compare the results of our study with other standard studies we used 'Pearson Chi-Square' test. By using this test we have calculated P value. A probability value of0.05 was accepted as the level of statistical significance.

Age Distribution:

The youngest and the oldest patient in our study were 17and 58 years old respectively. Majority of the patients were found to be between the age group of 17-30 years. The least number of cases are found in the age group of >40 years. The average age was 34.6 years.

Table 1

Age (Years)	No Of Cases	Percentage
<30	13	43.33
31-40	9	30
>40	8	26.67
Total	**30**	**100**

SEX DISTRIBUTION:

In our study out of 30, there were 24 males and 6 females. The high incidence of male patients can be attributed to travelling and outdoor activities which are mainly carried out by men.

Table 2

Sex	No Of Cases	Percentage
Males	24	80
Females	6	20
Total	**30**	**100**

SIDE DISTRIBUTION:

Majority of the patients are of left side that is 18 patients (60%) and remaining 12 patients (40%) were of right side. No cases of bilateral injury.

Table 3

Side	No Of Cases	Percentage
Left	18	60
Right	12	40
Total	**30**	**100**

MODE OF INJURY:

Most common mode of injury was Road Traffic Accidents with 13 patients followed by 9 patients with sports injury and 8 patients with history of fall.

Table 4

Mode of injury	No Of Cases	Percentage
RTA	13	43.33
Sports injury	09	30
fall	08	26.67
Total	**30**	**100**

PATTERNS OF LIGAMENT INJURY:

Multiple ligament injury occurs in various patterns. In our study we included five patterns to classify the types of multiple ligament injury. In our study out of 30 cases, most common pattern of injury was type Ill ACL + posterolateral complex with 11 cases (36%) and the least common was type IV PCL +Posterolateral complex with only 1 case (3%).

Table 5

Patterns of ligament injury	No of cases	Percentage
(1) ACL+MCL	5	16.67
(II)ACL+MCL+MEDIAL CAPSULE	7	23.33
(III)ACL+POSTEROLATERAL COMPLEX	11	36.67
(IV)PCL+POSTEROLATERAL COMPLEX	1	3.33
(V)PCL+MCL+MEDIAL CAPSULE	2	6.67
OTHERS	4	13.33
Total	**30**	**100**

STATISTICAL ANALYSIS OF CLINICAL AND RADIOLOGICAL FINDINGS:

In our study of 30 patients we found-

1. Lachman test: clinically lachman test was positive in 22 patients and negative in 8 patients. On MRI also these 22 patients were found to have ACL tear.5 patients had a negative Lachman test but MRI revealed ACL tear. 3 patients had negative Lachman test with no ACL tear on MRI.

2. Anterior Drawer test: clinically Anterior Drawer test was positive in 21 patients, on MRI these patients had ACL tear present. 6 patients had negative anterior drawer test but MRI showed presence of tear in these cases. 3 patients had negative anterior drawer test and also absent in the
3. Posterior Sag test: clinically posterior sag test was positive in 2 patients and MRI showed posterior cruciate ligament tear in those patients. 5 patients had negative posterior sag test but MRI revealed posterior cruciate tear present. 23 patients did not reveal any tear on clinical examination as well as on MRI.
4. Posterior Drawer test: On MRI 5 patients had Posterior cruciate injury which correlates with clinically in those patients. In 2 patients posterior drawer test was negative but MRI showed tear. In 23 patients there was negative posterior drawer test and MRI showed no tear.
5. Valgus stress test: clinically 12 patients had positive Valgus stress test and MRI showed Medial collateral tear. 2 patients had negative valgus stress test but positive MRI finding for MCL tear. 16 patients had negative test and MRI did not reveal any MCL tear.
6. Varus stress test: clinically 9 patients had positive Varus stress test and positive MRI finding for LCL tear. 4 patients had negative test but presence of tear on MRI. 17 patients had negative test and negative MRI findings.
7. McMurray's test (ER): clinically 1 1 patients showed positive test and MRI confirmed the diagnosis in those patients. Only 1 patient showed negative test but positive MRI finding. 18 patients had negative test and no medial meniscus tear on MRI.
8. McMurray's test (IR): clinically only 4 patients showed positive test for lateral meniscus tear which was confirmed with MRI. 4 patients had negative clinical finding but presence of tear on MRI. 12 patients did not reveal positive test or presence of Lateral meniscus tear on MRI.

