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How to Identify and Monitor Axial and Peripheral Psoriatic Arthritis by Magnetic Resonance Imaging

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ABSTRACT. Psoriatic arthritis (PsA) is characterized by a spectrum of clinical manifestations. Magnetic resonance imaging (MRI) is a crucial tool in elucidating inflammatory and structural lesions associated with both peripheral and axial forms of the disease. The implementation of standardized definitions and scoring systems for active and structural MRI lesions facilitates a rigorous evaluation of axial and peripheral joint involvement and enthesitis in patients with PsA. Further, the emerging potential of whole-body MRI techniques shows promise in differentiating treatment effects. The annual MRI workshop, held at the Group for Research and Assessment of Psoriasis and Psoriatic Arthritis (GRAPPA) 2024 meeting in Seattle, Washington, USA, aimed to underscore the significant role of MRI in the comprehensive assessment of PsA manifestations. Through the presentation of interactive case studies, the workshop illustrated the practical applications of MRI in the clinical management of individuals with PsA, enhancing understanding of its diagnostic capabilities and highlighting its contributions to treatment strategies.

Key Indexing Terms: diagnostic imaging, GRAPPA, magnetic resonance imaging, psoriasis, psoriatic arthritis, spondyloarthritis

Introduction

Psoriatic arthritis (PsA) is an inflammatory condition characterized by various clinical presentations. Musculoskeletal manifestations arise from the involvement of peripheral and axial joints, tendons, and entheses. Many of these manifestations are challenging to detect and monitor through physical examination alone, making imaging tests particularly valuable for this condition. The combination of ultrasonography, radiographs, and computed tomography can detect various structural and inflammatory lesions in PsA. However, magnetic resonance imaging (MRI) excels in identifying all these pathologies and quantifying the inflammatory and structural involvement of the peripheral and axial joints and entheses. Additionally, whole-body MRI (WB-MRI) can comprehensively assess this condition by simultaneously evaluating the peripheral and axial joints and entheses in a relatively short examination time.

The objectives of the annual MRI workshop at the Group for Research and Assessment of Psoriasis and Psoriatic Arthritis (GRAPPA) 2024 meeting were to describe how MRI can identify inflammatory and structural lesions in PsA and objectively evaluate the burden of inflammation across its various manifestations. The workshop also explored the application of WB-MRI in clinical trials to assess inflammatory and structural lesions. Given the diverse manifestations of PsA, this comprehensive approach is particularly advantageous for offering an overall patient evaluation.

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MRI in evaluating peripheral manifestations of PsA

MRI is of significant value in identifying all peripheral lesions in PsA[1] (Figure 1), including detecting different patterns of peripheral enthesitis and assessing synovitis in small peripheral joints. Peripheral enthesitis can present differently across patients. Whereas some patients have inflammatory lesions in the soft tissues of the entheses and bursae, which can be visualized with ultrasound (US), only MRI can reveal the presence of bone marrow edema (BME) without inflammation of soft tissues.

In small peripheral joints, distinguishing between inflamed and noninflamed areas remains challenging with MRI without contrast injection. Instead, contrast-enhanced MRI is generally recommended for assessing synovitis in these areas since intravenous contrast injection increases the sensitivity and specificity for inflammation in the small peripheral joints.[2]

Additionally, standardized scoring systems have been designed to accompany MRI results. These include the Outcome Measures in Rheumatology (OMERACT) Psoriatic Arthritis Magnetic Resonance Imaging Score (PsAMRIS) and the OMERACT Heel Enthesitis MRI Scoring System (HEMRIS). PsAMRIS assesses and quantifies synovitis, tenosynovitis, periarticular inflammation, bone edema, and bone erosions in the fingers,[1,3] whereas HEMRIS monitors heel enthesitis in PsA and spondyloarthritis (SpA).[4] An atlas illustrating the different grades of this scoring system has been published, facilitating the use of HEMRIS in clinical cohorts and trials.[5]

