Research Article

Role of Ultrasonography in Evaluation of Abnormalities of Menisco Collateral Complex of The Knee joint; A Comparative Study with Magnetic resonance imaging, Arthroscopy and Clinical findings.

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Abstract
Background: The menisci and collateral ligaments of the knee are complex structures with various important functions within the knee. Loss of the menisci or collateral ligaments leads to a significantly increased risk of developing degenerative changes in the long term. **Purpose:** This study aimed to investigate the diagnostic value of high frequency musculoskeletal ultrasound in detection and evaluation of menisco-collateral complex abnormalities of the knee joint in comparison with magnetic resonance imaging, arthroscopy and clinical findings. **Patients and Methods:** This study included 50 patients, presented by pain, swelling, stiffness/limitation of movement or a history of acute/chronic knee trauma, in the duration between August 2018 and November 2019. The research was carried on the Radiology Department, Minia university Hospital. All patients underwent musculoskeletal ultrasound in different position then underwent magnetic resonance imaging included different pulse sequences and scanning planes, some of them underwent arthroscopy. **Results**: This study included 50 patients, 30(60%) males and 20(40%) females. Male patient's age ranged between 19 and 55 years with a mean of 31.18 ± 10.89 *S*D, while female patient's age ranged between 19 and 56 years with a mean of 42.60 ± 11.41*S*D. **Conclusion**: High resolution ultrasonography had high accuracy in detecting presence of tears in both the menisci and collateral ligaments. MRI is more sensitive in detection and determines types of tears than US.
Keywords: MRI Knee, ultrasound, menisci

Introduction
Knee injuries are among the most common injuries in the athletic population. The majority of knee injuries were related to sporting or recreational activities, with soft-tissue injuries.[1] When injury occurs, the superficial medial collateral ligament (MCL) is the most commonly damaged ligament of the knee, usually induced by valgus stress, and can occasionally be accompanied by a tear in the medial meniscus.[2,3] However: Lateral collateral ligament (LCL) injury as well as lateral meniscal tear are less likely. While clinical examination is essential in diagnosing tears of the medial as well as lateral compartments of the knee, imaging is almost required to make a conclusive diagnosis.[4,5]

In Non-traumatic conditions; the most common causes of knee pain and disability are tears in the medial or lateral meniscus (MM or LM) as well as collateral ligaments (CL).[6-8] Meniscal and collateral injuries are common in both elite athletes and the general population.[9]
Ultrasound (U/S) is a reliable method for diagnosing injuries to the tendons, ligaments, and muscles of the knee joint. Ultrasound (U/S) technique offers some advantages over magnetic resonance imaging (MRI). The equipment is generally less expensive, involves no radiation, portability, dynamic real-time assessment, high spatial resolution and easy side-to-side comparison. It can also obtain views in multiple planes, in addition it allows a dynamic examination and the complaints of the patient during sonopalpation with the probe can help to localize different musculoskeletal pathologies.[10,11]

Ultrasound major disadvantage is its operator dependence, as well as a long learning curve. It requires trained experienced hands, with appropriate high-resolution equipment, for ultrasound to succeed as an effective diagnostic

tool. Until recently, musculoskeletal ultrasound has been limited by a small field of view. This often prevents documentation of a finding on a single image. The use of split-screen imaging has aided the imaging of larger masses or findings, as well as comparison between two sides. The development of extended field of view imaging has further facilitated this process.[12-14]

Clinical examination still plays an important role in diagnosing meniscal tears, but the types of sensitive nerves in the knee joint are responsible for nonspecific pain, which is often correlated with too little specificity in meniscal tears. Thus, accurate diagnosis depends on imaging. Knee arthrography, which was once used widely [15] has largely been replaced by magnetic resonance imaging (MRI).[16]

Magnetic resonance imaging (MRI) has historically been considered to be the golden standard imaging modality to diagnose knee injuries including meniscal and collateral pathologies. However, it is contra-indicated to use MRI in much cases, such as the presence of indwelling cardiac pacemakers, metal implants and patient intolerance due to claustrophobia.[17-19]

