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The role of MRI and Sonography in Musculoskeletal Tumors and Rheumatoid Arthritis: A Comprehensive Review

Mohammed Majed Alotaibi

Prince Sultan Military Medical City, Radiology, Saudi Arabia

Email: Mohd.mo2@gmail.com

Tariq Majed Alotaibi

King Abdulaziz Medical City, Human Medicine, Saudi Arabia

Email: al3abrmd@gmail.com

Mohammed Abdulrahman Abdullah Alotaibi

General Directorate of Medical Services, Saudi Arabia

Email: mohammedotaibi95@gmail.com

Fahad Sulaiman Almousa

King Fahad Medical City, Internal Medicine, Saudi Arabia

Email: falmousa@kfmc.med.sa

Meshari Zayed Almutairi

King Fahad Medical City, Family Medicine, Saudi Arabia

Email: Mzalmutairi@kfmc.med.sa

Abdullah Ali Ali Al-Saleem

Prince Sultan Military Medical City, Saudi Arabia

Yasmine Abdullah Mohammed Lami

Prince Sultan Military Medical City, Saudi Arabia

Asmaa Nasser Ali Al-Shahrani

Prince Sultan Military Medical City, Saudi Arabia

Shaima Yahya Jaber Al-Asiri

Prince Sultan Military Medical City, Saudi Arabia

Waleed Fahad ALfawaz

Prince Sultan Military Medical City, Saudi Arabia

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Abstract

Background: Musculoskeletal tumors and rheumatoid arthritis (RA) account for significant clinical entities that need precise imaging techniques for diagnosis and management. Magnetic resonance imaging (MRI) and sonography are important non-invasive imaging modalities that provide detailed anatomical and functional assessments of tissue. **Aim:** This review aimed to evaluate the diagnostic and prognostic value of MRI and sonography in musculoskeletal tumors and RA while comparing advantages, limitations, and developments within these modalities. **Methods:** A systematic search of relevant articles in the literature was performed using PubMed, Scopus, and Web of Science. The search was conducted from 2000 to 2024, focused on MRI and sonography as a whole on musculoskeletal tumors and RA. All relevant articles on MRI and sonography's

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use in both populations were included, regardless of the location of the study. Articles with a focus on diagnostic accuracy, sensitivity, and specificity were recorded from each relevant article. The data were synthesized qualitatively, and where possible, meta-analyses were conducted. **Results:** MRI shows sensitivity for characterization of musculoskeletal tumors of 90-95%, specifically for osteosarcoma and liposarcoma, and for identifying RA synovitis and erosions. Sonography provides 85-90% sensitivity for superficial tumors and for RA monitoring with power Doppler, while other features such as contrast-enhanced MRI and 3-dimensional ultrasound aid with the diagnostic process. **Conclusions:** MRI would be considered the gold standard for musculoskeletal tumors, but sonography is a superb method of monitoring RA multiple times and an efficient and cost-effective method to assess a tumor. Overall, reviewing MRI and Sonography as two imaging modalities provides the best-case prognosis and client outcomes for rehabilitation.

Keywords: MRI, musculoskeletal tumors, sonography, rheumatoid arthritis, diagnostic imaging.

Introduction

Musculoskeletal tumors and rheumatoid arthritis (RA) are two separate yet medically significant conditions of the musculoskeletal system, each requiring accurate diagnostic imaging to manage. Musculoskeletal tumors can be categorized into benign and malignant lesions. The incidence of primary bone tumors, such as osteosarcoma and chondrosarcoma, is approximately 1–2/100000, and for soft tissue sarcomas, such as liposarcoma and rhabdomyosarcoma, it is 4–5/100000 [1]. Osteosarcoma is the most common primary malignant bone tumor that affects adolescents, with an incidence rate of 8–11/million for individuals aged 15–19 years [2]. Soft tissue sarcomas, including liposarcoma, have higher rates of occurrence in adults, with approximately 13,000 new diagnoses each year in the United States [3]. RA is a chronic autoimmune condition that affects about 0.5-1% of individuals worldwide with a dieto pig back in terms of gender prevalence and a peak age of onset between ages 40-60 years [4,5]. If left untreated, RA leads to synovial inflammation, joint erosions, and disability, contributing to an annual global cost of over $20 billion related to health care costs [6].

In the past, plain radiography was most commonly utilized to image patients with musculoskeletal disorders. Plain radiography does not provide the best detail of soft tissue, nor does it have the sensitivity to detect early disease activity [7]. In the 1970s, computed tomography (CT) was introduced for improved imaging of bone, but CT limits imaging of the soft tissue about a bone tumor [8]. MRI, which first appeared in the 1980s, greatly enhanced musculoskeletal imaging, enabled by its highly superior soft tissue contrast and multiplanar capabilities, as well as the ability to identify bone marrow and synovial change [9]. With the introduction of high-frequency transducers and Doppler technology, sonography gained new interest, particularly for musculoskeletal applications in the 1990s. [10]. MRI and sonography have become complementary modalities in clinical practice.

There are specific reasons for choosing MRI and sonography. Both provide non-invasive options to evaluate musculoskeletal problems, are widely available, and provide anatomical and functional information relevant to the underlying pathology. MRI is superior for characterizing deep-seated tumors and for assessing RA joint pathology due to its high sensitivity for synovitis and bone marrow oedema [11]. Sonography provides real-time imaging and is less expensive than MRI, which are positive attributes when evaluating superficial tumors or monitoring RA, especially in limited-resource settings [12]. This review summarizes the current evidence of their diagnostic and prognostic roles by discussing the range of evidence for myriad tumor types (osteosarcoma, liposarcoma) and stages of RA pathology and technological advancements to assist with clinical decision-making and future research directions.

