

Diagnostic Accuracy of Ultrasonography in the Evaluation of Knee Joint Injuries Compared to Magnetic Resonance Imaging and Arthroscopy

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ABSTRACT

Introduction: Knee joint injuries are common especially in sports persons. Injuries to soft tissues, such as ligaments, cartilage and tendons are commonly encountered. Ultrasound has become very popular modality in recent years for evaluation of knee joint injuries because of easy availability, non-invasiveness, and possibility of dynamic imaging assessment.

Aim: To evaluate the role of ultrasound in evaluation of knee joint injuries compared to MRI.

Materials and Methods: The prospective study included 60 patients with knee joint injuries. Ultrasound was done on both injured as well as normal knee, including dynamic assessment. It was followed by MRI of injured knee in all patients. MRI was used as Gold standard for comparison.

Results: Knee injuries are commonly seen in young age with maximum number of patients in the age group of 21-40 years. Most common cause of knee injuries is sports related trauma followed by road traffic accidents. It has been observed that Knee injuries show a definite male preponderance with male to female ratio of approximately, 5:1. Right knee was involved more frequently than left knee. Most frequent finding in knee injuries in our study was joint effusion. Medial meniscal tear was most common injury seen in this study.

Conclusion: Based on our results, it can be concluded that USG is an effective imaging modality that has positive effect on the management of many patients presenting with knee injuries. Knee USG has high accuracy in diagnosing menisco-ligamentous injuries. A wide availability, lower cost and fair reliability make it a modality of first choice for evaluation of knee injuries. MRI can be reserved for patients with suspicious USG results.

Keywords: Knee injuries, cartilage, ligaments, Ultrasound.

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INTRODUCTION

The knee joint is a compound type of synovial joint that consists of hyaline cartilage articulations between femur, tibia and patella. Due to limited bony support, stability of knee joint is highly dependent on its ligamentous structures and therefore injuries of ligaments and menisci are extremely common. Knee injuries are especially common in sports persons.¹⁻⁸ Clinical examination by even by the most experienced staff using the strictest of clinical methods is not always enough to diagnose knee injuries. Arthroscopy has been considered as the

gold standard for the diagnosis of knee injuries.⁹⁻¹⁵ But it is invasive, expensive and requires day surgery admission. MRI is now the non-invasive gold standard for the diagnosis of knee injuries, but MRI has long examination times and is expensive. Also, MRI is not always available on demand and does not allow dynamic testing.¹⁶⁻¹⁸ High resolution ultrasonography (HRUS) is becoming a leading imaging modality in the evaluation of the Musculo-skeletal system as it is readily available and economical. USG evaluates the fibrillary anatomy of muscles, tendons and ligaments. Other advantages of USG are ability to compress, dynamically assess structures and compare easily with the contralateral side. There have been studies done in the past that evaluated accuracy of either USG or MRI in detection of knee injuries and only few studies have compared the two methods.¹⁹⁻²⁷

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MATERIALS AND METHODS

The study was conducted in the Department of Radiodiagnosis and Imaging, Sher-i-Kashmir Institute of Medical Sciences, Srinagar in collaboration with the Department of Orthopaedics over a period of two years commencing from July 2018 and ending on July 2020.

Inclusion criteria

Clinically suspected patients having knee ligamentous or meniscal injuries.

Exclusion criteria

- Patients with contraindications to MRI.
- Patients with known or diagnosed fracture/dislocation involving the knee on plain radiography.
- Patients having undergone knee surgeries for any reason.

Method

From July 2018 to July 2020, 60 patients (50 males, 10 females) clinically suspected of having knee ligamentous or meniscal injuries were sent to our department from the department of orthopaedics. All the patients were informed about the study and their informed consent was taken. All the patients underwent ultrasonography of the injured knee as well as normal knee using high frequency linear probe (7-15 Hz) and MRI of the injured knee on the same day. All the sonographic exams and MRI were performed by consultant radiologists who were blinded to the results of other test. The decision to do arthroscopy was done according to the MRI findings and clinical findings by the orthopaedic surgeons. Arthroscopy was done in 23 patients.

Ultrasound Imaging Technique

Sonographic exams were performed with 7-15Hz linear probe in supine and prone positions through the anterior,

lateral and lateral approaches using static and dynamic techniques. In supine position, the knee was flexed 20-30 degree to examine anterior, medial, and lateral aspects of knee and prone position for posterior aspect of knee.

