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The Role of Magnetic Resonance Imaging and Ultrasonography in the Early Detection of Psoriatic Arthritis Lesions

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Abstract

Psoriatic arthritis (PsA) is a chronic immune-mediated musculoskeletal disease associated with psoriasis and characterized by heterogeneous involvement of peripheral joints, entheses, tendon sheaths, nails and the axial skeleton. Because early PsA may be oligosymptomatic or clinically silent, diagnostic delay remains a major challenge and may lead to irreversible structural damage. This narrative review summarizes the role of magnetic resonance imaging (MRI) and ultrasonography (US) in the early detection, assessment and monitoring of PsA-related lesions.

Ultrasonography is a widely accessible, dynamic and cost-effective imaging modality that enables real-time assessment of synovitis, tenosynovitis, enthesitis, dactylitis, nail-unit abnormalities and vascular activity using Power Doppler. It is particularly useful in peripheral disease and may help identify subclinical inflammation in patients with psoriasis. MRI provides superior visualization of deeper inflammatory lesions, including bone marrow edema, osteitis, sacroiliitis, axial involvement, synovitis, and soft-tissue inflammation. It is especially valuable when conventional radiography is normal or when axial or bone marrow involvement is suspected.

Both modalities support earlier diagnosis, monitoring of disease activity, and evaluation of treatment response, particularly in the context of biologic therapy and treat-to-target strategies. However, their interpretation requires clinical context. MRI is limited by cost, availability, and examination time, whereas ultrasound remains operator- and equipment-dependent. Subclinical lesions may also be nonspecific and do not always predict progression to clinically

manifest PsA. Overall, MRI and ultrasonography should be regarded as complementary tools that may improve early detection, guide personalized treatment decisions, and reduce the risk of irreversible joint damage in patients with psoriatic disease.

Key words : psoriatic arthritis, magnetic resonance imaging, ultrasonography, early diagnosis, enthesitis

1. Introduction

Psoriasis is a non-contagious, systemic inflammatory disease with an immunological basis, it can affect not only the skin but also the musculoskeletal system, and may even manifest as erythroderma, a condition in which the entire surface of the body is affected by the disease [1,2].

Psoriasis leads to numerous complications, but one of the most serious is psoriatic arthritis (PsA), which can result in joint damage or permanent disability. The early stages of psoriatic arthritis are usually oligosymptomatic or asymptomatic, making them difficult to diagnose. Untreated PsA can lead to irreversible structural changes, such as joint deformities or the formation of bone erosions. Therefore, early diagnosis of these changes is essential to initiate appropriate treatment and halt disease progression [3].

Imaging methods, such as ultrasound or magnetic resonance imaging (MRI), are frequently used in diagnosis. MRI allows for the assessment of bone marrow, synovitis or enthesopathies, while ultrasound focuses on dynamic changes in soft tissues, joint effusions and changes within tendon insertions [3–5]. Studies show that patients who do not exhibit symptoms of psoriatic arthritis may have inflammatory changes detected on early ultrasound examinations, which allows treatment to begin before the onset of symptoms that are painful for the patient and enables early intervention, limiting the occurrence of irreversible changes [3,6]. Imaging studies such as X-rays are not useful in the early stages, as they reveal only advanced structural changes [7].

Given the growing importance of ultrasound and magnetic resonance imaging in the diagnosis of early changes in psoriatic arthritis, the aim of this study is to present their clinical significance, role in disease monitoring and assessment of treatment efficacy.

2. Methods

This article was prepared as a narrative review. The literature search was conducted mainly in PubMed/MEDLINE, with additional relevant articles identified through manual screening of reference lists. The search focused on publications concerning psoriatic arthritis, psoriasis, magnetic resonance imaging, ultrasonography, early diagnosis, subclinical inflammation, synovitis, enthesitis, dactylitis, bone marrow edema, structural damage, and disease monitoring.

Peer-reviewed articles published in English were included, with priority given to recent reviews, systematic reviews, meta-analyses, clinical studies, and consensus-based papers relevant to imaging in psoriasis and psoriatic arthritis. Older publications were used when they provided important background on disease pathophysiology or imaging methodology. Case reports, non-English articles, and papers not directly related to imaging, musculoskeletal involvement, early diagnosis, or monitoring of psoriatic arthritis were excluded.

Because of the narrative character of this review, no formal PRISMA-based selection process, meta-analysis, or systematic risk-of-bias assessment was performed. The final selection of sources was based on relevance to the topic and their contribution to understanding the role of MRI and ultrasonography in early psoriatic arthritis assessment.

