Decoding The Diagnostic Triad: A 2018-2020 Study on the Clinical, MRI and Arthroscopic Correlation in Meniscal And ACL Injuries at BSMMU

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ABSTRACT

This prospective study aimed to evaluate the correlation between clinical and arthroscopic findings in knee injuries and compare them with MRI-based diagnoses. The research was conducted at BSMMU, Dhaka, between 2018 and 2020. The study population consisted of patients with knee injuries, specifically those with cruciate ligament and/or meniscal injuries that led to persistent knee instability for at least 1.5 months, remained unresponsive to conservative treatment, and did not have osteoarthritis or intra-articular fractures. Patients with a history of knee surgery, osteoarthritis, or ligament and meniscal injuries associated with intra-articular fractures were excluded. A total of 30 eligible cases were consecutively included in the study.

The participants had a mean age of 29.3 ± 10.6 years, and all were male. Among them, 40% were students, followed by service-holders (26.7%), businessmen (13.3%), farmers (10%), day laborers (3.3%), and uniformed service personnel (6.7%). The median duration of symptoms was 10.5 months, ranging from 1.5 to 60 months. The left knee was affected in 53.3% of cases, while 46.7% had right knee injuries. More than half (56.7%) of the injuries occurred during sports activities, while 43.3% were work-related. The most commonly reported symptoms were pain (80%) and knee instability or "giving way" (60%). Clinical examination frequently revealed quadriceps muscle wasting (73.3%), a positive Lachman Test (70%), and a positive Anterior Drawer Test (73.8%). Additionally, the McMurray Test was positive in 46.7% of cases.

Clinically, anterior cruciate ligament (ACL) injuries were diagnosed in 73.3% of patients, while 43.3% had medial meniscus injuries, with only a few cases of lateral meniscus injuries. Isolated injuries were present in 73.3% of cases, whereas 26.7% had combined injuries. MRI findings identified ACL injuries in 80% of patients and medial meniscus injuries in 60%, with lateral meniscus injuries observed in only 10%. Isolated injuries were found in 50% of cases, and the remaining 50% had combined injuries. Arthroscopic examination confirmed ACL injuries in 73.3% of cases, medial meniscus injuries in 20%, and lateral meniscus injuries in 13.3%. Isolated injuries were identified in 73.3% of cases, while 16.7% had combined injuries.

The diagnostic accuracy of clinical examination was 93.3% for ACL injuries, 86.7% for medial meniscus injuries, and 90% for lateral meniscus injuries. The sensitivity of clinical diagnosis was 95.2% for ACL injuries, 90.9% for medial meniscus injuries, and 50% for lateral meniscus injuries. Specificity values were 88.9% for ACL injuries, 84.2% for medial meniscus injuries, and 96.2% for lateral meniscus injuries. Positive predictive values (PPVs) were 95.2% for ACL injuries, 76.9% for medial meniscus injuries, and 66.7% for lateral meniscus injuries, while negative predictive values (NPVs) were 88.9% for ACL injuries, 94.1% for medial meniscus injuries, and 92.6% for lateral meniscus injuries.

MRI demonstrated a diagnostic accuracy of 76.7% for ACL injuries, 53.3% for medial meniscus injuries, and 90% for lateral meniscus injuries. The sensitivity of MRI for diagnosing ACL injuries was 86.4%, 60% for medial meniscus injuries, and 50% for lateral meniscus injuries. Specificity values were 50% for ACL injuries, 50% for medial meniscus injuries, and 92.9% for lateral meniscus injuries. The PPVs for MRI were 82.6% for ACL injuries, 37.5% for medial meniscus injuries, and 33.3% for lateral meniscus injuries, while the NPVs were 57.1% for ACL injuries, 71.4% for medial meniscus injuries, and 96.3% for lateral meniscus injuries.

The findings of this study highlight the high accuracy of clinical diagnosis, particularly for ACL injuries. Compared to MRI, clinical examination demonstrated superior sensitivity, specificity, predictive values, and overall diagnostic accuracy for ACL injuries.