MRI Technique and Protocol

MRI was carried out using 1.5 T MR system (Magnetom Avanto, Siemens Medical Systems, Erlangen, Germany) using following protocol.

Statistical Analysis

Collected data is presented in form of tables and diagrams. Continuous variables are expressed as Mean/ SD and categorical variables are summarized as frequencies and percentages. Frequency distribution tables, bar and pie charts are used for data presentation.

Sensitivity, specificity and diagnostic accuracy of USG is calculated keeping MRI as standard for comparison by using following formulas:-

$$\text{Sensitivity: } \frac{\text{True positive results}}{\text{True positive} + \text{False negative results}} \times 100\%$$

$$\text{Specificity: } \frac{\text{True negative results}}{\text{True negative} + \text{False positive results}} \times 100\%$$

$$\text{Accuracy: } \frac{\text{TP} + \text{TN}}{\text{No. Of examinations.}}$$

RESULTS

We evaluated sixty patients with knee injuries in our department. Collected data is presented as follows:

Table 2: Gender distribution.

Gender	Frequency	Percentage (%)
Male	50	83.3
Female	10	16.7
Total	60	100

*Approx. 5/6th of patients was of male gender

Table 1: MRI protocol.

Sequences	TR	TE	THK	FOV	RFOV (%)	NSA
T1W TSE SAG	450–500	15–25	3.0/ 0.7	210	80	2
TIW TSE COR	450–500	15–25	3.0/ 0.7	210	100	2
PD SPAIR COR	1500–3000	12–18	3.0/ 0.7	210	100	3
PD SPAIR TRA	1500–3000	12–18	3.0/ 0.7	210	100	3
PD SPAIR SAG	1500–3000	12–18	3.0/ 0.7	210	100	3
T2W SAG	3500	102	3.0/ 0.7	210	100	2

Table 3: Age distribution.

Age (years)	Frequency	Percentage (%)
≤+20	07	11.7
21 - 30	15	25
31 - 40	16	26.7
41 - 50	11	18.3
51+	11	18.3
Total	60	100

*Mean age = 35.78 years.

* Half of the patients were in the age group of 21–40 years.

Table 4: Right vs. Left knee involvement.

KNEE INVOLVED	Frequency	Percentage (%)
Right	38	63.3
Left	22	16.7
Total	60	100

Table 5: Mode of trauma.

Mode of trauma	Frequency	Percentage (%)
RTA	15	25
Fall on ground.	15	25
Sports injury.	16	26.6
Fall from height.	10	16.6
Blunt trauma.	01	1.6
Physical assault.	02	3.33
Fall from stairs.	01	1.6
Total.	60	100

Table 6: Frequency of types of knee injuries as seen on USG.

Structure involved	Frequency
aCL	11
PCL	15
MM	23
LM	11
MCL	15
LCL	07
EFFUSION	33

Most frequent finding was joint effusion followed by medial meniscal injury.

Arthroscopy was done in only 23 patients with high grade meniscal tears and cruciate ligament ruptures requiring intervention.

We used MRI as standard for comparison of USG findings to calculate sensitivity, specificity and diagnostic accuracy for the following reasons:

1. MRI was done in all the 60 patients in our study, while as arthroscopy was done in only 23 patents.
2. There was absolute agreement (Kappa value >0.9) for all findings between MRI and Arthroscopy in these 23 patients.
3. As it is mentioned in literature, some intra-substance meniscal tears can be missed on arthroscopy.

