American Journal of Medicine and Medical Sciences 2025, 15(5): 1603-1605
DOI: 10.5923/j.ajmms.20251505.65

The Role of Ultrasound Diagnostics in the Rehabilitation of Complications of Injuries to the Internal Structures of the Knee Joint

Umarova Nargiza[1], Khamidov Obid[2]

[1]Samarkand State Medical University, Samarkand, Uzbekistan
[2]Research Institute of Rehabilitology and Sports Medicine of Samarkand State Medical University, Samarkand, Uzbekistan

Abstract Knee joint injuries, particularly involving internal structures such as the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), menisci, and synovium, represent a major source of functional impairment and long-term disability. The increasing burden of knee trauma in both athletic and aging populations necessitates precise and ongoing assessment during rehabilitation. While MRI remains the gold standard for initial imaging, it is often inaccessible, expensive, or unsuitable for serial evaluations. Ultrasound diagnostics (US) have emerged as a vital, cost-effective, and dynamic alternative. This article evaluates the clinical utility, diagnostic accuracy, and prognostic significance of ultrasound in monitoring complications and guiding therapeutic strategies during the rehabilitation of knee injuries. Based on a prospective study of 60 patients, we demonstrate that ultrasound offers high sensitivity and specificity in detecting joint effusion, synovitis, ligament laxity, scar formation, and cartilage pathology, proving indispensable in functional rehabilitation planning.

Keywords Knee joint, Ultrasound, Rehabilitation, ACL, PCL, Meniscus, Synovitis, Musculoskeletal imaging, Dynamic ultrasonography

1. Introduction

The knee joint is one of the most biomechanically complex and frequently injured joints in the human body. Injuries to its internal structures — notably the cruciate ligaments, menisci, articular cartilage, and synovium — can significantly impair mobility, stability, and quality of life. Timely and accurate diagnosis followed by a structured rehabilitation protocol is essential to prevent chronic instability, osteoarthritis, and functional decline [1].

Traditionally, MRI has been considered the imaging modality of choice for evaluating intra-articular knee injuries due to its excellent soft tissue contrast. However, limitations in availability, cost, contraindications (e.g., pacemakers, claustrophobia), and inability to provide real-time dynamic assessment make it suboptimal for serial follow-ups [2,3].

Ultrasound, once limited to superficial structures, now plays an expanding role in musculoskeletal diagnostics. High-resolution linear probes, advanced Doppler modalities, and portable devices allow dynamic evaluation of joint structures, real-time visualization of movement, and rapid detection of inflammatory and mechanical complications. This study explores the integrative role of US in guiding rehabilitation strategies, optimizing patient outcomes, and reducing healthcare burden [5].

Received: May 5, 2025; Accepted: May 26, 2025; Published: May 30, 2025
Published online at http://journal.sapub.org/ajmms

2. Materials and Methods

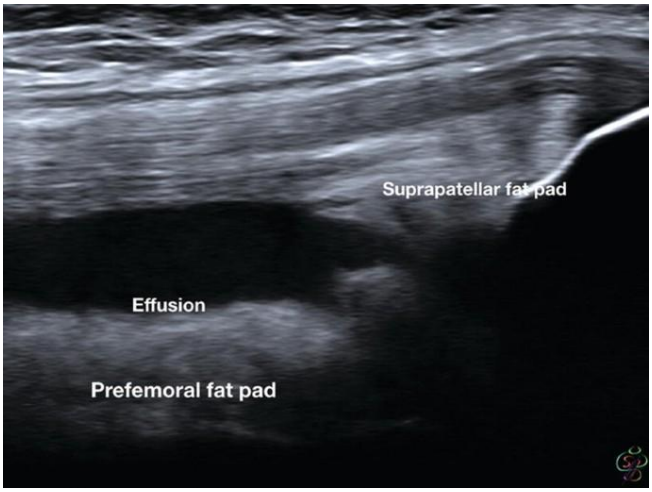

Figure 1. High-resolution ultrasound image of suprapatellar joint effusion

Study Design and Population: We conducted a prospective observational study at a tertiary rehabilitation center between

January 2024 and March 2025. Sixty patients aged 18–50 years (mean age 31.4 ± 6.9) with diagnosed internal knee injuries were included. Of these, 35 were male and 25 female. Inclusion required confirmed acute or subacute injury to the ACL, PCL, meniscus, or synovium. Patients with previous surgery, inflammatory arthritis, or systemic connective tissue disorders were excluded.