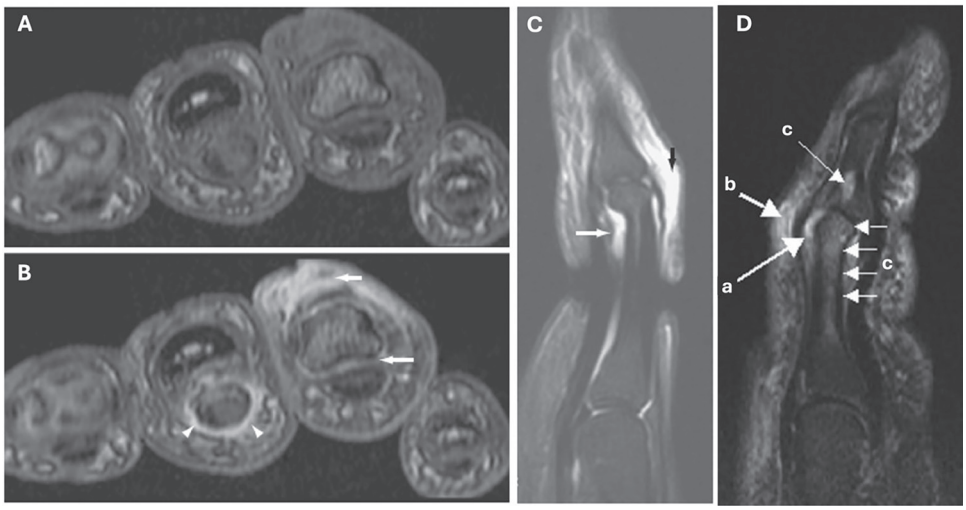

Figure 1. Example of inflammatory manifestations observed in a patient with psoriatic arthritis using magnetic resonance imaging of the hands. Left: Axial T1-weighted images (A) before and (B) after intravenous contrast injection. Arrowheads show tenosynovitis, whereas arrows show synovitis and periarticular inflammation. Middle: Sagittal STIR image of a finger showing synovitis (white arrow) and periarticular inflammation (black arrow). Right: (D) Sagittal STIR image of a finger showing (a) synovitis, (b) periarticular inflammation, and (c) bone marrow edema. Modified with permission from Østergaard et al.[23] STIR: short-tau inversion recovery.

Although MRI is highly valuable in assessing peripheral PsA, owing to its detailed imaging and ability to detect BME, it is important to consider its advantages and disadvantages compared to other imaging modalities, especially US. MRI provides better visualization of deep tissues and detects early joint damage, but it can be costly and less accessible, and requires patient cooperation. In contrast, US is more portable, cost-effective, and provides real-time imaging of superficial tissues. However, it relies on the operator's skills and is less effective for deep structures.[6] Both modalities have strengths and limitations, and the choice depends on the clinical question, patient symptoms, and availability.

MRI in the evaluation of axial PsA

Fluid-sensitive sequences of MRI focused on the sacroiliac joints (SIJs) and the spine are effective for assessing axial manifestations in PsA. Establishing standardized definitions is essential for characterizing these images to ensure global consistency and accuracy in evaluating lesions associated with axial PsA. The Assessment of SpondyloArthritis international Society (ASAS) working group formulated a common language to standardize these definitions.[7] The definitions also apply to axial PsA, as distinct lesion types specific to this condition have not been described.

MRI of the SIJ. Active lesions in the SIJ in PsA are comparable to those in other types of axial SpA. These lesions typically appear bright on fluid-sensitive sequences such as short-tau inversion recovery. They can be BME, capsulitis, inflammation in an erosion cavity, enthesitis, or joint effusion. Although BME is frequently observed, it may also occur in other conditions; conversely, capsulitis, though highly specific, occurs less frequently.

Regarding structural lesions in the SIJ, it has been observed that after the resolution of BME, typical fat lesions appear with increased signal intensity on T1-weighted sequences, often localized adjacent to the subchondral bone. A similar tissue response is noted after resolving inflammatory processes within erosion cavities, a phenomenon referred to as "backfill." The histopathological nature of this tissue response is not fully understood; however, it is hypothesized to be a fibroblastic reaction expressing fatty acids. Notably, these changes can occur rapidly, evidenced by a 12-week period in a placebo-controlled trial.[8] Additional structural lesions include erosions, characterized by a loss of the dark signal from cortical bone alongside the loss of adjacent bright marrow signal on T1-weighted sequences.[7] Erosions can be visualized with higher sensitivity on erosion-sensitive MRI sequences. Ankylosis is represented by a bridging hyperintensity on T1-weighted images across the joint cavity, whereas a bone bud protrudes into the cavity without bridging it.