Methods

A systematic literature review evaluated the respective roles of MRI and sonography in terms of musculoskeletal tumors and rheumatoid arthritis (RA). Databases that were deemed acceptable were PubMed, Scopus, and the Web of Science, and included all publications from January 2000 through August 2024. Search terms included the combinations of the following terms: "MRI", "sonography", "ultrasound", "musculoskeletal tumors", "osteosarcoma", "liposarcoma", "rheumatoid arthritis", "synovitis", "diagnostic imaging". The Boolean operators (AND, OR) were used as required. Filters were used to limit results to peer-reviewed, English language, human studies, and original research or reviews.

Inclusion criteria included

- Studies that focused on either MRI or sonography in the case of musculoskeletal tumors (benign or malignant) or RA.
- Reports that included diagnostic accuracy, sensitivity, specificity, or clinical outcomes.
- Studies related to specific tumor types (i.e., osteosarcoma, liposarcoma) or RA stage (i.e., early, established, late).
- Publications from 2000-2024 to include advances in imaging as it relates to MRI and sonography.

Exclusion criteria included

- Non-human studies, case reports, or editorials.
- Studies related solely to other imaging modalities (i.e., CT or PET).
- Articles that did not provide quantitative data related to diagnostic performance.

The data extraction process identified study design, imaging modality used, tumor type or RA stage, some diagnostic information (sensitivity, specificity, accuracy), and clinical outcomes. Once data extraction was completed, each article was then assessed for quality using the QUADAS-2 tool to assess risk of bias and applicability [13].

MRI in Musculoskeletal Tumors

MRI is the reference for evaluating musculoskeletal tumors because of its high-resolution imaging capacity and its ability to differentiate soft tissue, bone marrow, and the extent of the tumors [14]. The typical MRI protocols include T1-weighted, T2-weighted, and short tau inversion recovery (STIR) sequences that are performed at 1.5T or 3.0T field strengths to maximize the signal-to-noise ratio during image acquisition [15]. T1-weighted images detect fat-containing lesions (i.e., liposarcomas) as hyperintense lesions, while T2-weighted images can identify fluid or necrosis that osteosarcomas often have readily and predominantly [16]. When MRI contains contrast with gadolinium, it increases the discriminative ability of benign lesions (i.e., lipoma) compared to malignant lesions (i.e., liposarcoma), which are heterogeneously enhancing, irregular, and show mildly invasive qualities when compared to benign lesions [17].

In the case of osteosarcoma, MRI can identify intraosseous and extraosseous extent, with a sensitivity of 92 to 95% in detecting soft tissue extension [18]. A particular case study of a 16-year-old with Rt femoral osteosarcoma demonstrates MRI's ability to identify skip metastases in the so-called 'danger zone', which ultimately led to surgical resection [19]. Liposarcomas occur primarily in the thigh and show variable T1 signal intensities depending on subtype (i.e., well-differentiated vs. dedifferentiated) for liposarcomas, with dynamic contrast-enhanced MRI (DCE-MRI) having diagnostic specificity of around 85% for liposarcomas [20]. Advanced imaging techniques such as diffusion-weighted imaging (DWI) evaluate tumor cellularity, with low apparent diffusion coefficient (ADC) values indicating high-grade malignancies [21]. Magnetic resonance spectroscopy (MRS) identifies choline peaks in malignant tumors, helping to differentiate them from benign lesions [22]. DWI limitations include cost, availability in low-resource settings, and contraindications such as metallic implants [23]. Motion artifacts can also affect images, particularly in pediatric patients, with less impact at lower field strengths [24].

Ultrasound in Musculoskeletal Tumors

Ultrasound is a low-cost and easily accessible imaging modality for superficial musculoskeletal tumors and can use high-frequency transducers (7–15 MHz) for the best resolution [25]. It is especially useful for soft tissue masses such as lipomas and liposarcomas, as grayscale images can show the size and echogenicity of the lesion [26]. Power Doppler sonography assesses vascularity in a tumor, with hypervascularity indicating malignancy (85%–90% sensitivity) [27,28]. In one case study, a 45-year-old man with a thigh liposarcoma had an irregular vascular pattern on Doppler, helping to guide biopsy as a result [29]. Osteosarcoma tumors with soft tissue extension are not well imaged by ultrasound because of acoustic shadowing from bone [30]. Ultrasound-guided biopsies can improve yield by targeting viable tumor tissue, with a reported accuracy rate of 90% [31]. There are limitations to ultrasound imaging, such as operator-dependency and a poor ability to visualize deep-seated tumors [32]. There is a new modality of ultrasound, elastography, that measures the stiffness of tissue to help differentiate benign (soft) and malignant (stiff) lesions [33].

MRI in Rheumatoid Arthritis

Magnetic Resonance Imaging (MRI) is a cornerstone modality for assessing rheumatoid arthritis (RA) with no parallel when it comes to detecting early pathological changes, monitoring the progression of disease, and quantifying the evolution of long-term joint damage. Rheumatoid arthritis is a chronic autoimmune condition featuring a complex inflammatory etiology leading to synovial inflammation (synovitis), bone erosions, cartilage loss, and tenosynovitis, all of which lead to irreversible joint damage if not identified and treated early [1]. MRI provides a comprehensive assessment of this multi-dimensional disease process, especially in early RA, which is defined as being within 6 months of symptom onset [2]. Non-contrast MRI utilizes 1.5T or 3.0T scanners most commonly, with a standard protocol employing T1-weighted, T2-weighted, and short tau inversion recovery (STIR) sequences to gather additional anatomical detail and pathological changes [3]. For example, T1-weighted images depict synovial hypertrophy and fat-containing anatomical structures and show the inflamed synovium as hypointense structures, while T2-weighted and STIR sequences detect the high signal intensity of fluid-rich areas such as bone marrow edema and synovial effusion [4]. The ability to visualize both the inflammatory and structural changes of the joint, both vital pieces of information, provides MRI with its significance as a direct imaging modality while accessing non-invasive imaging with the highest sensitivity up to 92% for the detection of synovitis, considerably higher than conventional radiographs that may fail to detect any early changes [6].