DISCUSSION

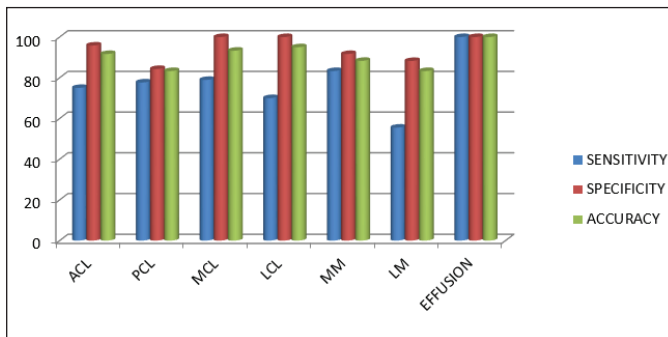
Ultrasonographic diagnosis of orthopaedic conditions has gathered pace in recent years. It has become popular because it is quick, easily available and fairly reliable. USG diagnosis of knee injuries has been tried in various studies with variable results.^{28–30} The current study was carried out at SKIMS Soura Srinagar, a tertiary care institute of the valley in the department of radiodiagnosis and imaging. A total of 60 patients were included in the study. All the 60 patients underwent USG and MRI of the knee and 23 patients underwent Arthroscopy. As there was absolute agreement between MRI and Arthroscopic findings in these 23 patients and also it is mentioned in literature that some intra-substance meniscal tears can be missed on arthroscopy, MRI was used as a standard for comparison of USG findings to calculate its sensitivity, specificity and diagnostic accuracy.

In our study, the mean age of patients was 35.7 years (range 16–59 years), the percentage of males was 83.3% and the percentage of females was 16.7%. The findings were similar to study carried out by Nasir *et al.*³¹, where mean age was 35.3 years and percentage of males and females was 78% and 22 %, respectively. The high male to female ratio may be because of the fact that males are more involved in outdoor activities, sports and industrial works and are thus more prone to injuries. Knee joint effusion was the most frequent finding seen in 29 out of 60 patients. Ultrasound was consistent with MRI in 60 out of 60 patients (29 true positives and 31 true negatives) resulting in accuracy of 100%. The results were consistent with the study conducted by Singh B *et al.*,³² which showed 100% accuracy of ultrasound in detecting knee joint effusion.

Regarding statistical results for ACL tears, Ultrasound was consistent with MRI in 55 (91.67%) out of 60 patients as it yielded 09 true positive, 46 true negative, 02 false positive and 03 false negative results. Sensitivity, specificity

Table 7: Sensitivity, Specificity and Accuracy of USG as compared to MRI.

	Sensitivity (%)	Specificity (%)	Diagnostic accuracy (%)	Lower-upper 95% CIs	Chi- square test	p-value
ACL	75	95.83	91.67	75.60–92.05	16.36	0.002
PCL	77.7	84.31	83.33	73.09–90.20	10.73	0.010
MCL	78.94	100.0	93.35	85.00–97.54	43.15	0.001
LCL	70.0	100.0	95.0	81.23–95.84	26.03	0.001
MM	83.33	91.67	88.3	79.11–94.60	34.2	0.000
LM	55.55	88.23	88.33	70.71–88.30	4.49	0.080
EFFUSION	100	100	100	98.39–100	56.97	0.000

**Figure 1:** BAR diagram showing sensitivity, specificity and accuracy of USG.

and accuracy of ultrasound in detecting ACL injury was 75%, 95.8% and 91.67 %, respectively. Our results were concordant with the study done by Fried W *et al.*,²⁴ who has documented sensitivity and specificity of 70% and 98%, respectively. Our results were slightly lower than the study conducted by Ptaznik R *et al.*,²⁶ who has documented sensitivity and specificity of 91% and 100%, respectively. Our results were also complemented by the study done by Abdel El Monem *et al.*,²⁹ which showed USG sensitivity of 81% and specificity of 84% for detection of ACL tears.

For PCL tears, ultrasound was consistent with MRI in 50 (83.3%) out of 60 patients as it yielded 07 true

positives, 43 true negatives, 08 false positives and 02 false negatives. Sensitivity, specificity and accuracy of USG was found to be 77.7%, 84.3% and 83.3%, respectively. The study conducted by Singh B *et al.*³² reported sensitivity, specificity and accuracy of 75 %, 93.4% and 92%, respectively.

The statistical results of medial meniscal tears in our study are: 20 true positives, 03 false positives, 33 true negatives and 04 false negatives. Sensitivity, specificity and accuracy of 83.3%, 91.67% and 88.3% was seen, respectively. For lateral meniscal tears, our study resulted in 05 true positives, 45 true negatives, 06 false positives and 04 false negatives with sensitivity, specificity and accuracy of 55.5%, 88.23%, and 88.33%, respectively. The results were concordant with the study conducted by Singh B *et al.*³² which had sensitivity, specificity and accuracy of 83.8%, 89.4% and 86% for medial meniscal tears and 40%, 91% and 78.3% for lateral meniscal tears, respectively. However, we were not able to identify types of meniscal tears on ultrasound. On MRI evaluation, types of tears were easily found. Out of 25 meniscal tears, 17 (68%) were horizontal type, 05 (20%) were bucket handle type and 03 (12%) were flap type tears. The morphology of tear was also seen easily on arthroscopy.