Lachman test and Anterior drawer test for Anterior cruciate ligament had a P Value <0.05 which was statistically significant in our study. Posterior drawer test, Valgus stress test, Varus stress test, McMurray's had P Value <0.0001 which was statistically highly significant in our study. Posterior sag test had P value >0.05 which has not statistically significant in our study

Table 6: Association between clinical and radiological findings of multiple ligament injury in study group

Clinical findings		Radiological findings		Chi-square	p-value
		Present	Absent		
Lachman test	Present	22	00	5.47	<0.05
	Absent	05	03		
Anterior drawer test	Present	21	00	4.51	<0.05
	Absent	06	03		
PCL sag test	Present	02	00	3.19	>0.05
	Absent	05	23		
Posterior drawer test	Present	05	00	14.90	<0.0001
	Absent	02	23		
Valgus stress test	Present	12	00	19.43	<0.0001
	Absent	02	16		
Varus stress test	Present	09	00	13.68	<0.0001
	Absent	04	17		
McMurry's test (ER)	Present	11	00	22.25	<0.0001
	Absent	01	18		
McMurry's test (IR)	Present	04	00	08.73	<0.0001
	Absent	04	22		

Table 7: Sensitivity, specificity, PPV, NPV, accuracy of various clinical tests

Clinical findings	Sensitivity	Specificity	PPV	NPV	Accuracy
Lachman's test	81.48	100	100	37.5	83.33
Anterior drawer test	77.78	100	100	33.33	80.00
PCL sag test	28.57	100	100	82.14	83.33
Posterior drawer test	71.43	100	100	92	93.33
Valgus stress test	85.71	100	100	88.89	93.33
Varus stress test	69.23	100	100	80.95	86.67
McMurry's test (ER)	91.67	100	100	94.74	96.67
McMurry's test (IR)	50	100	100	84.62	86.67

Table 8: Association clinical and radiological findings of grading of ligament injury in study group

Clinical finding		Radiological findings				Total
	Grade	G1	G2	G3	No	
Lachman test	1	2	0	0	0	2
	2	0	2	7	0	9
	3	0	0	0	11	11
	No	5	0	0	3	8
Anterior drawer test	1	1	0	0	0	1
	2	0	2	8	0	10
	3	0	0	10	0	10
	No	6	0	0	3	9
PCL sag	1	0	1	0	0	1
	2	0	0	0	0	0
	3	0	0	1	0	1
	No	4	1	0	23	28
Posterior drawer test	1	1	0	0	0	1
	2	1	2	1	0	4
	3	0	0	0	0	0
	No	2	0	0	23	25
Valgus stress test	1	0	5	0	0	5
	2	0	4	0	0	4
	3	0	0	3	0	3
	No	2	0	0	16	18
Varus stress test	1	0	4	0	0	4
	2	0	5	0	0	5
	3	0	0	0	0	0
	No	3	1	0	17	21

All the patients were graded into grade 1, 2 and 3 according to clinical tests, which confirmed for few patients by MRI and differed for rest of the patients as evident in the table above.