INTRODUCTION

The knee is the body's largest joint and one of the most mechanically complex. Due to its anatomical structure, exposure to external forces, and functional demands, it is also one of the most frequently injured joints. Structurally, the knee is inherently unstable, as its articular surfaces lack congruence. The tibial condyles are relatively small and shallow, making it difficult to securely accommodate the large, convex femoral condyles.

The knee's structural components are categorized into three main groups: osseous structures, extra-articular structures, and intra-articular structures. Among the intra-articular structures, the most crucial are the medial and lateral menisci, along with the anterior and posterior cruciate ligaments.

Menisci play a vital role in maintaining normal knee function. They serve as a joint buffer, compensating for the incongruence between the femoral and tibial articulating surfaces. Additionally, they prevent capsular and synovial impingement during flexion and extension, facilitate joint lubrication, distribute synovial fluid, and aid in nourishing the articular cartilage (Robert et al., 2008).

The cruciate ligaments contribute to both anteroposterior and rotational stability, as well as resisting excessive valgus and varus forces. These ligaments have a layered structure, with certain fibers remaining taut in all knee positions. Anterior displacement of the tibia (anterior drawer sign) is restricted by the posteromedial portion of the anterior cruciate ligament (ACL) and the medial capsule, while posterior displacement is prevented by the posterior cruciate ligament (PCL) (Solomon et al., 2001).

Meniscal injuries most commonly result from rotational forces when a flexed knee extends. The medial meniscus, being less mobile on the tibia, is more susceptible to being trapped between the femoral and tibial condyles, leading to injury. The posterior horn of the medial meniscus is the most frequent site of injury, with longitudinal tears being the most common type. Other tear patterns include transverse and oblique tears, complex tears (a combination of longitudinal and transverse), cystic meniscal tears, and tears associated with discoid menisci.

Miller, Warner, and Earner classified meniscal tears based on vascularity into three zones: red (fully vascularized), red-white (at the vascular border), and white (avascular). Ligament injuries in the knee often occur during athletic activities, while motorcycle accidents are also a frequent cause. Four primary mechanisms of ligamentous injury have been identified: (i) abduction, flexion, and internal rotation of the femur on the tibia, (ii) adduction, flexion, and external rotation of the femur on the tibia, (iii) hyperextension, and (iv) anteroposterior displacement (Robert et al., 2008).

When an abduction, flexion, and internal rotation force is applied to the knee, the medial supporting structures, including the medial collateral ligament and medial capsular ligament, are typically the first to sustain injury. If the force is significant, the ACL may also rupture. In such cases, the medial meniscus may become trapped between the femoral and tibial condyles, leading to a peripheral tear. This sequence of injuries—medial collateral ligament damage, ACL rupture, and medial meniscus tear—is known as the "Unhappy Triad of O'Donoghue."

Diagnostic arthroscopy is a valuable tool for assessing knee injuries and provides direct visualization of intra-articular structures. However, it is not a substitute for a thorough clinical evaluation. A detailed history and careful physical examination remain essential in reaching an accurate diagnosis. While arthroscopy reveals internal knee abnormalities, clinicians must determine which findings are actually responsible for the patient's symptoms (Solomon et al., 2001). Therefore, arthroscopy should be used as a diagnostic aid alongside a comprehensive history, physical examination, and appropriate radiographic imaging.

In resource-limited settings, such as in our country, many patients come from lower socioeconomic backgrounds, making MRI an added financial burden (Phillips, 2008). MRI has been widely regarded as a noninvasive alternative to diagnostic arthroscopy. In routine clinical practice, MRI is frequently used to confirm meniscal and ACL injuries before proceeding with arthroscopy or surgical intervention (F. Rayan, D. Shukla, 2008). A review of existing literature suggests that most studies focus on only two out of the three diagnostic methods—clinical examination, MRI, and arthroscopy. Therefore, this study aims to evaluate and establish a correlation among all three diagnostic modalities for knee injuries.