Imaging Protocol: Ultrasound was performed using a GE Logiq E9 and Mindray TE7 with 7.5–12 MHz linear transducers. Examination was conducted in both static and dynamic modes, including B-mode, Color Doppler (CD), and Power Doppler (PD). Elastography was applied in select cases to assess fibrotic or degenerative changes.

The following structures and findings were evaluated:

Ligaments (ACL, PCL): continuity, echogenicity, fiber retraction (fig 2.)

Menisci: bulging, intrasubstance degeneration, extrusion

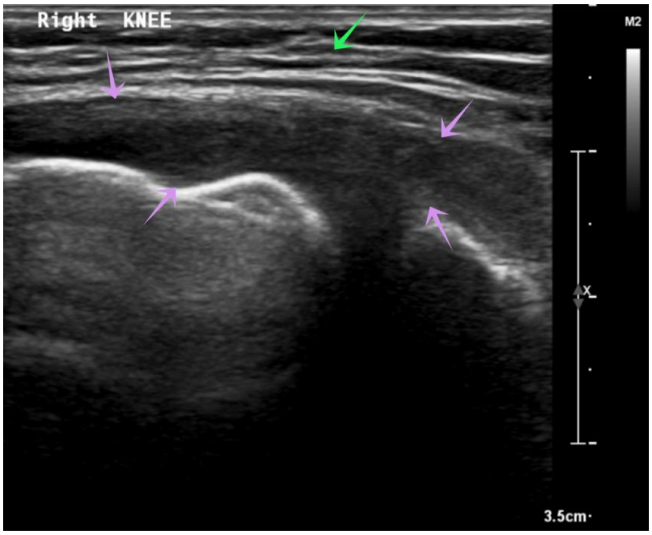

Figure 2. Dynamic US image of ACL under anterior drawer stress test

Cartilage surfaces: thickness, irregularities

Synovium: hypertrophy, Doppler signal intensity (fig 3.)

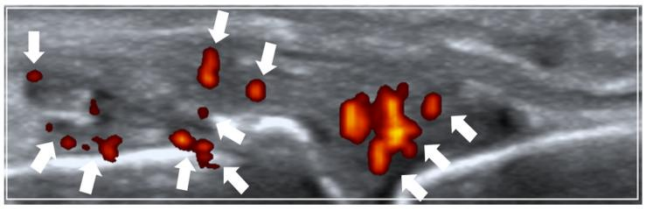

Figure 3. Power Doppler image indicating active synovitis in medial recess

Effusion and Baker's cysts: size and compressibility

Muscle-tendon units: atrophy, strain, retraction

Rehabilitation Monitoring Protocol: US was conducted at three time points: initial (baseline), 6 weeks, and 3 months. Functional progress was tracked using the Lysholm Knee Score, Tegner Activity Level, and manual muscle testing. Rehabilitation regimens were adjusted based on sonographic findings (e.g., persistent effusion, ligament insufficiency fig 4.).

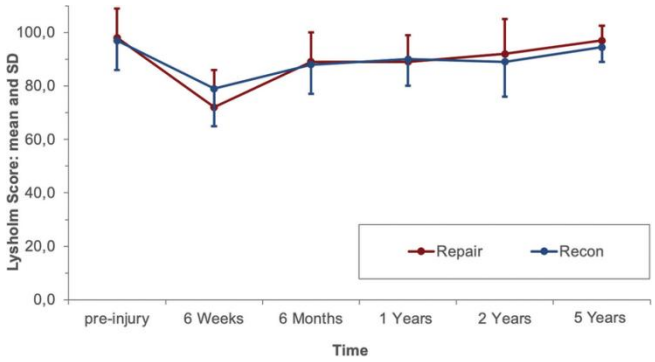

Figure 4. Graph of Lysholm score progression in US-monitored vs control patients

Reference Imaging and Statistics: Baseline MRI served as the gold standard for diagnostic comparison. Sensitivity, specificity, positive and negative predictive values were computed (fig 5.). Interobserver reliability for US interpretation was calculated using Cohen's kappa. Descriptive and inferential statistics were analyzed using SPSS v27 [7,8].