Inflammatory and structural lesions identified in MRI sequences can be quantified using the Spondyloarthritis Research Consortium of Canada (SPARCC) SIJ inflammation score (SIS) and the SPARCC SIJ structural score.[9,10] For the first time in PsA research, the SPARCC SIS was recently applied in a clinical trial investigating the effects of apremilast in PsA.[11]

The SIS uses semicoronal fluid-sensitive sequences to divide the SIJ into quadrants and score BME. Each quadrant is evaluated, with a maximum score of 12 points per slice and a total of 0 to 72 points across 6 slices. Structural scores are similar, with 5 slices evaluated, starting from the transitional slice. Each SIJ quadrant is scored for fat metaplasia and erosions (maximum 8 points/slice, totaling 0-40 points) and backfill and ankylosis (maximum 4 points/slice, totaling 0-20 points). These scores are not combined due to different tissue responses during inflammation resolution.

MRI of the spine. Spine MRI can identify various lesion types, including vertebral body and posterolateral lesions. Some vertebral body lesions are not specific, as they are also observed in degenerative disease. Particular attention is drawn to the lateral slices, where the spinal canal is not visible. In the thoracic region, costovertebral joint inflammation may be seen as hyperintensity in the posterolateral aspect of the vertebral body and the adjacent rib head. Further lateral inspection may reveal bright signals within the facet joints, the rib, and the transverse process, indicating inflammation.[12,13] Structural lesions in the spine, such as fat lesions, erosions, and ankylosis, can also be observed. Fat metaplasia is of particular interest, as conventional T1-weighted MRI is not optimally suited for evaluating new bone formation, and erosions remain less frequent.[14]

Inflammatory and structural spine lesions can be quantified using the Canada-Denmark (CanDen) MRI scoring system, which can assess the vertebral bodies and the posterolateral elements.[15] The CanDen MRI scoring system for the spine uses an anatomical-based approach to evaluate different regions of the spine, including the anterior and posterior vertebral corners as well as the thoracic spine (Figure 2).[15] This system assesses both inflammatory and various structural lesions (fat lesions, bone erosions, and new bone formation) and incorporates subscores for various lesion types, which is a helpful feature when scoring specific areas of interest during therapeutic interventions. The CanDen scoring system was recently documented to be sensitive to change during therapy in a trial of patients with PsA.[11]

A look into the future: WB-MRI in PsA

WB-MRI is an emerging technique that facilitates the simultaneous evaluation of peripheral and axial joints, as well as entheses. With this modality, images of the spine, SIJs, peripheral joints, and entheses can be obtained within a reasonable examination timeframe of approximately 1 hour.[16-18] Although image quality is somewhat diminished in smaller joints and entheses, WB-MRI provides a valuable overarching assessment of patients with diverse musculoskeletal manifestations, particularly in PsA.[19]

The OMERACT WB-MRI Score for Inflammation in Peripheral Joints and Entheses (MRI-WIPE) has been developed and validated to quantify inflammation in different areas.[20,21] The MRI-WIPE score has demonstrated the ability to differentiate between active treatment and placebo groups within 6 weeks, indicating promising potential for future clinical applications.[22]

In practice, WB-MRI involves acquiring images using different anatomical stations, including shoulders, hips, hands, knees, ankles, feet, spine, and SIJs.[20] Coronal or sagittal imaging planes are recommended for optimal data acquisition of each body region as follows: coronal planes are recommended for assessing the shoulder/anterior chest wall, hips/pelvis, hands, and feet, whereas sagittal planes are preferable for knee and ankle evaluations (Figure 3). The acquired images may be both fluid-sensitive and T1-weighted, allowing for the visualization of changes in inflammatory and structural lesions over time, but mainly inflammation is currently assessed.