MATERIALS AND METHODS

3. 1 Study design:

Cross sectional, analytical study.

3. 2 Duration of Study:

July 2018 to June 2020

3.2 Place of study:

Bangabandhu Sheikh Mujib Medical University, Shahbagh, Dhaka, Bangladesh.

3.3 Study population and sampling:

Convenience sampling method was used to select 30 (thirty) patients.

3.3.1 Inclusion criteria:

1. Anterior cruciate ligament and meniscal injury leading to persistent instability of knee for at least 1 month after injuries that were non responsive to conservative treatment.
2. ACL and meniscal injuries without osteoarthritis and associated intra-articular fracture about knee

3.3.2 Exclusion criteria:

1. Previous operation of knee injuries
2. Osteoarthritis of knee
3. Associated intra-articular fracture of knee

RESULTS

A total of 30 subjects of knee injury were evaluated clinically, MRI and arthroscopically to compare the correlation between the clinical and MRI findings with the clinical and arthroscopic diagnosis. The findings obtained from data analyses are presented below.

4.1 Age distribution:

Out of 30 subjects 23.3% were 20 or < 20 years, 46.7% 21 – 30 years, 16.7% 31 – 40 years and 13.3% 41 – 50 years. The mean age of the subjects was 29.3 ± 10.6 years and the minimum and maximum ages were 16 and 50 years respectively.

Table I. Distribution of patients by age (n = 30)

Age (yrs)*	Frequency	Percentage
≤ 20	7	23.3
21 – 30	14	46.7
31 – 40	5	16.7
41 – 50	4	13.3

***Mean age** = (29.3 ± 10.6) years; **range** = (16 – 50) years.

4.2 Sex:

All of the subjects were male.

4.3 Occupation:

Over 26% of the subjects were service-holders followed by 40% students, 13.3% businessmen, 10% farmers, 3.3% day labourers and 6.7% people were on uniformed service (Fig. 1).

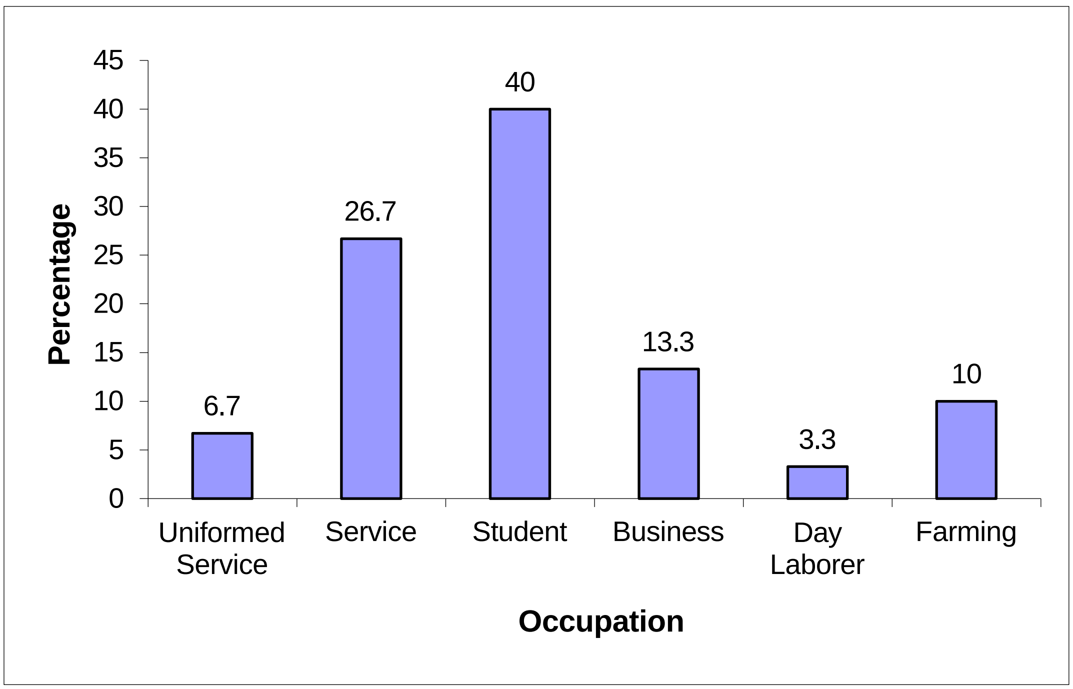

Fig. 1: Distribution of subjects by occupation (n = 30)