Table 8: Diagnostic accuracy of ultrasound in present study in comparison with other studies in detecting knee injuries.

Studies	ACL	PCL	MCL	LCL	MM	LM	Effusion
Abdel El Monem et al.	83	90	—	—	73	86	—
Singh B et al.	90	92	96	96	96	94	100
Singh A et al.	73.3	83.3	96.5	95	95	86.6	—
Present study.	91.6	83.3	93.3	95	95	88.3	100



Figure 2: Medial meniscal tear. (A) USG image depicts hypoechoic cleft within medial meniscus. (B) PD/SPAIR sagittal image depicts hyperintense signal in PHMM. (C) Horizontal MMT seen on arthroscopy.

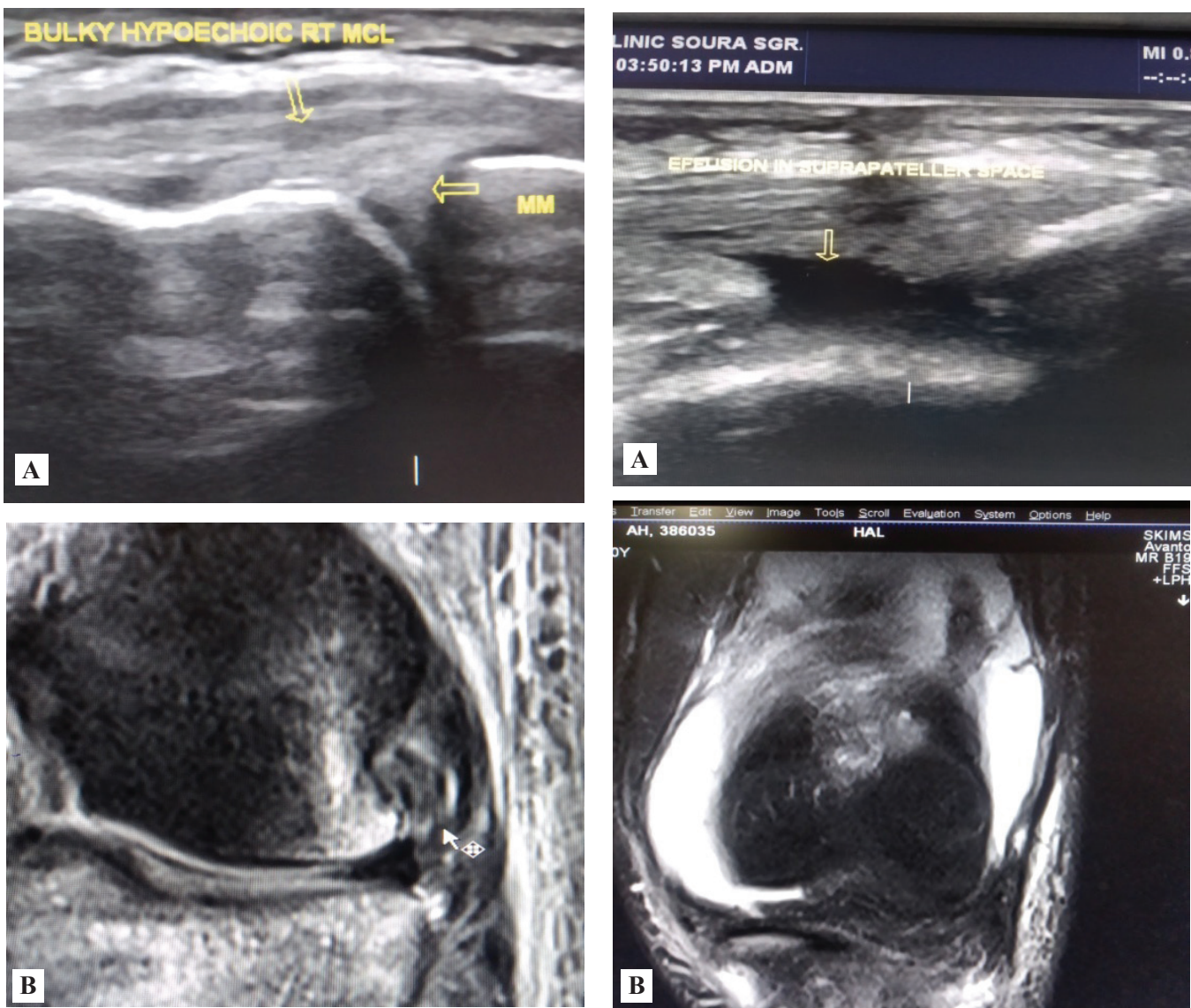


Figure 3: Medial collateral ligament sprain. (A) USG image depicts bulky hypoechoic MCL. (B) MRI depicts high signal intensity of MCL on PD/SPAIR coronal image.

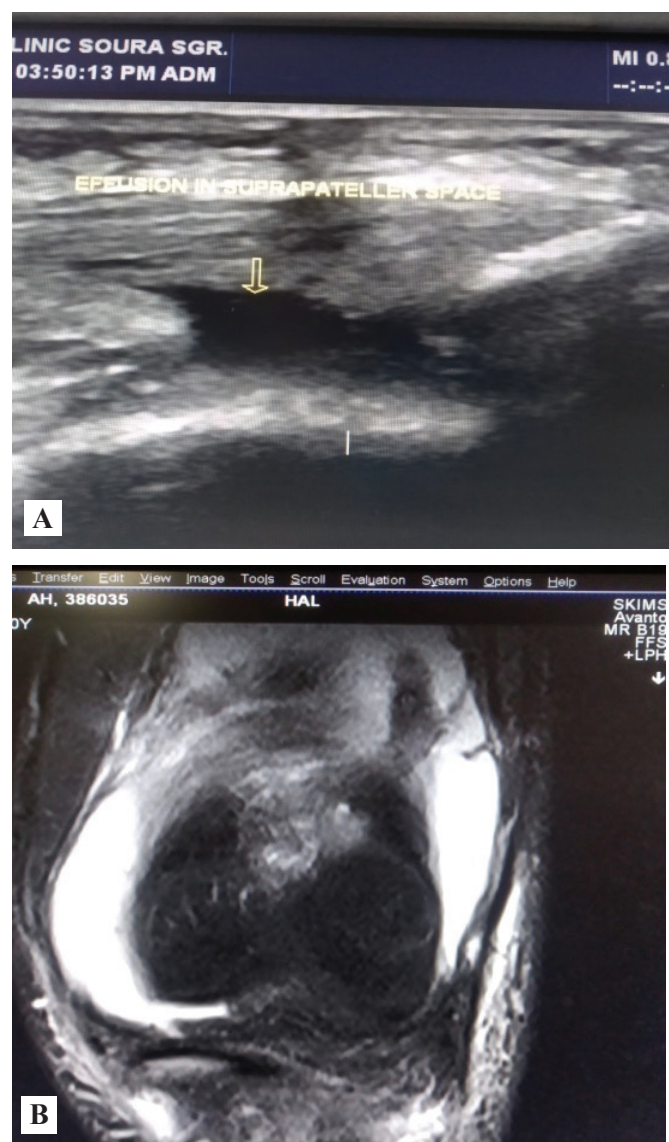


Figure 4: (A) USG image shows mild to moderate fluid accumulation in suprapatellar joint space. (B) PD/SPAIR coronal image shows moderate knee joint effusion.