Arthroscopy a very effective tool for treating knee problems.[20] It's the gold standard in diagnosis and repair of meniscal lesions. Arthroscopic knee surgery for degenerative knee disease is the most common orthopaedic procedure for repair of knee injuries[20] and on a global scale is performed more than two million times each year.[21-24]

Current guidelines generally discourage arthroscopy for patients with clear radiographic evidence of severe osteoarthritis alone. However; Knee arthroscopy can be used to treat meniscal and articular cartilage tears, fat pad impingement and chronic plica irritation.[25]

Aim of the work

This study will be done to assess the diagnostic value of high frequency musculoskeletal ultrasound in detection and evaluation of menisco-collateral complex abnormalities of the knee joint in comparison with magnetic resonance imaging, arthroscopy and clinical findings.

Patients and methods

This study included 50 patients, presented by pain, swelling, stiffness/limitation of movement or a history of acute/chronic knee trauma, in the duration between August 2018 and November 2019. The research was carried on the Radiology Department, Minia University Hospital. **This study was approved by the Ethics Board of Minia University.**

All the patients underwent musculo-skeletal ultrasound in different position then underwent magnetic resonance imaging including different pulse sequences and scanning planes, ten patients underwent arthroscopy.

Inclusion criteria included:

1. Full history taking and revision of previous clinical reports and laboratory studies from all patients.
2. Ultrasonography examination of knee joint at both sides in all patients.
3. MRI study of the affected one knee joint in all patients.
4. Arthroscopic examination of the affected one knee joint by experienced orthopedic surgeon in selected patients.

Exclusion criteria:-

1. Difficulties of the ultrasonography, e.g. patient were not co-operative with doctor.
2. Contraindications to magnetic resonance imaging, e.g. claustrophobia, cardiac pacemakers, metallic plates.
3. Contra indications to arthroscopy, e.g. marked arthritis, unfit for surgery.

Patient Preparation for ultrasound:

No specific patient preparation was required

Technique for ultrasound

Sonographic exams (GE logic and Toshiba oxario) were performed with 11 MHz probe in supine and prone positions through the anterior, lateral and posterior approaches using static and dynamic techniques.

Most of the imaging was done in the longitudinal plane. In the static technique, the anterior horns of the menisci were imaged in supine position with the knee in full extension and 20−30 degrees of flexion. Then the probe

was moved to sides to visualize the bodies of the menisci. Afterwards the patients were placed prone and posterior horns were imaged with the knee in extension first then 45 degrees flexion. In dynamic imaging, the knee was subjected to mild internal and external Varus stresses to allow better imaging of the menisci using movements.

Patient Preparation for MRI:
The patients were questioned about history of intracranial surgical clips, cardiac pace-makers, cochlear implants and metallic objects in the body before the MR examination. No specific patient preparation or sedation was required. The clinical details and any prior imaging diagnostic result were available. The patients were examined in supine position.

Technique for MRI:
Magnetic resonance imaging will be performed by using a 1.5-T MR system (Philips MR system Ingenia).
1- Patients were placed supine with the knee extended and slightly externally rotated (10-15°) in an extremity coil to optimize the signal to noise ratio.
2- Images were obtained mainly in both the sagittal and coronal planes, where sagittal images were done with the knee externally rotated to permit imaging in the plane of the ACL. Axial images were also scanned to study the supporting ligaments around the knee.
3- Routine MRI sequences were used including turbo spin echo sagittal proton density; T1 and T2 weighted images as well as coronal STIR & axial PD weighted images. Additional sequences were sometime used as sagittal STIR, coronal T1 or T2 weighted images. These were obtained using a field of view of 12-16 cm, slice thickness of 4mm, and a matrix of 256/192 or 512/224. A skip of (0–20% of slice thickness) was used between imaging sections.