4.4 Duration of suffering:

Distribution of subjects by duration of suffering shows that 56.7% of the subjects had been suffering from the disease for 12 or < 12 months at the time of entry and 43.3% for > 12 months (table II). The median duration of suffering was 10.5 months and the lowest and highest durations were 2 and 60 months respectively.

Table II. Distribution of patients by duration of suffering (n = 30)

Durationn of suffering (months)*	Frequency	Percentage
≤ 12	17	56.7
> 12	13	43.3

***Median(range) duration** = 10.5 (1.5 – 60) months.

4.5 Affected knee:

Table III shows the distribution of the subjects by their affected knee. 46.7% of the subjects had right knee affected and the rest (53.3%) left knees affected.

Table III. Distribution of subjects by affected knee (n = 30)

Affected knee	Frequency	Percentage
Right	14	46.7
Left	16	53.3

4.6 Causes of injury:

Table IV demonstrates the causes of knee injury. Over 56% of the subjects received injuries during sports activities and 43.3% received them while they were working.

Table IV. Distribution of patients by causes of injury (n = 30)

Causes	Frequency	Percentage
Sports activities	**17**	**56.7**
Football	13	43.3
Others	4	13.3
Other than sports	**13**	**43.3**
RTA	9	30
Fall on ground	4	13.3

4.7 Mechanism Of Injury:

Evaluation of mechanism of knee injury shows that nearly 57% of the injuries were due to abduction, flexion and internal rotation of femur upon tibia and 10% of injuries occurred due to adduction, flexion and external rotation of femur upon tibia. Hyperextension of knee caused 20% of injuries and antero-posterior displacement caused 13.3% of injuries (Table V).

Table V. Distribution of patients by mechanism of injury (n = 30)

Mechanism	Frequency	Percentage
Abduction + Flexion + Internal rotation of femur upon tibia	17	56.7
Adduction + Flexion + External rotation of femur upon tibia	3	10
Hyperextension of knee	6	20
Antero-posterior displacement	4	13.3

4.8 Baseline characteristics (presentation):

Baseline characteristics show that pain and giving way were the predominant complaints (80% and 60% respectively). On examination, quadriceps wasting, positive Lachman Test, positive Anterior Drawer Test were frequently observed (73.3%, 70% and 73.8% respectiively). Positive McMurray Test was found in 46.7%. (Table VI).

Table VI. Baseline characteristics of the subjects (presentation) (n = 30)

Baseline functional status of knee	Frequency	Percentage
Pain	24	80
Swelling	2	6.7
Giving way	18	60
Joint line tenderness	15	50
Quadriceps wasting	22	73.3
Difficulty in walking & squatting	20	66.7
Lachman test positive	21	70
Anterior Drawer Test Positive	22	73.8
McMurray Test	14	46.7
Lateral Meniscus	2	6.7
Medial Meniscus	12	40

4.9 Clinical diagnosis:

Clinical diagnosis demonstrates that about three-quarters (73.3%) of the subjects had anterior cruciate ligament (ACL) injury and 43.3% medial meniscus injury. Very few were diagnosed as having lateral meniscus injury. Isolated injuries were found 73.3% and combined injuries were 26.7%. (Table VII).