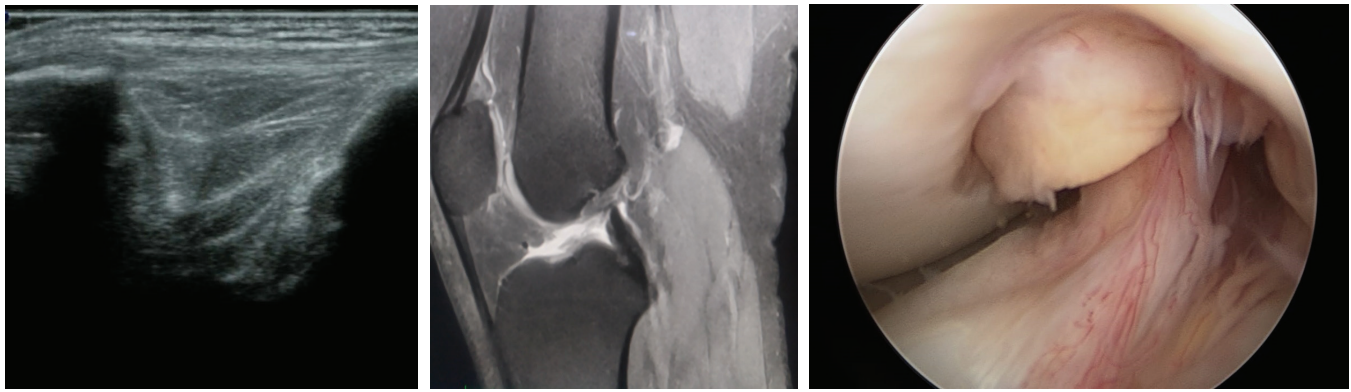


Figure 5: ACL tear. (A) On USG. (B) PD/SPAIR image showing near total tear of ACL. (C) Partial ACL tear on Arthroscopy.

In our study, the sensitivity, specificity and accuracy of ultrasound for detection of MCL injury was 78.9%, 100%, and 93.3% and for LCL injury was 70%, 100%, and 95%, respectively. The results were nearly similar to the study conducted by Singh A *et al.*³³ that revealed sensitivity, specificity and accuracy of 84.6%, 100%, and 96.6% for MCL injury and 84.6%, 97.8%, and 95% for LCL injury, respectively. So, for collateral ligament injuries, ultrasound is a specific, and accurate investigation.

CONCLUSION

Knee injuries are commonly seen in young age with maximum number of patients in the age group of 21–40 years. Most common cause of knee injuries is sports related trauma followed by road traffic accidents. It has been observed that Knee injuries show a definite male preponderance with male to female ratio of approximately, 5:1. Right knee was involved more frequently than left knee. Most frequent finding in knee injuries in our study was joint effusion. Medial meniscal tear was most common injury seen in this study.

Based on our results, it can be concluded that USG is an effective imaging modality that has positive effect on the management of many patients presenting with knee injuries. Knee USG has high accuracy in diagnosing menisco-ligamentous injuries. A wide availability, lower cost and fair reliability make it a modality of first choice for evaluation of knee injuries. MRI can be reserved for patients with suspicious USG results.

Ethical standards: There were no ethical issues

Informed Consent: Consent was taken from all the participants.

Acknowledgement: We express our sincere gratitude to all the participants

Data Availability Statement: yes

REFERENCES

1. Kapur S, Wissman RD, Robertson M *et al.* Acute knee dislocation: revive of an elusive entity. *Curr Probl Diagn Radiol.* 2009;38(6):237-50.
2. Jon A Jacobson: *Fundamentals of musculoskeletal ultrasound-2nd ed.* ISBN 978-1-4557-3818-2. P212-215.
3. Friedl W, Glaser F (1991). Dynamic sonography in the diagnosis of ligament and meniscal injuries of knee. *Arch Orthop Trauma Surg* 1991;110:132-8.
4. Casser HR, Sohn C, Kiekenbeck A *et al.* Current evaluation of sonography of the meniscus. Results of a comparative study of sonographic and arthroscopic findings. *Arch Orthop Trauma Surg* 1990;109:150-4.
5. Yu Tw, Wang TG, Sheih JY *et al.* Diagnosis of meniscal lesion of knee by high resolution ultrasound. *J Rehab Med Assoc ROC* 1999;27:57-62.
6. Wang TG, Wang CL, Hsu TC *et al.* sonographic evaluation of posterior cruciate ligament in amputated specimens and normal subjects. *J Ultrasound Med* 1999;18:647-53.
7. Hsu CC and Tsai WC. Ultrasound examination of normal and injured cruciate ligament. *J Clin Ultrasound* 2005;33:277-82.
8. Cho KH, Lee DC, Chemm RK *et al.* normal and acutely torn posterior cruciate ligament of knee at US evaluation: preliminary experience. *Radiology* 2001;219:375-80.
9. Ptasznik R, Feller J, Barlett J *et al.* The value of sonography in the diagnosis of traumatic rupture of