Data analysis and Statistical data display:
To obtain diagnostic values, we measured sensitivity, specificity, positive and negative predictive values and accuracy.

Results

Fifty patients (50 knees) were included in this study of different age groups and sex. Thirty patients (60%) were males and twenty patients (40%) were females (Table 1,2)

Table (1): Demographic data of studied samples (N=50).

Variable	Descriptive statistics	
Age	Mean+/-SD Range	34.75+/-12.12 19-56
Sex	Males	30 (60%)
	Females	20 (40%)

Table (2): Distribution of age according to sex of studied sample.

Variable	Males (N=30)	Females (N=20)
Mean+/- SD	31.18+/-10.89	42.60+/-11.41
Range	19-55	19-56

Fourty five patients were diagnosed with meniscal injuries (90%). Thirty five patients (70%) were diagnosed as lesions of medial meniscus and ten patients (10%) were diagnosed as lesions of lateral meniscus. Twenty five patients in our study were injured with posterior horn medial meniscus (PHMM) (50%), only two patients in our study of meniscal injuries are bucket handle tear of lateral meniscus (4%). (Table 3).

Table (3): Distribution of site of meniscal injury detected in our study.

Meniscal injury	Number (%)
PHMM	25 (50%)
MM root	5 (10%)
Bucket Handle MM	5 (10%)
PHLM	4 (8%)
AHLM	4 (8%)
Bucket Handle LM	2 (4%)
Total	45 (90%)

During comparison of findings of ultrasound and MRI examinations, thirty two patients have the same findings in both examinations (64%), however; twelve patients (24%) had different findings at both techniques as (root tear, bucket handle tear and flipped lateral meniscus) as described below. (Table 4, 5).

Table (4): Findings in 38 patients with the same diagnosis at both U/S and MRI.

Meniscus	U/S Findings	MRI Findings	Number (%)
MM	Complex	Complex	10 (20%)
	Myxoid	Myxoid	7 (14%)
	Oblique	Myxoid	5 (10%)
	Horizontal, abnormal meniscal apex	Horizontal, radial	2 (4%)
	Horizontal	Horizontal	1 (2%)
LM	PHLM Horizontal	PHLM Horizontal	2 (4%)
	PHLM Oblique	PHLM Oblique	1 (2%)
	PHLM Myxoid	PHLM Myxoid	1 (2%)
	AHLM Myxoid	AHLM Myxoid	1 (2%)
	AHLM Horizontal	AHLM Horizontal	1 (2%)
	AHLM Complex	AHLM Complex	1 (2%)
Total			32 (64%)

Table (5): Findings in 12 patients with the different at both U/S and MRI.

Meniscus	U/S Findings	MRI Findings	No. (%)
MM	PHMM Extruded+ Horizontal + Dead meniscus	PHMM Extruded+ Horizontal + Root tear	10 (20%)
	Small sized & horizontal tear in PHMM	(Loss of bow tie+ Double PCL sign) Bucket Handle tear	7 (14%)
LM	Small sized & horizontal tear in PHLM	(Loss of bow tie+ Double PCL sign + Double meniscal sign) Bucket Handle tear + Flipped meniscus	2 (4%)
Total			12 (24%)

Ten patients (20%) were referred to orthopedic department for arthroscopy by experienced orthopedic surgeons. Arthroscopy results were compared with those of U/S and MRI were positively correlated with U/S and MRI in seven patients (70%). However; Bucket handle tear in three patients was not diagnosed by ultrasound but clearly diagnosed by MRI and confirmed by arthroscopy (30%). Orthopedic surgeon performing arthroscopy was blinded of U/S and MRI results. (Table 6)

Table (6): US in diagnosis of meniscal injuries comparing with MRI and arthroscopy

Site	U/S Findings	MRI & Arthroscopy Findings	Number (%)
MM	Horizontal tear	Horizontal tear	3 (6%)
	Vertical tear	Vertical tear	1 (2%)
LM	Small sized & horizontal tear MM	(Loss of bow tie & Double PCL sign) Bucket Handle tear	3 (6%)
	PHLM tear	PHLM tear	2 (4%)
	AHLM tear	AHLM tear	1 (2%)