An illustrative application of WB-MRI can be observed in the MOSAIC trial, a phase IV open-label study designed to evaluate the effect of apremilast on MRI outcomes in patients with active PsA.[11] In this trial, all participants were administered apremilast, with contrast-enhanced MRI of the hand and WB-MRI conducted at baseline, week 24, and week 48. The primary endpoint was a change in the inflammation score of the hand as measured by the PsAMRIS. All images were evaluated in a random order by blinded assessors. The results indicated a reduction in several inflammatory variables and modifications in the individual components of inflammation, whereas no significant changes were noted in the structural components. Specifically, WB-MRI demonstrated that image resolution for smaller joints is not yet optimal, though sufficient clarity was

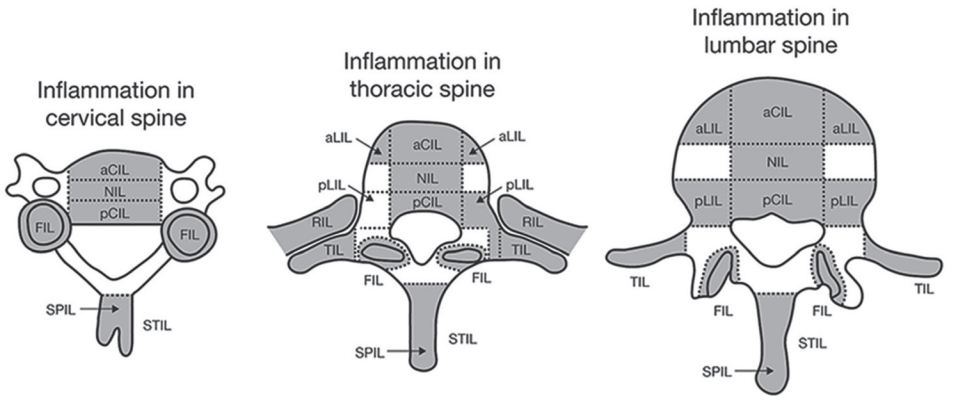

Figure 2. Cervical, thoracic, and lumbar vertebrae with different anatomical areas assessed using the CanDen magnetic resonance imaging spine inflammation scoring system. See Krabbe et al[15] and Østergaard et al[24] for details on how the individual areas contribute to various CanDen scores. Reprinted from Østergaard, et al.[24] Licensed under CC-BY-NC. aCIL: anterior corner inflammatory lesion; aLIL: anterior lateral inflammatory lesion; CanDen: Canada-Denmark; FIL: facet joint inflammatory lesion; NIL: noncorner inflammatory lesion; pCIL: posterior corner inflammatory lesion; pLIL: posterior lateral inflammatory lesion; RIL: rib inflammatory lesion; SPIL: spinous process inflammatory lesion; STIL: soft tissue inflammatory lesion; TIL: transverse process inflammatory lesion.