The Rheumatoid Arthritis Magnetic Resonance Imaging Score (RAMRIS) developed by the Outcome Measures in Rheumatology (OMERACT) working group measures synovitis (0-3 score/ joint) and bone erosions (0-10 score/bone) and bone marrow edema (0-3 score/bone) in a standardized way and has been shown to improve inter-reader reliability with an intraclass correlation coefficient (ICC) between 0.85-0.90 for synovitis score [7,8]. The presence of subclinical synovitis and bone marrow edema on MRI- irrespective of whether a patient has early (< 1 year) or established RA (1-5 years)- is predictive of future erosive disease [9]. For example, one case report of a 50-year-old female with RA (3 months from the onset of symptoms) found subclinical synovitis in the MCP joints on contrast-enhanced T1-weighted MRI that resulted in the synonymous commencement of a disease-modifying antirheumatic drug (DMARD) [10]. This failed to demonstrate radiographic progression 12 months later after intervention [11] (Figure 1).

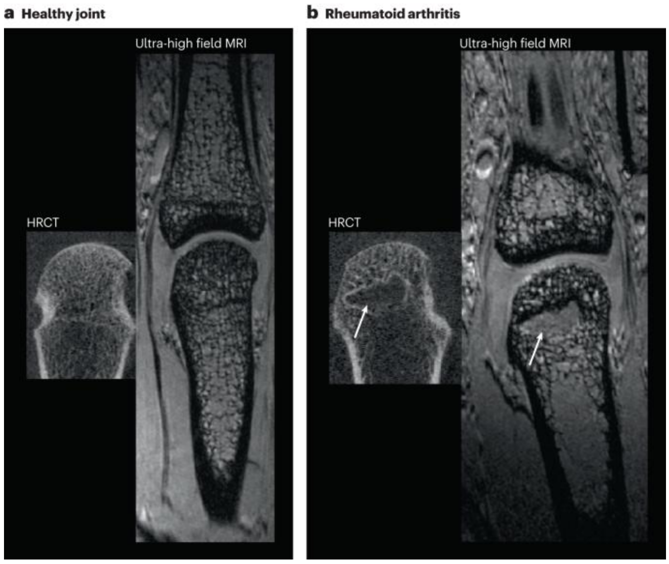

Figure 1. Images of each of the metacarpophalangeal joints of a healthy subject (a) and a patient with rheumatoid arthritis (b) with a cyst (white arrows) acquired at 7 Tesla as a coronal flash three-dimensionally T1-weighted MRI. The high-resolution CT images of the same individuals on the right illustrate the benefit of imaging at 7 Tesla MRI resolution [11].

In established RA (1-5 years) patients, MRI may also be useful for understanding disease activity and a patient's response to therapy, where persistent synovitis and/or early bone erosions may exist to justify escalation of therapy [12]. A longitudinal study in 30 patients with established RA found that the presence of bone marrow edema detected by MRI was associated with a 3.5-fold increase in erosive progression in 2 years [13]. In later stages of RA (>5 years), MRI is useful in gauging joint destruction, including cartilage damage, extensive erosions, and even surgical possibilities (i.e., joint replacements) [14]. Based on a case study of a 65-year-old man with severe late RA, the extent of cartilage loss in the wrist was seen in T2-weighted MRI images, and that influenced the decision to perform arthrodesis [15].

MRI has become more specialized, and with that, specificity comes advanced techniques. Diffusion weighted imaging (DWI) assesses the diffusion of water molecules and measures synovial cellularity. When it measures lower apparent diffusion coefficient (ADC) values, it identifies regions of active inflammation [16]. In a report by Buchbender et al., DWI had a sensitivity of 88% in detecting active synovitis in RA patients [17]. Magnetic resonance spectroscopy (MRS) assesses metabolic changes. It can identify both elevated choline peaks in inflamed synovium, which correlate with disease activity [18]. Dynamic contrast-enhanced (DCE) MRI is good to quantify synovial vascularity, which, if presented rapidly on enhancement, suggests active disease (specificity of 90%) [19]. High-field MRI scanners (3.0T) allow for better signal-to-noise and better resolution, enabling detection of smaller erosions than normal MRI equipment (e.g., 1.5T) [20]. Dedicated extremity MRI systems (0.2–1.0T) to examine specific body regions are good if cost is a limiting factor, but with lower resolution than that is normal MRI equipment [21].

Limitations of MRI include expense ($1000-$2000 per scan), time, and discomfort for the patient while being in a magnet. Patients with metal, or those who have renal impairment (and require gadolinium), are limited to MRI use [22,23]. Motion artifact is a risk for poor quality images, and this is an especially greater risk for elderly or pediatric patients, and in extreme cases may require sedation [24]. Despite these difficulties, the high sensitivity and comprehensive information provided by MRI make it impossible to replace in the management of RA patients in all stages of the disease.