- anterior cruciate ligament of the knee. *AJR Am J Roentgenol* 1995;164:1461-3.
10. Maffauli N, Binfield PM, King JB et al. Acute haemarthrosis of the Knee in athletes. A prospective study of 106 cases. *J Bone Joint Surg Br* 1993; 75:945-9.
11. Friedl W, Glaser F. Dynamic sonography in the diagnosis of ligament and meniscal injuries of the knee. *Arch Orthop Trauma Surg* 1991;110:132-8.
12. Chylarecki C, Hierholzer G, Klose R et al. Ultrasound diagnosis of Acute rupture of anterior cruciate ligament. A clinical and Experimental study. *Unfallchirurg* 1996;99:24-30.
13. Friedman I, Finlay F, Jurrains E et al. Ultrasound of the knee. *Skeletal Radiol* 2001;30:361-77.
14. Strome GM, Bouffard JA, Holsbeeck M et al. *Knee Clin Diagn Ultrasound* 1995;30:201 -19.
15. Friedl W, Glaser F. Dynamic sonography in the diagnosis of Ligament and meniscal injuries of knee. *Arch Orthop Trauma Surg* 1991;110:132-8.
16. Strome GM, Bouffard JA, Holsbeeck M et al. *Knee Clin Diagn Ultrasound* 1995;30:201 -19.
17. Amandeep S, Indermeet M, Thukral CL et al. Diagnostic accuracy of USG in Evaluation of knee injuries with MRI correlation. *IJARS* 2018 jan, vol-7(1):RO50-RO55.
18. Khan Z, Faruqui Z, Rosset G et al. Ultrasound assessment of internal derangement of knee. *Acta Orthop Belg* 2006;72(1):72-6.
19. Shanbhogue AK, Sandhu MS, Singh P et al. Real time spatial ultrasound in the evaluation of meniscal injuries. *Knee* 2009;16(3):191-95.
20. Friedman I, Finlay K, Jurrains E et al. Sonographic findings in patient with anterior knee pain. *J Clin Ultrasound* 2003;31(2):85- 97.
21. USG of the knee. *RSNA* 2016.
22. Suzuki S, Kasahara K, Futami T et al. Ultrasound diagnosis of pathology of anterior and posterior cruciate ligaments of knee joint. *Arch Orthop Trauma Surg* 110,200-203(1991).
23. Tomasella G, Turra S, Soliman A et al. Ultrasonography in the study of lesions of menisci and the cruciate ligaments of the knee. Finding in 48 surgically treated patients. *La Radiologia Medica* (1991), 81(6):822-826.
24. Friedl W, Glaser F. Dynamic sonography in the diagnosis of Ligament and meniscal injuries of knee. *Arch Orthop Trauma Surg* 1991;110:132-8.
25. Ritzmann C, Weyand F. The value of sonographic diagnosis of the injured knee joint in trauma-surgical practice. *Unfallchirurg* 1997;100:280-5.
26. Ptasznik R, Feller J, Bartlett J et al. The value of sonography in the diagnosis of traumatic rupture of the anterior cruciate ligament of the knee. *AJR Am J Roentgenol* 1995, 164(6):1461-3.
27. Skovgaard Larsen LP, Rasmussen OS. Diagnosis of acute rupture of anterior cruciate ligament of the knee by sonography. *Eur J Ultrasound* 2000,12(2):163-7.
28. Chung YW, Hsing KW, Chao YH et al. Role of sonographic examination in traumatic Internal knee derangement. *Arch Phys Med Rehabil* vol.88, aug 2007.
29. Monem SAE, Enaba MM. Comparative study between HRUS and MRI in the diagnosis of meniscal and cruciate ligament injury of the knee. *Med J Cairo Univ (Internet)*, 233-242, 2012.
30. Ivanoski, Ohrid/MK(2013): Ultrasound evaluation of the most common knee pathology. 10.1594/ecr2013/C-2255.
31. Nasir A I. The role of magnetic resonance imaging in the knee joint injuries. *Int. Res. J. Medical Sci.*, 1(5):1-7.
32. Bhanupriya S, Khushal N, Suhas SG et al. Evaluation of knee joint by USG And MRI. *IOSR-JDMS* 2016; vol 15, issue 10, PP 122-131.
33. Amandeep S, Indermeet M, Thukral CL et al. Diagnostic accuracy of USG in Evaluation of knee injuries with MRI correlation. *IJARS* 2018 jan, vol-7(1):RO50-RO55.