In our study six patients were diagnosed equally by both U/S and MRI as combined menisco-collateral injuries of medial compartment (12%), three patients of them were diagnosed as PHMM myxoid with medial collateral ligament sprain (6%). (Table 7)

Table (7): Menisco-collateral complex injury diagnosis by U.S / MRI

Imaging	Menisco-collateral injury	Number (%)
U/S + MRI	PHMM Myxoid+ MCL sprain	3 (6%)
	PHMM Tear + MCL Grade II tear	2 (4%)
	PHMM Myxoid + MCL Grade II tear	1 (2%)
Total		6 (12%)

Eighteen patients were diagnosed in the study as multiple meniscal injuries (36%). Ten patients (20%) of them were diagnosed by U/S. The most common was diagnosed as PHMM extrusion with tear and truncated root (10%), the least common (2%) was diagnosed as PHLM myxoid degeneration with complex tear involving the PHMM. (Table 8, 9).

Table (8): Multiple meniscal lesions diagnosed by U/S

Types of injury	Number (%)
PHLM tear+ PHMM Myxoid	3 (6%)
PHMM Myxoid +AHLM Oblique tear	2 (4%)
PHLM Myxoid + PHMM Myxoid	2 (4%)
Extruded PHMM + tear	2 (4%)
PHLM Myxoid + PHMM Complex tear	1 (2%)
Total	**10 (20%)**

Table (9): Multiple meniscal lesions diagnosed by MRI only.

Types of injury	Number (%)
PHMM Extrusion+ tear+ root	5 (10%)
Bucket Handle LM+ Flipped meniscus	2 (4%)
Discoid LM+ AHLM Myxoid + PHMM Myxoid	1 (2%)
Total	**8 (16%)**

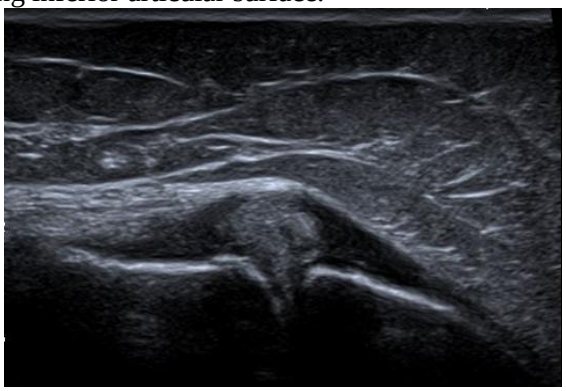
Sensitivity (83.3%) & specificity (71.4%) of U/S in detecting medial meniscal injuries was compared to lateral meniscal lesions (87.5 %) & (66.6%). Accuracy in diagnosis of medial meniscus lesions (85.7%) was compared to lateral meniscal lesions (80%). (Table 10).

Table (10): Statistical analysis of U/S in diagnosis of meniscal & collateral injuries (50 patients).

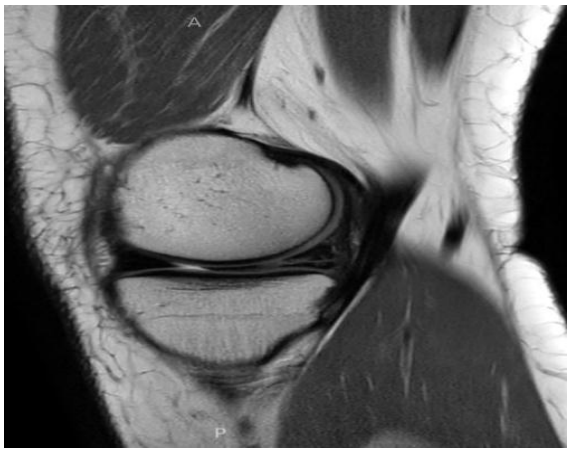
U/S	Sensitivity	Specificity	Accuracy
MM	87.5%	83.3%	86%
LM	87.5%	92.85%	92%
MCL	100%	100%	100%

Case 8

By Ultrasonography: Horizontal & small vertical hypoechoic lines seen traversing the posterior horn of medial meniscus, reaching inferior articular surface.