3. Pathophysiology of Joint Involvement in Psoriatic Arthritis

The transition from cutaneous psoriasis to clinically evident psoriatic arthritis (PsA) is a complex, multi-stage process that may develop over several years [8]. Since skin involvement usually precedes joint disease, patients with psoriasis represent a population in which early musculoskeletal inflammation may be detected before irreversible joint damage occurs [9,10]. This progression is thought to move from immune activation and subclinical inflammation through a prodromal phase, eventually leading to clinically apparent PsA [11].

Diagnostic delay remains one of the major challenges in PsA management. When the disease is not recognized early, ongoing inflammation may lead to permanent structural damage, including bone erosions, joint space narrowing, deformity, and functional impairment [6,9,12].

The difficulty is that inflammatory lesions may be present before they are clinically obvious or visible on conventional radiography, which limits the sensitivity of physical examination and X-ray in the earliest stages of the disease [1,5,6].

A key concept in PsA pathophysiology is the involvement of the synovio-entheseal complex [13]. In contrast to rheumatoid arthritis, where synovitis is usually the dominant pathological process, PsA is strongly associated with enthesitis, defined as inflammation at the sites where tendons, ligaments, or joint capsules attach to bone [13,14]. The enthesis are exposed to repeated mechanical stress, and this may interact with immune pathways, particularly the IL-23/IL-17 axis. Activation of IL-17-, IL-22-, and TNF-α-mediated inflammation may then contribute not only to local entheseal inflammation but also to synovitis, osteitis, and abnormal bone remodeling.

The inflammatory process in PsA extends beyond the synovium. Peripheral disease may involve synovitis, tenosynovitis, peritendinous inflammation, enthesitis, and extracapsular soft-tissue inflammation [13]. Dactylitis, clinically recognized as “sausage digit”, is considered a hallmark clinical feature of PsA and may appear early in the disease course. It reflects inflammation across several anatomical structures, including flexor tendon sheaths, synovium, subcutaneous tissue, extensor tendons, and entheses [6,15]. Because these components cannot be reliably separated by clinical examination alone, ultrasound is particularly useful for identifying which structures are involved and whether active inflammation is present on Power Doppler imaging [13,16].

The anatomical relationship between the nail unit, the distal interphalangeal (DIP) joint, and the extensor tendon enthesis may explain the frequent association between nail psoriasis and distal joint involvement [17]. Nail disease should therefore not be treated only as a cosmetic or dermatological problem. In patients with psoriasis, it may also serve as a clinical marker suggesting a higher risk of musculoskeletal involvement [5,13].

A distinctive feature of PsA is the coexistence of bone destruction and pathological new bone formation [14,15]. Erosions and osteolysis may occur alongside periostitis, enthesophytes, syndesmophytes, and ankylosis [6]. This dual pattern of bone remodeling helps distinguish PsA from other inflammatory arthritides. Before irreversible structural lesions become established,

MRI may reveal bone marrow edema, also referred to as osteitis, which is considered an important early inflammatory lesion and may precede erosive damage [8,12].

These pathophysiological features explain why advanced imaging has become so important in early PsA assessment. Ultrasound allows real-time evaluation of superficial peripheral structures, including synovium, tendon sheaths, entheses, periarticular soft tissues, and vascular activity [6]. MRI provides access to deeper inflammatory lesions, particularly bone marrow edema, osteitis, sacroiliitis, and axial involvement [6,9]. Used together, both modalities may help detect subclinical or early inflammatory changes at a stage when treatment can still prevent progression toward irreversible structural damage [9,18].

4. Imaging Modalities in Early Psoriatic Arthritis

4.1 Ultrasonography

Ultrasonography currently plays a key role in the early diagnosis of psoriatic arthritis. It is characterized by high sensitivity, particularly in soft tissues, tendon insertions, the synovial membrane, and the nail bed. Due to the development of Power Doppler technology, it also allows for monitoring the effectiveness of biologic therapy by analyzing the vascularization of a particular location [13,15].

One of the most characteristic changes assessed in an ultrasound examination is synovitis, which is inflammation of the synovial membrane. It manifests as thickening of the synovial membrane, the presence of synovial fluid and increased vascularization [13]. The chronic persistence of such inflammatory changes leads to degradation of articular cartilage and bone destruction [19]. Therefore, early diagnosis is clinically important, as it allows for the initiation of treatment before irreversible changes occur [7].