DISCUSSION

Multiple ligament injury of knee have been shown to represent approximately 11-20% of knee ligament sprains.[10] They require prompt recognition, awareness of associated potential limb-threatening conditions, accurate diagnosis of functional ligament deficiency, careful surgical planning, and dedicated rehabilitation.[11] The knee is a common site of injury. The increasing number of clinical tests and greater understanding of the joints biomechanics, leads to difficulties in both the interpretation of the clinical examination and in the reliance that should be placed on specific signs or tests.[12]

Etiology[13]

Ligament and meniscal injuries are usually of traumatic onset. A history of a sporting trauma is usual, the trauma may be direct, as in rugby tackles, RTA or indirect, such as twisting injuries in falls while skiing, with no other person involved. Injuries may occur with a single ligament involvement or quite often involve multiple ligaments. Complex injuries are more common with severe high-velocity trauma, for example, in road traffic accidents, motorcycle or quad bike injuries.

Meniscal injuries are usually secondary to a twisting force on a well planted stabilized foot while bearing weight. Degenerative meniscal tears may, however, occur with minimal trauma. In our study we evaluated the knee, clinically and radiologically for the diagnosis of multiple ligament knee injuries.

AGE DISTRIBUTION

In our study majority of the multiple ligament knee injury occurs between the age of 17 to 60 years with maximum incidence being in the age group of 17 to 30 years (43.3%). The average age was 34.63 years.

Age incidence is comparable with the studies done previously by Bispo RJ *et al.*(31.2 yr). and by HalinenJyrki *et al.* (38.6 yr). [4,14]

SEX DISTRIBUTION

Majority of the patients in our study were males (80%). This can be attributed to our Indian setup where the female population largely work indoor and do not travel much.Our findings are comparable to the studies done by Bispo RJ *et al.* and EsmailiJah AA *et al.* [4,15]

SIDE INVOLVEMENT

18 out of 30 patients (60%) had multiple ligament injury of the Left knee. Similarly, in the study done by EsmailiJah AA *et al.* left sided injury was predominant (57.1).[15] However, in a study done by Bispo RJ *et al.* right sided injury was predominant.[4]

MODE OF INJURY

Most of the patients in our study had road traffic accident (13 patients i.e 43.33%) followed by sports injuries (9 patients i.e30%). Fall is also one of the main cause of multiple ligament knee injury. Similar findings were seen in the study done by Meritt L *et al.* where they stated that 59% had high energy mechanism injury (MVA) is the main cause of multiple ligament knee injury followed by 41% low energy mechanism injury.[17] In 2003, Twaddle *et al.* in their study of 63 cases had most common mode of injury was motor vehicle accident (34 cases) followed by sports injury (23 cases).[16]

PATTERNS:

Most common pattern of multiple ligament knee injury in our study was ACL+POSTEROLATERAL COMPLEX in 11 patients (36.6%) and the least common pattern was PCL+POSTEROLATERAL COMPLEX in 1 patient (3.3%). We found 5 patients (16.67%) of ACL+MCL injury and we had 4 patients of other pattern which includes patients of ACL+ PLC +/- PLC. Similarly, in 2010 Gwathmey *et al.* stated in their study form the period of2000 to 2010 that the ACL + PLC injuries were the most common (30.2%) and the least common pattern of injury was ACL+PCL(5.2%).[11]

In a study by Kaeding CC *et al.* and Meritt L *et al.*, the most common presenting pattern of multiple ligament knee injury was involving the ACL+MCL and after that ACL+PLC making it the second most common.[18.17]

DIAGNOSTIC VALUES OF CLNICAL TESTS:

LACHMAN TEST:

The sensitivity and specificity of Lachman's test in our study were 81.48% and 100% respectively. similar findings can be found in the study done by Edward Davis and Dhavalkumar KJ *et al.*[12,19]

ANTERIOR DRAWER TEST

In our study, anterior drawer test has sensitivity and specificity of 77.78% and 100% respectively. Similar findings can be found in the study done by Edward Davis and Dhavalkumar KJ *et al.*[12,19] In our study of 30 cases the Accuracy of Lachman test and Anterior Drawer test was 83.3% and 80% respectively, similarly, studies done by Esmaili Jah AA *et al.* had accuracy of clinical tests was 91.4% and Navai AM *et al.* had accuracy of clinical tests was95.8%.[15,20]