By MRI: Sagittal PDWI revealed two components (Horizontal & vertical) high signals within posterior horn of medial meniscus, interrupting inferior articular surface



Final Diagnosis: PHMM Complex tear.

Discussion

Meniscal and collateral ligament injuries, especially medial one, are common not only in elite athletes but also in the general population. [26] The most common causes of knee pain and disability are tears in medial or lateral menisci. Accurate diagnosis of meniscal tear depends upon imaging. In the last decade, musculo-skeletal imaging has rapidly expanded due to the imaging capabilities of magnetic resonance imaging and ultrasound.[27] MRI is currently the diagnostic method of choice in evaluation of menisci.[28,29] However, the use of MRI is not only expensive, but also has some limitations.[30,31] USG diagnosis of orthopedic conditions has gathered pace in recent years. It has become popular because it is safe, quick, inexpensive and fairly reliable. It has been proposed to use ultrasonography for the study of the menisci and collateral ligaments of the knee and particularly for diagnosing injuries since 1989. [32-35]

Arthroscopy is a very effective tool for treating knee problems. Arthroscopic Partial menisectomy (APM) was done in patient with symptomatic degenerative meniscal tears.[36] There are three options for treatment of acute traumatic meniscal tears including: (Non-operative rehabilitation, surgery to trim out the area of torn meniscus or surgery to repair (stitch together) the torn meniscus).[37]The treatment chosen will depend on the location of the tear; the size of the tear, ligamentous stability of the knee and any associated injury.[38] It takes between two and 6 weeks to recover from arthroscopy, during which time patients may experience pain, swelling, and limited function.[40,41]

Most patients cannot bear full weight on the leg (that is, they may need crutches) in the first week after surgery, and driving or physical activity is limited during the recovery period.[39] In our study, 30 males and 20 females were included. This correlates with the study done by Hossam A et al., in 2019 who found meniscal injuries were more common in men (62%). This could be explained by the fact that males are more vulnerable to such traumatic knee injury during daily activity and sports injury, while females are more vulnerable to meniscal degeneration resulting from weight bearing due to obesity.[41]

The patient's age in our study ranged between 19 and 55 years in males and also ranged between 19 and 56 years in females with a mean of 31.18 ± 10.89 SD & 42.60 ± 12.12 SD respectively. Taking in mind the distribution of the lesions according to the affected horn. This correlates with a study done by Hossam A et al., in 2019 who published that age of patient ranged between 10 and 67 years in males and also ranged between 29 and 55 years in females with a mean of 36.35 ± 11.03 SD & 40.00 ± 8.34 SD respectively. This could be explained by the fact that degenerative meniscal injuries occurs most commonly in old aged people due to repetitive stresses on the menisci over time, however; Acute traumatic meniscal tears are usually in young and middle aged people especially athletes as a result of twisting injury of knee during trauma.[41]

Thirty five patients (70%) were diagnosed as medial meniscal lesions, 10 patients (20%) were diagnosed as lateral meniscal lesions, 39 patients of them (78%) were diagnosed as posterior horn lesions, while only 6 patients (12%) were diagnosed as anterior horn lesions, our results was different from the results obtained from the study done by Nasir AI, in 2013 who reported 14 patients (53.84 %) were diagnosed as anterior horn lesions, while 12 patients (46.15%) were diagnosed as posterior horn lesions.[35] The only two explanations of this discrepancy is that Nasir AI, study in 2013 was conducted upon relatively smaller number of meniscal lesions in his study which were only 26 patients which are much more smaller than our study which diagnosed 45 patients with meniscal injuries. However, the incidence of medial meniscal tear in his study was 65% and the incidence of lateral meniscal tear was 35% which were correlated with our study (70% medial meniscus lesions and 20% of lateral meniscus). However, the incidence of medial meniscal tear in his study was 65% and the incidence of lateral meniscal tear was 35% which were correlated with our study (70% medial meniscus lesions and 20% of lateral meniscus).