Another common manifestation of psoriatic arthritis visible on ultrasound is tenosynovitis, an inflammation of the tendon sheaths [16]. This may be one of the first symptoms of PsA. The ultrasound image is characterized by the presence of fluid around the tendons, thickening of the sheaths and an increased Power Doppler signal [13]. The tendons of the finger flexors are most commonly affected, which can lead to limited mobility and pain.

Another important finding is enthesitis, which appears on ultrasound as reduced echogenicity, the presence of bone erosions or calcifications and increased vascular flow [13,16]. It typically affects the Achilles tendon, the plantar fascia or the insertions of the finger extensor tendons [13]. Early diagnosis of subclinical enthesial changes in patients without clinical symptoms has significant clinical value.

Dactylitis — simultaneous inflammatory changes in the tendon sheaths, synovial membrane and surrounding soft tissues, referred to as "sausage finger" — should not be overlooked [16,17]. It manifests as diffuse swelling of the entire finger or toe, leading to limited mobility, impaired function of the affected digit and severe pain. Ultrasound and power Doppler allow for the differentiation of dactylitis from other causes of finger swelling [13].

An increasingly common examination is nail ultrasonography, which allows for the assessment of nail plate thickness, the nail bed, the matrix and the level of vascularisation [5,17]. Studies show a link between changes within the nail and inflammation of the distal interphalangeal joints in particular. This increases its potential role in identifying individuals at risk of developing PsA [5].

In summary, ultrasound is an important imaging method used to assess early changes in PsA, along with the power Doppler technique, which allows for the evaluation of vascularization, a factor that correlates with inflammatory activity [15]. These examinations allow for the assessment of synovitis, tenosynovitis, enthesitis and dactylitis, which are key manifestations of psoriatic arthritis [13,16]. Nail bed ultrasound is gaining popularity, as it allows for the identification of patients at risk of developing PsA [17,19]. As a result, imaging methods not only improve diagnostic accuracy, but also support personalized treatment and the assessment of treatment efficacy in patients with PsA [15].

4.2 Magnetic Resonance Imaging

Magnetic resonance imaging is one of the most sensitive imaging methods used to diagnose early psoriatic arthritis [5,6]. Unlike conventional X-rays, MRI allows for detailed imaging of soft tissues and the detection of early changes within the bone marrow [2,14].

One of the most important changes indicative of active inflammation is bone marrow edema [9,15]. It appears as an area of decreased signal intensity on T1-weighted sequences and increased signal intensity on T2-weighted and SITR sequences, as these are sensitive to the presence of fluid and inflammatory cell infiltration within the bone marrow [5]. They are most commonly located within the articular surfaces, at tendon insertions (which is characteristic of PsA), the sacroiliac joints, or in the small joints of the hands and feet [1,2]. The presence of bone marrow edema indicates active inflammation and requires intensified treatment, particularly biologic therapy. If left untreated, it can lead to bone erosions and permanent structural changes, which will result in a reduced quality of life for patients [9,20].

A specific marker of PsA on MRI is also involved in the axial skeleton and the sacroiliac joints [5,6]. Early diagnosis based on conventional X-rays is nearly impossible, yet this is a common form of the disease in patients—that is, a condition in which the disease affects the spine and sacroiliac joints [6]. This manifests as sclerosis, inflammation of the ligamentous attachments of the spine, swelling of the bone marrow within the vertebral bodies, inflammation of the intervertebral joints, and inflammatory changes present within the cervical and thoracic spine [5]. MRI also allows for the differentiation of PsA from ankylosing spondylitis, as the first is more asymmetrical in nature and may present with less severe changes [5,6]. Detecting early axial lesions is of significant clinical importance, as it allows for diagnosis before symptoms appear in patients and enables earlier initiation of treatment to prevent irreversible changes. MRI is also used to monitor biologic therapy, which in this case most often relies on TNF-α or IL-17 inhibitors [6,15].

Magnetic resonance imaging also allows for the assessment of synovitis, which is a very common manifestation in patients with PsA [6,13]. It appears on MRI as synovial thickening and shows intense enhancement after the administration of an intravenous contrast, indicating active inflammation and vascularization [5]. The chronic persistence of such changes will lead

to degradation of articular cartilage and bone destruction. MRI also has significant prognostic value, as it allows for the diagnosis of changes before symptoms appear in patients [15].

Magnetic resonance imaging plays a key role in the early diagnosis of PsA lesions, allowing for the assessment of bone marrow edema, synovitis and axial involvement [5,6]. Early identification of lesions allows for earlier initiation of biologic therapy, thereby reducing the occurrence of irreversible changes that impair patients' quality of life [18,20]. MRI imaging also enables the detection of lesions before clinical symptoms appear, as well as monitoring treatment efficacy and evaluation of inflammatory activity [18].