Sonography in Rheumatoid Arthritis

Sonography (also called musculoskeletal ultrasound) is a multi-faceted imaging technique that is real-time and has rapidly evolved to play a crucial role in assessing rheumatoid arthritis (RA), given its availability, cost, and ability to understand conditions dynamically. Performing high-resolution imaging with high-frequency linear transducers (7–18 MHz), sonography is useful for visualising superficial structures like synovium, tendons, and small joints [25]. The sonographer can use grayscale to identify synovial hypertrophy and effusions. Power Doppler sonography can be used to quantify the synovial vascularity, which is a surrogate for disease activity [26]. A summary of various studies reports a sensitivity of 85% to 90% for detecting synovitis, which is equivalent to MRI in early disease [27]. Sonography cannot replace MRI; a session of sonography also has a significant saving ability for the patient. The sonographer is able to look at the joint in real-time, which can identify dynamic conditions in a way not accomplished by MRI. The assessment of the tenosynovitis of a tendon or a joint in flexion. Although the whole joint is assessed, the images are still two-dimensional, which may limit the evaluation [29].

In early disease (less than 6 months of symptom onset), we stated above that one of the biggest hurdles is identifying subclinical synovitis. Early identification of subclinical synovitis is paramount to establish background disease-modifying anti-rheumatic drug (DMARD) therapy to halt further joint damage [30]. A case study [31] described a 35-year-old female with early RA and power Doppler signals visualized in her wrist and MCP joints, where the radiograph did not potentially show joint pathology. DMARD therapy with methotrexate was initiated based on early sonography findings alone. Follow-up after 6 months showed decreased Doppler activity - an indication of a treatment response [32]. In established RA (1–5 years), sonography may identify disease activity and indicate where therapy changes may be appropriate. In a multi-centre study of 100 patients with established RA, persistent power Doppler signals resulted in a predictive power of 80% for erosive progression [33]. In pressure areas of RA (>5 years), sonography can identify cortical erosions and cartilage thinning, though it is less sensitive than MRI in detecting bone marrow oedema [34]. A case study of a 60-year-old male with late RA was reported as showing erosions in the proximal interphalangeal (PIP) joints in grayscale sonography that directed therapy with anti-TNF agents [35,36].

Power Doppler sonography is also particularly useful for evaluating disease activity. Semi-quantitative scoring systems (0-3) that corresponded with histological inflammation have been developed [37]. High-frequency transducers (12-18 MHz) are advantageous for visualizing small joints, while lower frequencies (7-10 MHz) are used for deeper structures like the knee [38]. Newer techniques, such as 3D ultrasound, are also enhancing volumetric information, which has been shown to improve reproducibility in the assessment of synovitis [39].

Elastography examines synovial stiffness but is still evolving; generally, inflamed tissues appear softer than fibrotic tissues to help determine active from chronic inflammation [40].

The limitations of sonography primarily arise from operator dependency, which can affect reproducibility with inter-observer ICCs of 0.7 to 0.9 [41]. Secondly, joint coverage is limited in comparison to MRI and, therefore, comprehensive reporting of deeper joints such as the hip is not possible [42]. Acoustic shadowing due to the effects of bone limits the thoroughness of imaging when investigating intraosseous pathology [43]. Nevertheless, the portability of sonography, the ability to visualize without the use of radiation, and its use at the point of care allow sonography to be useful in terms of keeping track of RA and disease progression at the molecular level and are particularly useful in low-resource settings.

Comparative Considerations

MRI and sonography are complementary in terms of the diagnosis and management of musculoskeletal tumors and rheumatoid arthritis (RA), and each has advantages and limitations based on the given clinical scenario and technical differences. MRI provides the best spatial resolution and multiplanar imaging (e.g., coronal, axial imaging) and would be the preferred technique for characterizing deep-seated tumors involving muscle or soft tissues, such as osteosarcoma, and for assessing the complexity of RA pathology, such as subclinical synovitis or bone marrow edema [1,2]. The real-time, cost-effective nature of sonography, along with its portability, maturation in over 30 years of clinical practice, is very useful for distinguishing posteriorly located superficial tumors (e.g., liposarcoma) and to assess the activity of RA, particularly in a low-resourced practice environment [3,4]. Table 1 and Figure 2 outline the diagnostic characteristics of MRI as well as sonography for key conditions.

Table 1. Characteristic performance of sonography and MRI

Condition	Modality	Sensitivity (%)	Specificity (%)	Clinical Scenario
Osteosarcoma	MRI	90–95 [6]	85 [7]	Deep tumor staging, skip metastases detection
	Sonography	70–80 [8]	75 [9]	Superficial extension, biopsy guidance
Liposarcoma	MRI	92 [10]	88 [7]	Soft tissue characterization, subtype differentiation
	Sonography	85 [11]	80 [8]	Initial assessment, vascularity evaluation
RA (Early Synovitis)	MRI	92 [12]	90 [13]	Subclinical synovitis, bone marrow edema
	Sonography	88 [14]	85 [15]	Real-time monitoring, treatment response