In our study, multiple tear patterns of meniscal lesions were diagnosed which were almostly all patterns of meniscal injuries. Our study was prospective study. The incidence of meniscal lesions were variable in all cases. The highest percentage (20%) were complex tears of PHMM, (10%) with bucket handle tear of medial meniscus, however; only 1 patient (2%) was diagnosed as flipped lateral meniscus anteriorly using MRI examination only.

A recent study by Hossam A. et al.,, in 2019 published difference of incidence of meniscal lesions diagnosed in his study, 44 patients out of 62 lesions were diagnosed as PHMM myxoid degeneration in (70.97 %), however; only 2 patients (3.23%) were diagnosed as bucket handle tear of medial meniscus and 2 patients were diagnosed as flipped tear of lateral meniscus (3.23%) [41]

The possible explanation of the difference is that Hossam A. et al.,, study in 2019 included patients presented by only pain, and acute/chronic knee trauma, in the duration between November 2017 and July 2018.

Their duration of study was shorter than our duration (from August 2018 to November 2019). In addition; Our study was a prospective study, all patients were examined with different symptoms including (Acute / chronic knee pain, locking, limitation of movement and acute / chronic traumatic injuries) which raise possibility to diagnose both degenerative and traumatic meniscal injuries of different patterns.

In our prospective study, ultrasonography was found to be a highly sensitive and specific imaging method for the detection and definition of meniscal tears, comparing with MRI. Regarding our statistical results for meniscal tears, U/S was consistent with MRI in 38 (76%) lesions out of 50. Sensitivity of U/S in detecting medial and lateral meniscal tears was hence found to be 87.5% and 87.5 %, specificity was 83.3% and 92.85 % while accuracy was 86% and 92% respectively.

Our results were correlated with the study done by Abd El-Monem S et al., in 2012, the sensitivity of US in diagnosis of meniscal tears were 80.5%, specificity was 76.9%, while accuracy was 80 %.[42] The possible explanations is their study had the same duration (November 2010 to November 2011) as our study (August 2018 to November 2019), their study was also prospective and including nearly the same patients complaints such as knee pain, swelling, limitation of movement and trauma, thus; the probability to examine multiple patterns of meniscal lesions is high. In addition; Abd El-Monem S et al., study in 2012; 15 patients (30%) out of 50 patients couldn't be diagnosed using U/S which is nearly the same number of patients (24%).

On the other way, another recent study done by Najafi et al.,, in 2006 reported a 100% and 95% sensitivity and specificity of ultrasonography in detecting meniscal tears respectively with higher accuracy than the results from our study: 98% in medial meniscus and 97% in lateral meniscus.[43] There are some possible explanations for this discrepancy.

Firstly: Their study was retrospective as they only examined the posterior horns of both medial and lateral menisci, however; our study was prospective and examined all horns of both menisci.

Secondly; Patients were also selected in their study because the patients chosen for arthroscopy were from those with positive sonographic findings; thus, bucket handle tears, root tears and radial tears which were difficult to diagnose by sonography, were automatically excluded from their study. However: In our study 5 patients with bucket handle tear at medial meniscus, 5 patients with root tear at medial meniscus and 1 patient with radial tear of medial meniscus were included.

The MCL, the longest ligament in the body, is also the most commonly injured ligament of the knee. In our study we also diagnosed medial collateral ligament injuries in 6 patients (12%), 3 of them (6%) were MCL sprain and 3 (6%) were MCL Grade II injury. All MCL injuries in the study had similar appearance on ultrasound as has been described for MRI.