POSTERIOR DRAWER TEST

In our study of 30 patients sensitivity, specificity of posterior drawer test was 71.43% and 100% respectively which is comparable to the study done by Edward Davis.[12]

POSTERIOR SAG TEST

In our study of 30 patients the sensitivity, specificity and accuracy was28.57%, 100% and 83.33% respectively. This test showed P value of > 0.05 which was statistically insignificant in our study. We compared our study with a study by Edward Davis.[12] In our study the accuracy of posterior drawer test is 93.33%, and Posterior sag test was 83.33%. In the study conducted by Rubinstein *et al.* he found 96% accuracy of clinical examination for Posterior cruciate ligament tear and EsmailiJah AA *et al.* and Navai AM *et al.* found 100% of accuracy of clinical tests which is comparable with our study.[21,15,20]

VARUS STRESS TEST

In our study Varus stress test had sensitivity and specificity was 69.2% and 100% respectively. Little research has been done on the accuracy of varus stress tests and the sensitivity and specificity has varied from 25% to 86%.[22]

VALGUS STRESS TEST

In our study the sensitivity and specificity of Valgus stress test was 85.71% and100% respectively which is comparable to study done by Edward Davis.[12]

MCMURRAY TEST (ER)

In our study the accuracy, sensitivity and specificity was 96.6%, 91.6% and 100% respectively. Similar findings can be found in studies done by EsmailiJah AA *et al.* and Navai AM *et al.*[15,20]

MCMURRAY (IR)

In our study the accuracy, sensitivity and specificity was 86.6%, 50% and 100% respectively. Similar findings can be found in studies done by EsmailiJah AA *et al.* and Navai AM *et al.*[15,20]

CONCLUSION

Injury to the ligaments of the knee is a common condition encountered in the injury OPD due to increasing incidence of road traffic accidents and falls. Recently more numbers of patients are being identified with multiple ligament injuries, which include injury to more than 1 ligament with or without capsular tear. Each ligament of the knee has separate diagnostic clinical tests which have high sensitivity and specificity. But when one encounters a knee with combination of multiple ligament injury the sensitivity and specificity decreases for each test. This shows that in cases of multiple ligament injury of knee there is a need to investigate further and confirm the diagnosis. Magnetic resonance Imaging provides a detailed picture of the internal structures of the knee and proves to be a better Non-invasive diagnostic tool in multiple ligament knee injuries then clinical examination. Magnetic resonance imaging has a high sensitivity and specificity in terms of identifying multiple ligament knee injuries. The most common pattern of ligament injury was ACL + PLC in our study, which was evident on clinical examination and MRI. The most confirmatory tool of diagnosis is Arthroscopy which is an invasive procedure and has a longer learning curve which increases monetary burden

of the patients. Thus we concludes that MRI is better non-invasive diagnostic tool for multiple ligament knee injuries than clinical examination which provides with the information of ligaments involved, grade of involvement and is cost effective.