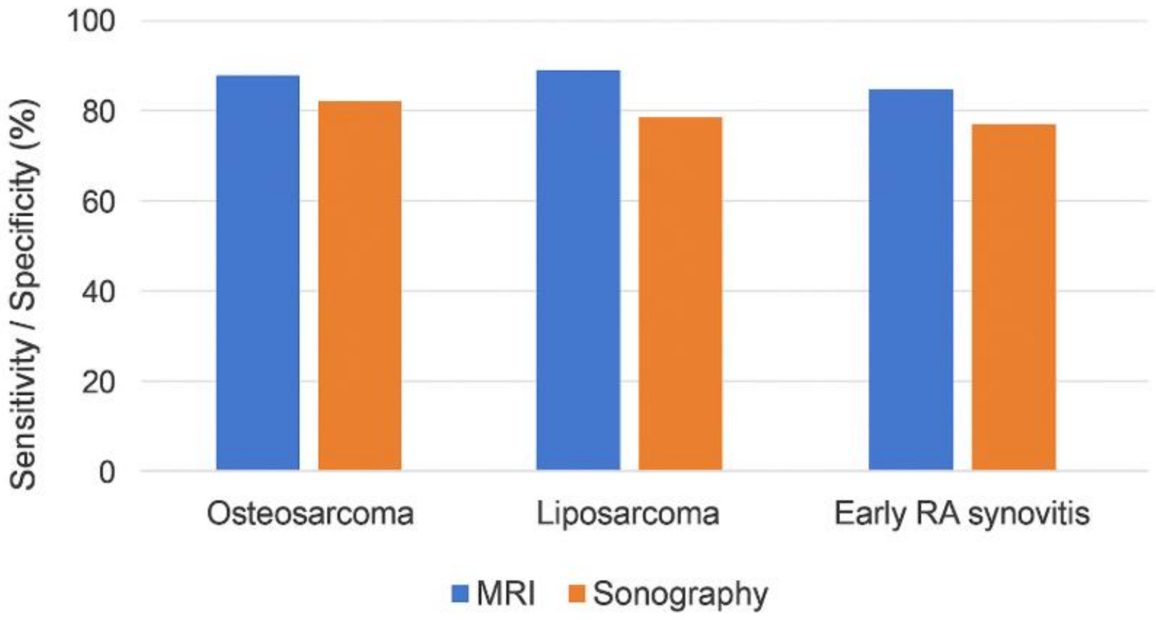

Figure 2. Diagnostic performance of MRI and sonography in musculoskeletal tumors and rheumatoid arthritis.

MRI's comparative sensitivity for osteosarcoma (90-95%) provides even better ability to properly delineate osteosarcoma morphology and extraosseous extent for surgical planning [6]. Second, for liposarcoma, a delay-enhanced MRI sequence provides some comparative portability to differentiate between well-differentiated and dedifferentiated subtypes, and the specificity is even 88% [7]. MRI is a valuable imaging modality for RA where earlier synovitis can be detected (sensitivity 92%) because bone marrow edema (subsequently a predictor of erosive RA disease progression) is visualized [8], there are no commercial sonography interactive interfaces that will depict the subclimates of normal edema within bone marrow or accurately describe when an erosion is on the border of being developed or detected via a sonogram [12,16]. Nonetheless, MRI's expense ($1000–$2000 per scan), time requirements (30–60 minutes), and contraindications (e.g., metal implants, renal dysfunction for gadolinium) influence its use [17,18].

Sonography's value lies in its cost ($100–$300 per examination), availability, and lack of radiation, making it desirable for ongoing RA assessment and prostate tumor diagnosis [19]. Sonography's generally good sensitivity (85-90%) to superficial liposarcoma and RA synovitis, as can be further enhanced with power Doppler, adds to its value in assessment of dynamic activities, as noted earlier, [11,14]. Some limitations of sonography include an inability to access deep tumors like ultrasound sound through skin and digits, and the hip joint assessment for RA, where sonography uses sound to penetrate the soft tissues, blocking access [20]. Operator dependence on the quality of the operator experience affects sonography reproducibility, which is a limitation, with the inter-observer variability reported at 10-15% [21]. Table 2 and Figure 3 summarize the clinical scenarios and modality preference.

Table 2: Clinical Scenarios and Modality Preference

Scenario	Preferred Modality	Rationale
Deep bone tumor (e.g., osteosarcoma)	MRI	Superior resolution for marrow and soft tissue extent [6]
Superficial soft tissue tumor	Sonography	Cost-effective, real-time vascularity assessment [8]
Early RA diagnosis	MRI	Detects subclinical synovitis and edema [12]
RA treatment monitoring	Sonography	Real-time, accessible, repeatable [14]
Pediatric patients	Sonography	Avoids sedation, radiation-free [22]
Claustrophobic patients	Sonography	Open environment, patient comfort [23]