Nasir AI in 2013 reported that 9 patients (18%) out of 50 patients in his study were diagnosed with medial collateral ligamentous injuries.[35] These results correlate with our study which diagnosed medial collateral ligamentous injuries in 6 patients (12%). The explanation is that Nasir AI, study in 2013 was conducted upon meniscal and collateral ligament injuries as our study which resulted in very limited number of patients (18%) with medial collateral ligament injuries as ours (12%).

In our prospective study, ultrasonography proved a very highly sensitive and specific imaging role for the detection and definition of medial collateral ligament injury. Regarding our statistical results for medial collateral ligament injuries, U/S was consistent with MRI in 6 patients (12%). Accuracy, sensitivity and specificity of U/S in diagnosing medial collateral ligament tears were 100%.

Singh B et al., in 2016 reported that their study diagnosed 8 patients (16%) with medial collateral ligament injuries. Their accuracy, sensitivity and specificity of U/S were 96%, 83% and 97% respectively.[44]

These statistical analyses were nearly the same as our study. This could be explained by the fact that Singh B et al.,, study in 2016 were not exclusive for collateral ligament injuries and

mainly conducted prospectively upon multiple knee injuries so that the number of medial collateral ligament injuries was limited in both studies which represented (12%) in our study and (16%) in their study.

Our study also diagnosed menisco-collateral complex injuries in 6 patients (12%), 3 patients (6%) were diagnosed prospectively using U/S as PHMM Myxoid degeneration with MCL sprain, also 2 patients (4%) were diagnosed as PHMM oblique tear with MCL Grade II injury. However; only 1 patient (2%) was diagnosed as PHMM Myxoid degeneration with MCL Grade II injury.

Nasir AI, in 2013 reported that 9 patients (18%) in his study which were diagnosed with medial collateral ligamentous injuries were also having additional meniscal injuries such as PHMM myxoid degeneration or oblique tear. Seven patients of them (14%) were diagnosed prospectively using U/S as PHMM oblique tear with MCL Grade II injury.[35] The explanation is that Nasir AI study in 2013 was conducted prospectively upon multiple types of knee injuries not only about menisco-collateral complex lesions but also other types of knee injuries, thus; the number of patients was limited (18%) as ours (12%).

In our prospective study, only 10 patients (20%) out of whole 50 patients included in our study were examined using U/S and MRI then underwent arthroscopic examinations which represent very limited number for analysis, 7 patients (70%) out of the 10 patients had the same diagnosis in all examinations such as (horizontal, vertical and oblique tears of both medial and lateral menisci). However; only 3 patients (30%) had different diagnoses in both MRI and arthroscopy as they were diagnosed as bucket handle tears of medial meniscus and flipped lateral meniscus.

A study by Ünlü EN et al., in 2014 used the arthroscopy as a gold standard for meniscal tears and calculated the diagnostic value of U/S and MRI comparing with arthroscopy in 21 patients. Seventeen patients (81%) were on medial meniscus, however; only 4 patients (19%) were on lateral meniscus. The results revealed that 11 patients (52.5%) had same findings in all examination, however; the remaining 10 patients (47.5%) had different diagnoses in U/S.[45]

The possible explanation of this difference is that our study were conducted upon very limited number of patients with arthroscopy (10 patients) which were less than 1/2 of number of patients included in their study (21 patients), the bigger number raise the expectation of discrepancy between U/S and arthroscopic details.

Our study had some limitations. First, a relatively small number of meniscal and collateral ligament tears were examined (50 patients). Second, most of ultrasonographic results were only compared with the MRI findings because most patients did not have arthroscopic evaluation for different reasons. Therefore, MRI was used as the reference standard in most of our patients. Third, a small number of patients (10 patients) underwent arthroscopic repair. Fourth, the blinding for the clinical findings might have been incomplete, because the radiologist might have been aware of the patient's complaint during the dynamic ultrasonographic examinations. This might affect the diagnostic accuracy of ultrasonography.

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