3. Results

Injury Distribution and Baseline Characteristics:

ACL injuries: 42% (n = 25)

Medial meniscus tears: 33% (n = 20)

PCL injuries: 10% (n = 6)

Synovitis and joint effusion: 25% (n = 15)

Table 1. Ultrasound Performance Compared to MRI

Lesion Type	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
ACL tear	89	94	91	92
Meniscal tear	81	87	84	85
Synovitis	92	90	88	94
Effusion	96	100	100	95
Cartilage defects	78	82	79	83

Dynamic Findings: Real-time dynamic evaluation revealed:

Ligamentous insufficiency under valgus/varus stress

Meniscal extrusion during joint flexion

Muscle contraction irregularities

Synovial thickness changes with motion

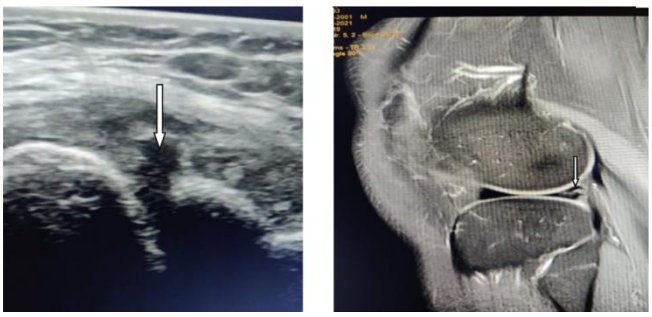

Figure 5. Comparative schematic of MRI and US workflows in knee injury rehab

Functional Outcomes: Patients monitored with US showed greater functional gains:

Lysholm score increased by a mean of 24 points in the US group vs 17 in the control group [3,5].

82% of patients with US-guided therapy returned to full activity within 4 months vs 64% without US monitoring.

Therapy modifications based on sonographic findings were made in 36% of cases (e.g., drainage of effusion, delayed weight-bearing).

4. Discussion

This study demonstrates that ultrasound plays a crucial role not only in diagnosing knee joint pathology but also in dynamically guiding rehabilitation. By providing immediate feedback on joint status, US enables tailored interventions such as targeted physical therapy, anti-inflammatory treatments, or guided injections.

Ultrasound is particularly advantageous in the following contexts: Post-operative surveillance: Detecting complications like hematomas or poor graft incorporation

Sports rehab: Real-time assessment of tendon recoil, effusion, muscle reactivation

Elderly rehab: Identifying degenerative synovitis and chondropathy non-invasively

These capabilities place US as a central tool in patient-specific rehabilitation planning. Furthermore, Doppler imaging allows objective monitoring of synovial inflammation and vascular activity, which correlates with disease activity in chronic or recurrent injuries.

Comparative Advantages Over MRI:

- Portable and bedside accessible
- Immediate and repeatable
- Safe for patients with contraindications to MRI
- Real-time dynamic assessment (impossible with MRI)

Limitations: Despite its strengths, musculoskeletal ultrasound is operator-dependent and subject to variable interpretation. Some posterior structures, like the posterior horn of the medial meniscus or deep intercondylar notch, remain difficult to visualize clearly. Standardized scoring systems for rehabilitation assessment remain under development [6,8].

5. Conclusions

Ultrasound is an essential modality in the rehabilitation of knee joint injuries. It enables the detection of subtle and evolving complications, facilitates dynamic and repeated assessment, and enhances patient outcomes through customized rehabilitation pathways. Its cost-effectiveness, safety profile, and accessibility make it an indispensable complement to MRI, especially in low-resource or outpatient settings. Integration into standardized rehab protocols is strongly recommended.

REFERENCES

[1] Klauser AS, et al. Musculoskeletal ultrasound beyond the joints: Tenosynovitis, bursitis, and muscle injuries. Radiol Clin North Am. 2019.

[2] Martinoli C. Musculoskeletal ultrasound: technical guidelines. Insights Imaging. 2017.

[3] Rehorn MR, et al. Role of ultrasound in sports-related knee injuries. Am J Sports Med. 2020.

[4] Zaidman CM, et al. US in evaluation of muscle and peripheral nerve disorders. JAMA. 2018.

[5] European Society of Musculoskeletal Radiology (ESSR) Guidelines, 2023.

[6] Albrecht T. Power Doppler sonography: clinical applications. Eur Radiol. 2022.

[7] Tscholl PM, et al. Ultrasound vs MRI in post-ACL reconstruction follow-up. Knee Surg Sports Traumatol Arthrosc. 2021.

[8] Bianchi S, Martinoli C. Ultrasound of the Musculoskeletal System. Springer; 2020.