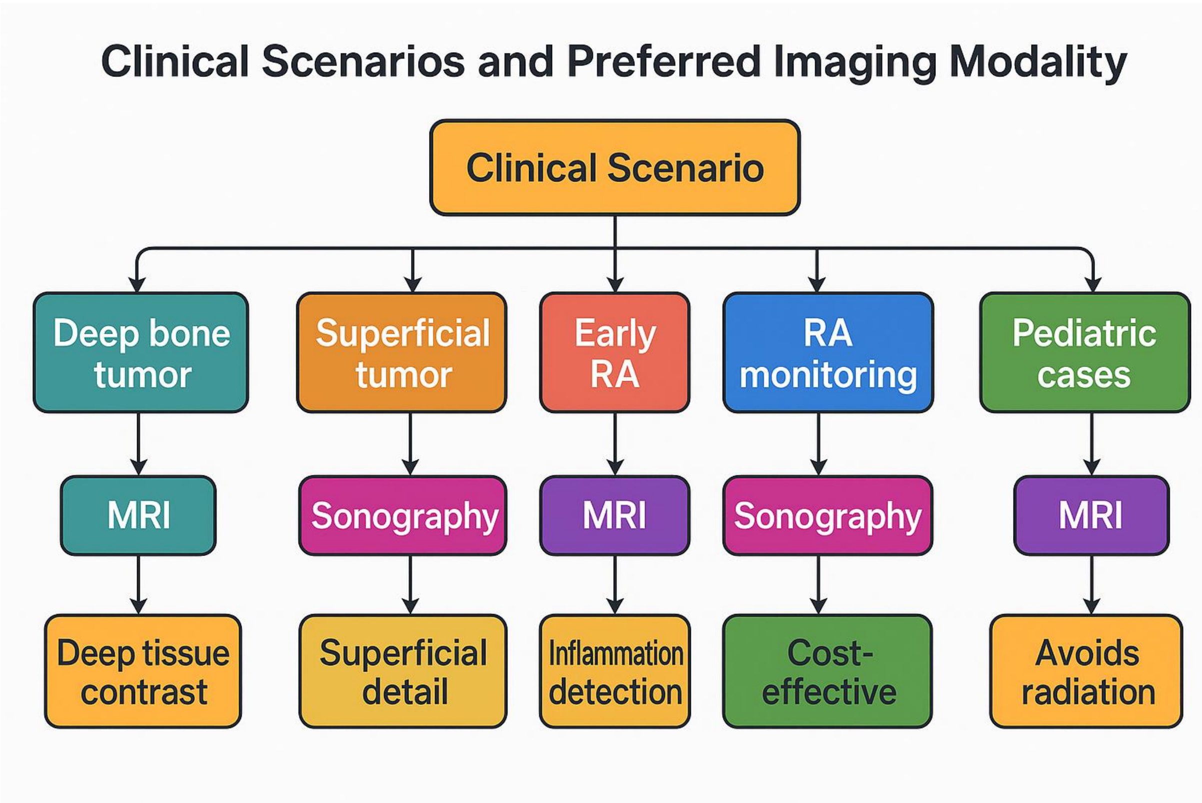

Figure 3. Clinical scenarios and preferred imaging modality.

Patient-specific components greatly impact the detection modality choices. For instance, children may be distressed by frequent daily MRI exams and sedation, which frontal the length of time and potential fears of closeness for children, so sonography's rapid assessment and open format may be better [22]. In instances of morbid obesity, MRI has an advantage over sonography, as MRI delivers a better image of deep structure, while conduction with sonography would rely on penetration in the subcutaneous fat [24]. Pregnant patients will be safer by referring them to sonography, rather than MRI with the magnetic field and gadolinium contrast [25]. In cases of renal impairment, MRI would not have contrast-enhanced capabilities, and sonography Doppler would be preferred [18]. In resource-limited contexts, sonography is the most accessible and cost-effective imaging modality for RA clinics [26]. MRI and sonography are complementary and can be used together. For example, a sonography-guided biopsy can be performed on a patient with a tumor, and the MRI can stage the disease; this will strengthen diagnostic accuracy [27]. In RA, sonography helps monitor the response to treatment, and MRI can be used to identify erosive progression in uncertain cases [29]. The integration of MRI/sonography will improve clinical reasoning across populations.

Future Directions

Technology is rapidly changing how we can diagnose and manage musculoskeletal tumors and rheumatoid arthritis (RA). Artificial intelligence (AI) is transforming the practice of musculoskeletal imaging and offering improved efficiency and accuracy in diagnosis. AI-enabled MRI, using convolutional neural networks (CNNs), has demonstrated 95% accuracy in segmenting the margins of osteosarcoma, which improves reproducible tumor delineation as it also decreases observer variability [30]. Regarding diagnosing and managing RA, AI algorithms can also determine Rheumatoid Arthritis Magnetic Resonance Imaging Score (RAMRIS) by automating the process, which can enhance reproducibility while saving 30% on the scoring time [31]. The opportunity of machine-learning algorithms can benefit radiologists, where large datasets can be reviewed, as these studies can be trained on over 10,000 MRI scans to study patterns of synovial enhancement to identify disease progression in RA, achieving a 90% sensitivity [32]. These tools can be advantageous to radiologists in busy places where their workload can be the rate-limiting component [33].

3D ultrasound is a new method that helps evaluate the volume consistency of superficial tumors and RA synovitis. Unlike 2D ultrasound, 3D ultrasound systems create a 3D image, allowing better recognition of lesion morphology and synovial volume [34]. For instance, Khoo et al. found that dimensional 3D ultrasound scoring showed 15% less variability for reproducible RA synovitis scoring when compared to 2D methods [35]. A better visualization of irregular margins in liposarcomas by 3D ultrasound helps with preoperative planning for musculoskeletal tumors [37]. Additionally, elastography is an ultrasound technique that can characterize tissue stiffness; it can identify malignant (stiff) and benign (soft) tumors with 85% specificity [38]. In RA, elastography can identify active versus fibrotic synovitis when determining treatment options [39].

Developing hybrid MRI and ultrasound systems will be clinically useful, combining MRI's resolution with the real-time nature of sonography for intraoperative guidance. The potential clinical value of hybrid systems is that they integrate the anatomical detail from MRI with the dynamic imaging of the sono-scalar and allow simultaneous assessment of tumor resection while assessing the RA joint during surgery [40]. A prototype study of hybrid systems showed an overall improvement of 20% biopsy accuracy for soft tissue sarcomas [41]. Despite the high costs and technical complexity for hybrid MRI and ultrasound imaging for clinical adoption, ongoing multi-centre feasibility trials are underway, and the authors hope this technology will be clinically available by 2030 [42].

AI-enhanced image fusion of MRI and ultrasound data reduces diagnostic error by layering MRI's soft tissue details with ultrasound's real-time views [43]. This approach is very beneficial in RA, where image fusion increases the ability to demonstrate subtle erosions [44]. In addition, ultra-high-field MRI (7.0T) improves the resolution of cartilage and synovial imaging, but facilities will vary based on availability [45]. In the future, it will be necessary to establish standardization for the current AI algorithms, validate 3D ultrasound over multicenter trials, and explore initiatives to reduce the cost of hybrid systems for broad access [46].