5. The Role of Imaging in Personalized Treatment

Modern imaging studies are beginning to play a key role in personalising treatment for psoriatic arthritis. They not only allow for early identification of lesions but also allow for accurate monitoring of the disease's progression, its location, the severity of lesions, and the effectiveness of the treatment regimen [15].

Magnetic resonance imaging (MRI) enables the diagnosis of deeper structures and lesions that may not be detectable during a clinical examination, such as bone marrow edema, sacroiliitis, deep enthesopathies or active lesions not visible on X-rays [15]. It is very important to assess each of these locations because, for example, bone marrow edema, which is considered a potential risk factor for the progression of bone destruction, indicates the presence of active inflammation, which may require the earlier initiation of more intensive treatment and more careful monitoring [9,17].

Ultrasound, on the other hand, focuses on assessing: changes within the synovial membrane, enthesopathies and the presence of synovial fluid [13,16]. The use of Power Doppler imaging is also important, as it allows for the assessment of vascularization, consequently, the greater the vascularization, the greater the inflammatory activity, which in biologic therapy translates to a need for more intensive treatment [13]. Meanwhile, a reduction in the Doppler signal correlates with a good response to the initiated therapy. The aforementioned imaging techniques allow for the assessment of the response to therapy even before the patient shows clinical improvement [15].

Imaging techniques such as MRI and ultrasound can identify the predominant immune mechanism, which serves as the basis for selecting the appropriate biologic therapy [9,19]. If enthesopathy is the dominant feature on imaging, IL-23 inhibitors are most commonly used in this patient group, as IL-23 is responsible for the activation of Th17 lymphocytes. Another interleukin inhibitor used in treatment is the IL-17 inhibitor, this is a pro-inflammatory cytokine produced by Th17 lymphocytes that leads to chronic inflammation in patients with PsA [19]. The use of its inhibitor reduces immune system activity, as well as the activity of enthesitis and dactylitis, which is visible on Power Doppler ultrasound as a reduction in signal intensity and soft tissue swelling [13,16]. Another target of biologic therapy is the cytokine TNF-α, which intensifies the chronic inflammatory process, stimulates immune cells to produce additional cytokines, activates osteoclasts, promotes cartilage degradation, and increases the production of tissue-destructive enzymes (MMPs), leading to bone erosions, joint deformities and progressive damage to joint structures [19]. Its increased activity is visible on ultrasound as increased blood flow [13]. Therefore, TNF-α blockade plays a key role in the selection of PsA treatment and was one of the first effective lines of biologic therapy for psoriatic arthritis [9,19].

Modern treatment strategies employ a “treat-to-target” approach, which aims to achieve remission or reduce disease activity and most importantly, prevent the development of irreversible structural changes [9]. In this model, MRI and ultrasound play a key role in selecting biologic therapy due to their ability to monitor actual inflammatory activity. This enables more precise treatment decisions, faster detection of ineffective treatment and the prevention of irreversible changes [9,15].

6. Emerging Directions

Recent developments in imaging techniques for psoriatic arthritis are enabling earlier detection of inflammatory changes and a more accurate assessment of disease activity. This progress has sparked significant interest, leading to the development of technologies that support image analysis, such as artificial intelligence (AI), radiomics, and advanced imaging protocols [15].

The most popular technology is AI, which is used to assist in the interpretation of MRI and ultrasound scans by analyzing large volumes of images and detecting subtle differences between them that may not be visible in standard radiological evaluation. The algorithms allow for the assessment of disease progression dynamics, inflammatory activity and the

identification of early changes. This leads to faster diagnosis of the disease and earlier onset of treatment [9,15].

Radiomics is also gaining increasing attention, its operation is based on identifying additional subtle changes invisible to the human eye regarding inflammatory activity and potential disease progression [15]. As this technique develops, its role in supporting the selection of personalized therapy and the assessment of a patient's response to biologic treatment grows [9].

Another modern trend in diagnostic development is whole-body MRI, which offers an advantage over other techniques by simultaneously analyzing multiple sites affected by inflammation and facilitating the monitoring of disease activity. It is particularly important in patients with extensive musculoskeletal involvement [15]. At the same time, advanced ultrasound protocols are being developed that utilize power Doppler technology, enabling a more accurate assessment of vascularization and changes within tendon insertions [13,16].