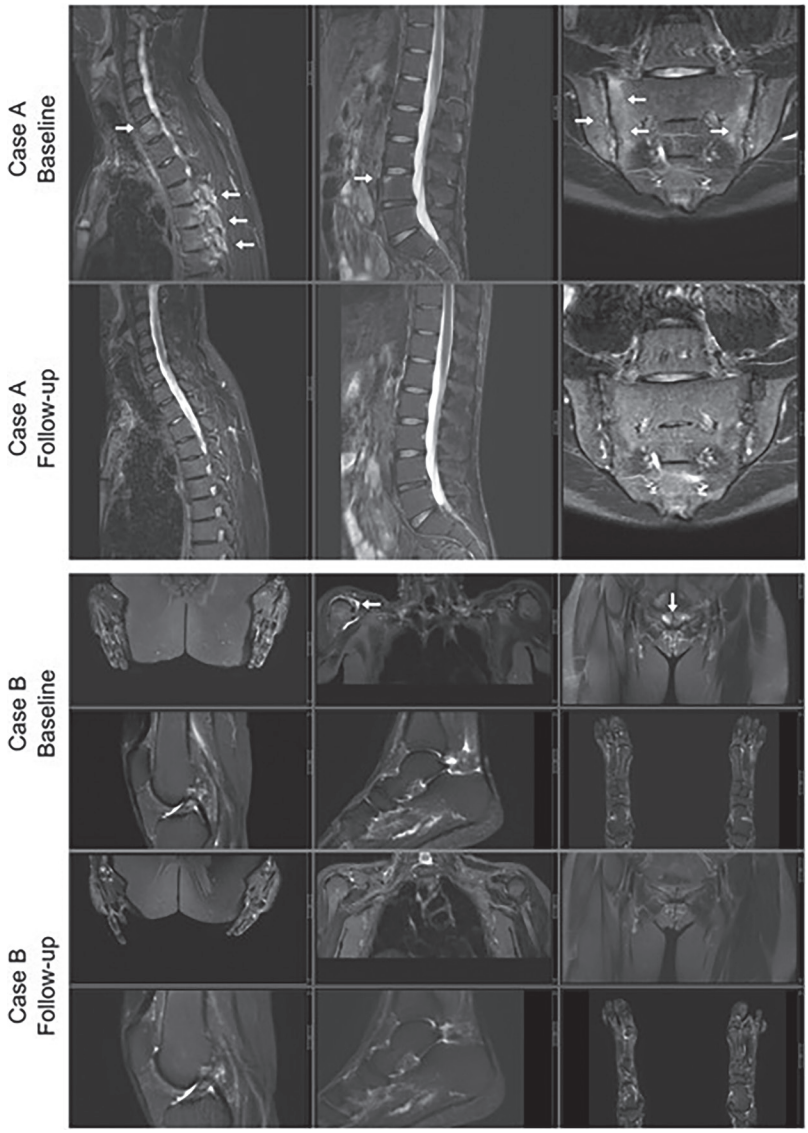

Figure 3. Examples of improvement in axial and peripheral inflammatory lesions documented by whole-body magnetic resonance imaging. Case A: Patient with improvement in axial inflammation. (L-R): Sagittal STIR of upper spine, sagittal STIR of lower spine, and semicoronal STIR of SIJ. Inflammatory lesions in facet joints and lateral parts of vertebral bodies at rib insertions and inflammation of both SIJ at baseline improved during treatment. Case B: Patient with improvement in peripheral inflammation. (L-R): Coronal STIR of hands, coronal STIR of shoulders and anterior chest wall, coronal STIR of pelvis, sagittal STIR of knees, sagittal STIR of ankles, and coronal images of feet. Synovitis and/or effusion in the right glenohumeral (shoulder) joint and osteitis at the pubic symphysis at baseline improved during treatment. Arrows indicate bone marrow edema (inflammation). Reprinted with permission from Krabbe et al.[25] SIJ: sacroiliac joints; STIR: short-tau inversion recovery.

achieved to identify changes in inflammatory lesions. Notably, the SPARCC score for the SIJs and spine in this study did not reveal significant changes among the axial joints; however, the CanDen score reflected improvements of inflammation in the spine, including the posterolateral elements, underscoring a limitation of the SPARCC score, which only assesses inflammation in vertebral bodies (Figure 2 and Figure 4).[11]

Although WB-MRI has great potential for assessing patients with PsA, its use in clinical practice remains limited. It can be expensive and less accessible, and the long scan times may cause patient discomfort and motion artifacts. Additionally, although WB-MRI provides a comprehensive overview, it may compromise on resolution for smaller joints.[19] Despite these challenges, WB-MRI remains a valuable tool for evaluating disease extent and monitoring treatment response, with promising future applications as technology advances.