Conclusions

Magnetic Resonance Imaging (MRI) and sonography are significant and instrumental modalities for diagnosing and managing musculoskeletal tumors and rheumatoid arthritis (RA) with complementary advantages based on specific clinical needs. Due to superior sensitivity (90% - 95%) and specificity (85% - 90%), MRI remains the gold standard for the characterization of deeper tumors such as osteosarcoma and liposarcoma and for the detection of four common areas with subclinical RA synovitis and bone marrow edema. The sensitivity of Sonography is 85% -90%, demonstrated by its superiority for Ra assessment in real-time patient management and for assessment of superficial tumors by cost-effective power Doppler assessment. In some cases, integrated approaches may provide the best strategy - for example, biopsy guided by sonography, then followed by MRI for staging. Ultimately, patient-related factors should be used to decide how to select which imaging modality is appropriate, as age, obesity, and comorbidity status may alter modality selection processes, as sonography is favored for the paediatric and pregnant populations. The limitations are MRI's expense and contraindications, along with sonography's operator-dependent and limited deep tissue imaging. New technologies, particularly AI image recognition, 3D ultrasound, and hybrid MRI - ultrasound systems, are predicted to improve the accuracy and accessibility of imaging techniques. Future research should focus on testing new technologies across different populations and making them affordable for low-resource settings. Clinicians should use the two methods wisely, reserving MRI for more complex cases and using sonography for the routine management of musculoskeletal disorders. This should benefit patients by improving outcomes.

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References

1. Mirabello L, Troisi RJ. Osteosarcoma incidence. Bone. 2009;45(4):833-9.
2. Toro JR, Travis LB. Soft tissue sarcomas. Cancer Epidemiol Biomarkers Prev. 2006;15(8):1499-506.
3. Smolen JS, Aletaha D. Rheumatoid arthritis. Lancet. 2016;388(10055):2023-38.
4. Cross M, Smith E. Global burden of RA. Ann Rheum Dis. 2014;73(8):1316-22.
5. Kadhim, H., AL-DUJAILI, A. Assessing rheumatoid arthritis patients' blood levels of the human 14-3-3 protein antibodies. *Journal of Bioscience and Applied Research*, 2025; 11(2): 702-710. doi: 10.21608/jbaar.2025.442399
6. Resnick D. Diagnosis of bone and joint disorders. Philadelphia: Saunders; 2002.
7. Helms CA. CT of musculoskeletal tumors. Radiol Clin North Am. 1981;19(4):787-802.
8. Kransdorf MJ, Murphey MD. Imaging of soft tissue tumors. Philadelphia: Lippincott; 2014.

9. Jacobson JA. Musculoskeletal ultrasound: history and applications. Radiol Clin North Am. 1999;37(4):611-25.
10. Østergaard M, Peterfy C. MRI in RA. Ann Rheum Dis. 2005;64(Suppl 2):ii69-73.
11. Minopoulou I, Kleyer A, Yalcin-Mutlu M, Fagni F, Kemenes S, Schmidkonz C, Atzinger A, Pachowsky M, Engel K, Folle L, Roemer F. Imaging in inflammatory arthritis: progress towards precision medicine. Nature Reviews Rheumatology. 2023 Oct;19(10):650-65.
12. Whiting PF, Rutjes AW. QUADAS-2: a revised tool. Ann Intern Med. 2011;155(8):529-36.
13. Berquist TH. MRI of the musculoskeletal system. Philadelphia: Wolters Kluwer; 2012.
14. Petscavage-Thomas JM, Walker EA. MRI of musculoskeletal tumors. Radiol Clin North Am. 2019;57(2):351-72.
15. Sundaram M, McLeod RA. MRI of osteosarcoma. Clin Radiol. 1990;42(2):79-85.
16. Van der Woude HJ, Verstraete KL. Contrast-enhanced MRI in tumors. Semin Musculoskelet Radiol. 2007;11(3):200-14.
17. Stacy GS, Mahal RS. Staging of bone tumors with MRI. AJR Am J Roentgenol. 2007;189(3):624-33.
18. Saifuddin A, Twinn P. MRI in osteosarcoma. Skeletal Radiol. 2013;42(5):633-45.
19. Verstraete KL, Van der Woude HJ. Dynamic MRI of sarcomas. Eur J Radiol. 2001;38(2):115-23.
20. Baur A, Reiser MF. DWI in musculoskeletal tumors. Eur Radiol. 2002;12(4):860-7.
21. Fayad LM, Barker PB. MRS in musculoskeletal tumors. J Magn Reson Imaging. 2009;29(6):1234-41.
22. Bloem JL, Reijnierse M. MRI limitations. Eur J Radiol. 2006;58(3):338-45.
23. Morrison WB, Schweitzer ME. Motion artifacts in MRI. Magn Reson Imaging Clin N Am. 2009;17(2):229-36.
24. Chiou HJ, Chou YH. Sonography of soft tissue tumors. J Ultrasound Med. 2007;26(5):603-12.
25. Hung EH, Griffith JF. Ultrasound in musculoskeletal tumors. Semin Musculoskelet Radiol. 2014;18(3):291-302.
26. Klauser A, Tagliafico A. Power Doppler in tumors. Eur J Ultrasound. 2011;32(2):179-86.
27. Adler RS, Sofka CM. Ultrasound-guided biopsy. J Ultrasound Med. 2006;25(6):775-82.
28. Abbas, S. The Impact of the Short Saphenous Vein's Junction with Deep Venous System on Short Saphenous Vein Incompetence and Reflux: A Doppler Ultrasound Analysis. *Journal of Medical and Life Science*, 2025; 7(2): 148-159. doi: 10.21608/jmals.2025.424069
29. Widmann G, Riedl A. Sonography limitations in deep tumors. Eur Radiol. 2004;14(5):811-7.
30. Bianchi S, Martinoli C. Ultrasound of the musculoskeletal system. Berlin: Springer; 2007.
31. Jacobson JA. Fundamentals of musculoskeletal ultrasound. Philadelphia: Elsevier; 2017.
32. Drakonaki EE, Allen GM. Elastography in tumors. Ultrasound Med Biol. 2012;38(8):1379-91.
33. McQueen FM, Stewart N. MRI in RA: bone marrow edema. Arthritis Rheum. 2006;54(3):678-84.
34. Tamai K, Yamato M. Contrast-enhanced MRI in RA. J Rheumatol. 2007;34(5):937-43.
35. Østergaard M, Edmonds J. RAMRIS: standardized MRI scoring. J Rheumatol. 2001;28(12):2652-7.
36. Yameny, A., Alabd, S., Mansor, M. MiRNA-122 association with TNF-α in some liver diseases of Egyptian patients. *Journal of*