Table VII. Distribution of subjects by clinical diagnosis (n = 30*)

Clinical diagnosis	Frequency	Percentage
ACL injury	22	73.3
Medial meniscus injury	13	43.3
Lateral Meniscus injury	2	6.7
Isolated injury	22	73.3
Combined injury	8	26.7

*** Multiple response**

4.10 MRI diagnosis:

MRI diagnosis demonstrates that more than three-quarters (80%) of the subjects had anterior cruciate ligament (ACL) injury and 60% medial meniscus injury. Very few were diagnosed as having lateral meniscus injury (10%). Isolated injuries were found 50% and combined injuries were 50%. (Table VIII).

Table VIII. Distribution of subjects by MRI diagnosis (n = 30*)

Clinical diagnosis	Frequency	Percentage
ACL injury	24	80
Medial meniscus injury	18	60
Lateral Meniscus injury	3	10
Isolated injury	15	50
Combined injury	15	50

*** Multiple response**

4.11 Arthroscopic diagnosis:

Arthroscopically 73.3% subjects were diagnosed as having ACL injury and 20% with medial meniscus injury. Only 13.3% had lateral meniscus injury. Isolated injuries were found 73.3% and combined injuries were 16.7%. (Table IX).

Table IX. Distribution of subjects by arthroscopic diagnosis (n = 30*)

Arthroscopic diagnosis	Frequency	Percentage
ACL injury	22	73.3
Medial meniscus injury	6	20
Lateral Meniscus injury	4	13.3
Isolated injury	22	73.3
Combined injury	5	16.7

*** Multiple response**

4.12 Accuracy of a screening test against an established diagnosis:

The present study was intended to determine the accuracy of Arthroscopic and MRI diagnosis in diagnosing knee injury. Before going to the test findings, it would be worthwhile to interpret the components of accuracy of a screening test against a confirmatory diagnosis, which is considered as the 'Gold Standard'. In table X, the letter 'a' denotes those individuals found positive on test who have the disease being studied (i.e., true positives), while 'b' includes those individuals who exhibit a positive test result but who do not have the disease in question (i.e., false positives). The letter 'c' is the number of negative test results having the disease (i.e., false negatives) and the letter 'd' number of negative results who do not have the disease (i.e., true negatives).

Table X. Accuracy of a screening test against an established diagnosis

Screening test	**Established diagnosis**		**Total**
	+ve	-ve	
+ve	a	b	**(a + b)**
-ve	c	d	**(c + d)**
Total	**(a + c)**	**(b + d)**	**(a + b + c + d)**

The following measures are used to evaluate a screening test:

1. Sensitivity = a/(a +c) × 100
2. Specificity = d/(b +d) × 100
3. Positive predictive value of the test (PPV) = a/(a +b) × 100
4. Negative predictive value of the test (NPV) = d/(c +d) × 100
5. Percentage of false +ve = b/(a +b) × 100
6. Percentage of false –ve = c/(c +d) × 100
7. Diagnostic accuracy = (a + d)/(a + b + c + d) × 100

5.13 Accuracy of Clinical Diagnosis In Diagnosing ACL Injury:

Table XI shows the accuracy of clinical diagnosis as a screening test in diagnosing knee injury. From the table it appears that sensitivity of clinical diagnosis in correctly diagnosing injury of those who have the disease is (20/21) × 100 = 95.2%, while the specificity of the test in correctly differentiating of those who do not have injury is (8/9) × 100 = 88.9%. The positive predictive value (PPV) of the test is (20/21) × 100 = 95.2% and the negative predictive value of the test is (8/9) × 100 = 88.9%. The overall diagnostic accuracy is 93.3%.

Table XI. Accuracy of clinical diagnosis in detecting ACL injury

Clinical diagnosis	**Arthroscopic diagnosis**		**Total**
	Yes	No	
Yes	20	1	**21**
No	1	8	**9**
Total	**21**	**9**	**30**

5.14 Accuracy of clinical diagnosis in diagnosing medical meniscus injury:

Table XII shows the accuracy of clinical diagnosis as a screening test in diagnosing knee injury. From the table it appears that sensitivity of clinical diagnosis in correctly diagnosing injury of those who have the disease is (10/11) × 100 = 90.9%, while the specificity of the test in correctly differentiating of those who did not have injury is (16/19) × 100 84.2%. The positive predictive value (PPV) of the test is (10/13) × 100 = 76.9% and the negative predictive value of the test is (16/17) × 100 = 94.1%. The overall diagnostic accuracy is 86.7%.