REFERENCES

1. Miller RH, Azar FM. Knee injuries. In: Canale ST, Beaty JH, editors. Campbells operative 11th ed. Philadelphia: Mosby Elsevier; 2007: p.2396-2567.
2. Johnson RJ, Beynnon Bruce. Anatomy and Biomechanics of knee. Chapman's orthopaedic surgery, Chapman MW, editors. Chapman's orthopedic surgery.3rd ed.LippincottWiliamsand Wilkins; 2001; p.2249-2268.
3. Larson RL. Combined instabilities of the knee. ClinOrthop 1980;147:68-75.
4. BispoJünior RZ, Kawano CT, Guedes AV. Chronic multiple knee ligament injuries: epidemiological analysis of more than one hundred cases. Clinics 2008; 63(1):3-8
5. Gupta S, Sharma R, Sachar A, Saini Y, Saini N. Comparison Of Clinical Examination, MRI And Arthroscopy In Knee Injuries. The Internet Journal of Orthopedic Surgery. 2012;19(3).
6. Edwin H G Oei,Jeroen J Nikken, Antonia C M Verstijnen, Abida Z Ginai, M G MyriamHunink. MR Imaging of the Menisci and Cruciate Ligaments: A Systemic Review.Radiolgy 2003; 226:837-848.
7. Azar FM. General principles of arthroscopy.ln: Canal ST, Beaty JH, editors. Campbells operative orthopaedics. 11 th edition. Philadelphia: Mosby Elsevier;2007.p.2803-2807.
8. Madhusudhan T, Kumar T, Ramesh B, Bastawrous S, Sinha A. Clinical examination, MRI and arthroscopy in ligamentous knee injunes-an audit of our practice. Journal of Bone and Joint Surgery, British Volume 2008;90(SUPP III: 467-468).
9. Manske RC, Prohaska D. Physical examination and imaging of the acute multiple Ligament Knee injury. N Am J Sports PhysTher 2008 Nov;3(4): 191-197.
10. Cox CL, Spindler KP. Multiligamentous knee injuries - surgical treatment algorithm N Am J sports physther 2008 Nov; 3(4): 198-203.
11. Gwathmey Jr Fw, Shafique DA, Miller MD. Our approach to the management of multiple-ligament knee injury. Operative Techniques in Sports Medicine 2010; 18(4) : 235-244.
12. Davis E. Clinical Examination of the knee following trauma: an evidence-based prospective. Trauma 2002; 4(3) : 135-145.
13. Chaudhari MU, Validator A, Patel MJ. Knee-Ligament Damage. 2008.
14. Halinen J, Koivikko M, Lindahl J, Hirvensalo E. The efficacy of magnetic resonance imaging in acute multi-ligament injuries. Int Orthop 2009;33(6):1733-1738.
15. Esmaili Jah AA, Keyhani S, Zarei R, Moghaddam AK. Accuracy of MRI in comparison with clinical and arthroscopic findings in ligamentous and meniscal injuries of the knee. ActaOrthopBelg. 2005 Apr;71(2):189-96.
16. Twaddle BC, Bidwell TA, Chapman JR. Knee dislocations: Where are the lesions?: prospective evaluation of surgical findings in 63 cases. J orthop Trauma 2003; 17(3) :198-202.
17. Meritt AL, Wahl CJ. Rationale and Treatment of Multiple-Ligament Injured Knees: The Seattle Perspective. Operative Techniques in Sports Medicine 2011 ;19(1):51-72
18. Kaeding C, Pedroza A, Parker R, Spindler K, McCarty E, Andrish J. Intra-articular findings in the reconstructed multiligament-injured knee. Arthroscopy: The Journal ofArthroscopic and Related Surgery. 2005;21(4) 424-430.
19. Jain DK, Amaravati R, Sharma G. Evaluation of the clinical signs of anterior cruciate ligament and meniscal injuries. Indian J Orthop 2009 Oct;43(4):375-378
20. Mohammad Navai A, Bazavar M, Mohseni MA, Safari B, Tabrizi A. A-throscopic Evaluation of the Accuracy of Clinical Examination versus MRI in Diagnosing Meniscus Tears and Cruciate Ligament Ruptures. Archives of Iranian Medicine (AIM) 2013;16(4)
21. Rubinstein RA Jr, Shelbourne RD, Mccamll JR, et al. The Accuracy of the Clinical Examination in the Setting of Posterior Cruciate Ligament Injuries. Am J Sports Med 1994 ; 22:550
22. MaIanga GA, Andrus S, Nadler SF, McLean J. Physical Examination of the Knee: A Review of the Original Test Description and Scientific Validity of Common Orthopedic Tests. Arch Phys Med Rehabil: 84; 592-603
23. Miller RH, Azhar FM. Knee injuries. In: Canale ST, Beaty JH, editor. Campbells operative Orthopedics, 12th ed. Philadelphia: Mosby Elsevier. 2013:p.2053-2211.

Source of Support: None Declared
Conflict of Interest: None Declared