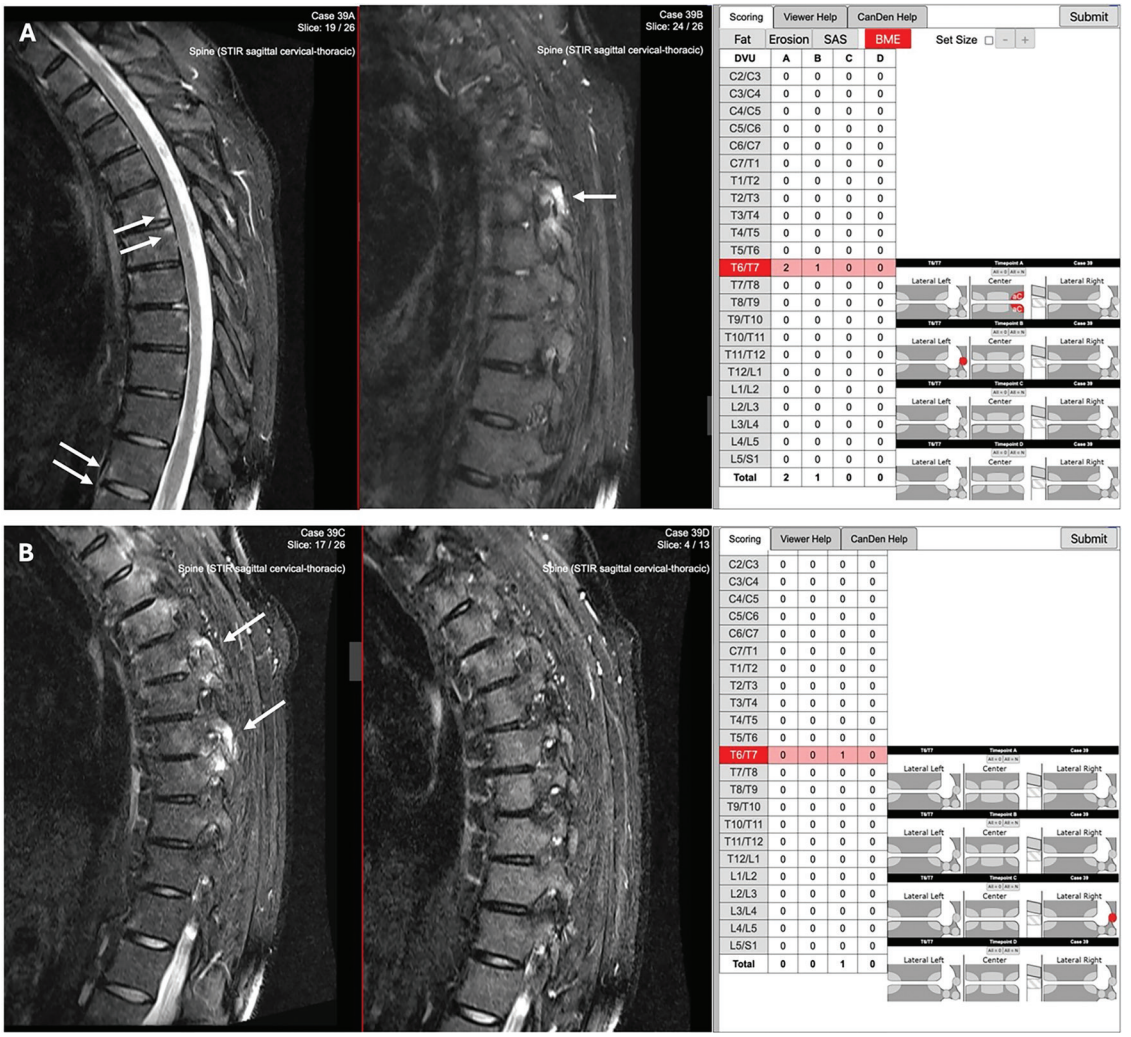

Figure 4. Sagittal STIR magnetic resonance imaging of the thoracic spine in a patient with axial psoriatic arthritis. (A) The left image is a central slice, showing several anterior and posterior corner inflammatory lesions (white arrows). The middle image is a lateral slice, documenting an inflamed facet joint (white arrow). The right schematic displays the online scoring interface, in which 2 posterior inflammatory corner lesions and facet joint inflammation are registered on the T6/T7 level. (B) The left image is a baseline pretreatment scan illustrating 2 facet joint inflammatory lesions. The middle image is a posttreatment scan illustrating the resolution of inflammation in the facet joints. See www.carearthritis.com for a detailed description.[26] BME: bone marrow edema; CanDen: Canada-Denmark; SAS: Spur and Ankylosis Score; STIR: short-tau inversion recovery.

Conclusion

MRI plays an essential role in detecting and evaluating both peripheral and axial manifestations of PsA. This imaging modality allows for the visualization of inflammatory and structural lesions across diverse presentations of PsA, providing crucial insights for diagnosis, monitoring, and treatment evaluation. Standardized definitions and scoring systems enhance the evaluation consistency of peripheral and axial manifestations, thereby improving the objective assessment of disease burden and therapeutic response. Further, applying WB-MRI in clinical trials illustrates its potential for comprehensive patient assessment in PsA. MRI is a valuable tool in the comprehensive management of PsA, offering detailed insights into the disease pathology across different affected areas.

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ETHICS AND PATIENT CONSENT

Institutional review board approval and patient consent were not required.

PEER REVIEW

As part of the supplement series GRAPPA 2024, this report was reviewed internally and approved by the Guest Editors for integrity, accuracy, and consistency with scientific and ethical standards.

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