Table XII. Accuracy of clinical diagnosis in diagnosing medical meniscus injury

Clinical diagnosis	**Arthroscopic diagnosis**		**Total**
	Yes	No	
Yes	10	3	**13**
No	1	16	**17**
Total	**11**	**19**	**30**

5.15 Accuracy of clinical diagnosis in diagnosing lateral meniscus injury:

Table XIII shows the accuracy of clinical diagnosis as a screening test in diagnosing knee injury. From the table it appears that sensitivity of clinical diagnosis in correctly diagnosing injury of those who have the disease is (2/4) × 100 = 50%, while the specificity of the test in correctly differentiating of those who do not have injury is (25/26) × 100 = 96.2%. The positive predictive value (PPV) of the test is (2/3) × 100 = 66.7% and the negative predictive value of the test is (25/27) × 100 = 92.6%. The overall diagnosis accuracy is 90%.

Table XIII. Accuracy of clinical diagnosis in diagnosing lateral meniscus injury

Clinical diagnosis	**Arthroscopic diagnosis**		**Total**
	Yes	No	
Yes	2	1	**3**
No	2	25	**27**
Total	**4**	**26**	**30**

5.16 Accuracy of MRI Diagnosis In Diagnosing ACL Injury:

Table XI shows the accuracy of clinical diagnosis as a screening test in diagnosing knee injury. From the table it appears that sensitivity of clinical diagnosis in correctly diagnosing injury of those who have the disease is (19/22) × 100 = 86.4%, while the specificity of the test in correctly differentiating of those who do not have injury is (4/8) × 100 = 50%. The positive predictive value (PPV) of the test is (19/23) × 100 = 82.6% and the negative predictive value of the test is (4/7) × 100 = 57.1%. The overall diagnostic accuracy is 76.7%.

Table XIV. Accuracy of MRI diagnosis in detecting ACL injury

MRI diagnosis	**Arthroscopic diagnosis**		**Total**
	Yes	No	
Yes	19	4	**23**
No	3	4	**7**
Total	**22**	**8**	**30**

5.17 Accuracy of MRI diagnosis in diagnosing medical meniscus injury:

Table XII shows the accuracy of clinical diagnosis as a screening test in diagnosing knee injury. From the table it appears that sensitivity of clinical diagnosis in correctly diagnosing injury of those who have the disease is (6/10) × 100 = 60%, while the specificity of the test in correctly differentiating of those who did not have injury is (10/20) × 100 = 50%. The positive predictive value (PPV) of the test is (6/16) × 100 = 37.5% and the negative predictive value of the test is (10/14) × 100 = 71.4%. The overall diagnostic accuracy is 53.3%.

Table XV. Accuracy of MRI diagnosis in diagnosing medical meniscus injury

MRI diagnosis	**Arthroscopic diagnosis**		**Total**
	Yes	No	
Yes	6	10	**16**
No	4	10	**14**
Total	**10**	**20**	**30**

5.18 Accuracy of MRI diagnosis in diagnosing lateral meniscus injury:

Table XIII shows the accuracy of clinical diagnosis as a screening test in diagnosing knee injury. From the table it appears that sensitivity of clinical diagnosis in correctly diagnosing injury of those who have the disease is (1/2) × 100 = 50%, while the specificity of the test in correctly differentiating of those who do not have injury is (26/28) × 100 = 92.9%. The positive predictive value (PPV) of the test is (1/3) × 100 = 33.3% and the negative predictive value of the test is (26/27) × 100 = 96.3%. The overall diagnosis accuracy is 90%.