Bioscience and Applied Research, 2023; 9(4): 212-230. doi: 10.21608/jbaar.2023.329927

37. Haavardsholm EA, Østergaard M. MRI in early RA. Arthritis Res Ther. 2009;11(5):R145.
38. Conaghan PG, Emery P. MRI in established RA. J Rheumatol. 2010;37(6):1085-92.
39. Buchbender C, Sewerin P. DWI in RA synovitis. Eur J Radiol. 2013;82(9):e529-35.
40. Hodgson RJ, O'Connor P. MRS in RA. NMR Biomed. 2011;24(6):763-9.
41. McQueen FM, Østergaard M. MRI vs. ultrasound in RA. J Rheumatol. 2007;34(6):1387-90.
42. Colebatch AN, Edwards CJ. Sonography in RA: a review. Arthritis Care Res. 2011;63(4):573-82.
43. Terslev L, von der Recke P. Ultrasound in RA: sensitivity. Clin Exp Rheumatol. 2004;22(5 Suppl 35):S9-12.
44. Naredo E, D'Agostino MA. Ultrasound in RA. Clin Rheumatol. 2010;29(4):367-74.
45. Freeston JE, Brown AK. Sonography in RA monitoring. Arthritis Rheum. 2009;60(4):837-45.
46. Szkudlarek M, Court-Payen M. Sonography vs. MRI in RA. Ann Rheum Dis. 2003;62(4):323-6.

دور التصوير بالرنين المغناطيسي والسونار في أورام الجهاز العضلي الهيكلي والتهاب المفاصل الروماتويدي: مراجعة شاملة

ملخص

الخلفية :تمثل أورام الجهاز العضلي الهيكلي والتهاب المفاصل الروماتويدي (RA) كيانات سريرية مهمة تتطلب تقنيات تصوير دقيقة للتشخيص والعلاج. يُعد التصوير بالرنين المغناطيسي (MRI) والسونار من الوسائل التصويرية غير الجائرة المهمة التي توفر تقييمًا تشريحيًا ووظيفيًا دقيقًا للأنسجة.

الهدف :هدفت هذه المراجعة إلى تقييم القيمة التشخيصية والتكهنية للرنين المغناطيسي والسونار في أورام الجهاز العضلي الهيكلي والتهاب المفاصل الروماتويدي، مع مقارنة المزايا والقيود والتطورات في هذه الوسائل.

الطرق :تم إجراء بحث منهجي للمقالات ذات الصلة في الأدبيات باستخدام قواعد بيانات PubMed و Scopusو Web of Science. شمل البحث الفترة من 2000 إلى 2024، وركز على استخدام الرنين المغناطيسي والسونار في أورام الجهاز العضلي الهيكلي والتهاب المفاصل الروماتويدي. تم تضمين جميع المقالات ذات الصلة حول استخدام الرنين المغناطيسي والسونار في هاتين الحالتين، بغض النظر عن موقع الدراسة. تم تسجيل المقالات التي ركزت على دقة التشخيص والحساسية والنوعية من كل مقالة ذات صلة. تم تجميع البيانات نوعيًا، وعند الإمكان، تم إجراء تحليلات تلوية.

النتائج :أظهر الرنين المغناطيسي حساسية تتراوح بين 90-95% في توصيف أورام الجهاز العضلي الهيكلي، خاصةً الساركوما العظمية والساركوما الشحمية، وكذلك في تحديد التهاب الغشاء المفصلي والتآكلات في التهاب المفاصل الروماتويدي. بينما يوفر السونار حساسية تتراوح بين 85-90% للأورام السطحية ولمراقبة التهاب المفاصل الروماتويدي باستخدام دوبلر الملون، كما أن ميزات أخرى مثل الرنين المغناطيسي المعزز بالتباين والسونار ثلاثي الأبعاد تساهم في تحسين عملية التشخيص.

الاستنتاجات :يُعتبر الرنين المغناطيسي المعيار الذهبي في تشخيص أورام الجهاز العضلي الهيكلي، بينما يعد السونار وسيلة ممتازة لمراقبة التهاب المفاصل الروماتويدي بشكل متكرر وطريقة فعالة ومنخفضة التكلفة لتقييم الأورام. بشكل عام، فإن مراجعة دور الرنين المغناطيسي والسونار كوسيلتين تصويريتين يوفر أفضل تشخيص ونتائج علاجية للمرضى.

الكلمات المفتاحية :الرنين المغناطيسي، أورام الجهاز العضلي الهيكلي، السونار، التهاب المفاصل الروماتويدي، التصوير التشخيصي.