The continuous development of imaging techniques may in the future improve the effectiveness of diagnosing early inflammatory changes in patients with psoriatic arthritis, enabling early detection of changes, monitoring their progression, and limiting the development of irreversible structural changes, which translates into an improved quality of life for the patient [20].

7. Limitations

Despite their clear advantages, MRI and ultrasound are not definitive standalone tools for the diagnosis or monitoring of psoriatic arthritis. Both methods have practical, technical, and interpretive limitations that need to be considered in everyday clinical practice [8,13].
MRI provides comprehensive visualization of soft tissues, bone marrow, and axial inflammatory lesions. However, its routine use is limited by high cost, restricted availability, and longer examination time. In addition, MRI protocols are usually focused on selected anatomical regions, which makes whole-body or broad screening approaches less practical in routine care [9,13]. Contrast-enhanced MRI may improve the assessment of synovitis and inflammatory activity, but gadolinium-based contrast agents add further cost and safety considerations . MRI findings also require clinical interpretation, as bone marrow edema and other inflammatory-appearing lesions are not always specific to PsA and may occur in other conditions [8,9,16].

Ultrasound is more accessible, less expensive, dynamic, and suitable for repeated bedside assessment of peripheral joints and entheses. Its main limitation is operator dependence. Diagnostic accuracy depends on the examiner's experience, scanning technique, equipment quality, transducer frequency, and Doppler settings [6,11]. Even probe pressure may influence Power Doppler signal detection, which can affect the assessment of active inflammation [13,16]. Ultrasound also has anatomical limitations. It cannot penetrate cortical bone and therefore cannot detect bone marrow edema [6,15]. Its value is also reduced in deep structures and axial disease because of limited acoustic windows [8].

Interpretation of subclinical findings remains another major challenge. Mild entheseal thickening, small joint effusions, structural irregularities, or low-grade Doppler signals may be detected in individuals without clinically evident PsA [11,21]. Such findings may be related to age, obesity, mechanical stress, physical activity, or degenerative changes rather than inflammatory disease [5,6,12]. This creates a risk of overinterpretation and potential overdiagnosis, particularly in asymptomatic patients with cutaneous psoriasis [11,21]. At present, it remains unclear which subclinical lesions reliably predict progression to clinically manifest PsA.

Standardization is also incomplete. Several imaging scoring systems have been developed, including PsAMRIS for MRI and ultrasound-based enthesitis or dactylitis scores [11,22]. However, many of these tools are time-consuming, require trained assessors, and are used mainly in research settings rather than routine dermatological or rheumatological practice [9,12]. For this reason, MRI and ultrasound findings should not be interpreted in isolation. They are most useful when integrated with clinical history, physical examination, disease phenotype, risk factors, and therapeutic context.

8. Conclusions

Magnetic resonance imaging and ultrasonography play an increasingly important role in the early assessment of psoriatic arthritis. Their main clinical value lies in the ability to detect inflammatory and structural lesions before irreversible joint damage becomes established. This

is particularly relevant because early PsA may be clinically subtle, and conventional radiography often reveals changes only at more advanced stages of disease.

Ultrasonography is especially useful for the evaluation of peripheral PsA. It allows dynamic and repeated assessment of synovitis, tenosynovitis, enthesitis, dactylitis, nail-unit changes, and Power Doppler activity. Because it is accessible, relatively inexpensive, and suitable for bedside examination, ultrasound may support early diagnosis, monitoring of inflammatory activity, and assessment of treatment response.

MRI provides complementary information by visualizing deeper inflammatory lesions that cannot be reliably assessed with ultrasound. It is particularly valuable for detecting bone marrow edema, osteitis, sacroiliitis, axial involvement, and early soft-tissue inflammation. These features make MRI one of the most sensitive methods for identifying early inflammatory changes and evaluating disease activity in anatomically complex or clinically unclear cases.

The two modalities should not be viewed as competing techniques but as complementary tools. Ultrasound offers practical real-time assessment of superficial peripheral structures, whereas MRI provides broader insight into bone marrow, axial disease, and deep inflammatory involvement. Their combined use may improve diagnostic accuracy, reduce diagnostic delay, and support individualized therapeutic decisions, including treatment escalation and monitoring of biologic therapy.

Despite these advantages, imaging findings should always be interpreted in the context of clinical symptoms, physical examination, disease phenotype, and patient-specific risk factors. Subclinical abnormalities may be nonspecific, and neither MRI nor ultrasound should replace clinical judgment. Future progress will depend on better standardization of imaging protocols, wider validation of scoring systems, and clearer identification of imaging features that predict progression from psoriasis to clinically manifest PsA.

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