Table XVI. Accuracy of MRI diagnosis in diagnosing lateral meniscus injury

MRI diagnosis	**Arthroscopic diagnosis**		**Total**
	Yes	No	
Yes	1	2	**3**
No	1	26	**27**
Total	**2**	**28**	**30**

DISCUSSION

The result from the study demonstrate that mean age of the subjects was 29.3 years and the minimum and maximum ages were 16 and 50 years respectively and all of the subjects were male. Over 26% of the subjects were service-holders followed by 40% students, 13.3% businessmen, 10% farmers, 3.3% day labourers and 6.7% people were on uniformed service. Madhusudhan (2008) reported a higher mean age (52 years) in his series with a age range from 18–70 years which is not consistent with the findings of our study.

The median duration of suffering was 10.5 months and the lowest and highest durations were 1.5 and 60 months respectively. About 46.7% of the subjects had right knee affected and the rest (53.3%) left knees affected. Over 56% of the subjects received injuries during sports activities and 43.3% received them while they were working. Jah (2005) reported about 43% of injuries with right knee and 57% with left knee affected. The mechanism of trauma was a non-professional sports injury in more than three-quarter (78.6%) of the patients, a motor car accident in 10 patients and a fall in 5 patients which are not consistent with findings of the present study

Pain and giving way were predominant complaints (80% and 60% respectively). On examination, quadriceps wasting, positive Lachman Test, positive Anterior Drawer Test were frequently observed (73.3%, 70% and 73.8% respectively). Positive McMurray Test was found in 46.7%

Clinical diagnosis demonstrates that about three-quarters (73.3%) of the subjects had anterior cruciate ligament (ACL) injury and 43.3% medial meniscus injury. Very few were diagnosed as having lateral meniscus injury. Isolated injuries were found 73.3% and combined injuries were 26.7%. MRI diagnosis demonstrates that more than three-quarters (80%) of the subjects had anterior cruciate ligament (ACL) injury and 60% medial meniscus injury. Isolated injuries were found 50% and combined injuries were 50%. Arthroscopically 73.3% subjects were diagnosed as having ACL injury and 20% with medial meniscus injury. Only 13.3% had lateral meniscus injury. Isolated injuries were found 73.3% and combined injuries were 16.7%.

The diagnostic accuracy of clinical examination was 93.3% for ACL, 86.7% for medial meniscus injury and 90% for lateral meniscus injury. The sensitivity of clinical diagnosis was 95.2% for ACL injury, 90.9% for medial meniscus injury and 50% lateral meniscus injury. The specificity was 88.9% for ACL injury, 84.2% for medial meniscus injury and 96.2% for lateral meniscus injury.

The sensitivities of the clinical diagnosis for the corresponding injuries were 85.7%, 100%, 100% 84.6% respectively and the specificities for the corresponding injuries were 95.9%, 100%, 95.6% and 91.2% respectively.

The diagnostic accuracy of MRI study was 76.7% for ACL, 53.3% for medial meniscus injury and 90% for lateral meniscus injury. The sensitivity of clinical diagnosis was 86.4% for ACL injury, 60% for medial meniscus injury and 50% lateral meniscus injury. The specificity was 50% for ACL injury, 50% for medial meniscus injury and 92.9% for lateral meniscus injury.

CONCLUSION

We examined the correlation between clinical examination, MRI scan and arthroscopy for meniscal and ACL injuries. By analyzing the data we came into the conclusion that carefully performed clinically examination can give better or equal diagnosis of meniscal or ACL injuries than MRI scan. MRI scan can be used to rule out the above mentioned injuries other than to diagnose them. When clinical signs and symptoms are inconclusive a MRI scan may be beneficial in avoiding unnecessary arthroscopic surgery. But when clinical examination is in favor of meniscal and/or ACL injuries, a MRI scan prior to arthroscopic examination is of little importance. So it can be said that MRI scan should not be used as a primary diagnostic tool for diagnosing meniscal and ACL injuries.

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