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Rheumatology: Current Research

Commentary

Imaging in Pediatric Rheumatology from Visual Aid to Clinical Cornerstone

Marco Matteo*

Department of Neurosciences, University of Genoa, Genova, Italy.

DESCRIPTION

The landscape of pediatric rheumatology has transformed remarkably in recent years, driven in part by advances in imaging technology. The integration of ultrasound and magnetic resonance imaging into clinical practice has enhanced the diagnosis, monitoring, and management of pediatric rheumatic diseases, especially where traditional clinical assessments fall short. These modalities, once seen as supplementary, are now central to modern care paradigms. Their growing role reflects both the increasing complexity of disease management and a deeper understanding of how early, accurate visualization can change clinical outcomes.

At the heart of this evolution is the complementary nature of ultrasound and MRI. Each modality brings unique strengths to the table. Ultrasound offers real-time imaging, superior spatial resolution, and the ability to assess multiple joints during a single session all without the need for sedation or exposure to ionizing radiation. It excels in the evaluation of enthuses, synovial hypertrophy and effusions and is particularly well suited for younger patients due to its portability, safety and patient-friendly nature.

MRI, by contrast, provides unparalleled visualization of bone marrow, cartilage, and deep tissue structures. It is especially advantageous for regions difficult to access via ultrasound, such as the Temporomandibular Joint (TMJ) and the axial skeleton, including the sacroiliac joints and spine. These areas are often sites of early and significant pathology in diseases like Juvenile Idiopathic Arthritis (JIA), enthesitis-related arthritis, and systemic conditions like lupus or vasculitis. MRI's multiplanar capability and high soft tissue contrast make it indispensable for detecting osteochondral lesions, bone marrow edema, and early erosions findings that may be invisible to ultrasound or conventional radiographs.

Importantly, both modalities now benefit from substantial progress in standardization and quantification. The development of standardized scoring systems and imaging protocols allows clinicians not only to detect disease activity with precision but also to track it over time. This is especially critical in pediatric rheumatology, where disease phenotypes can vary widely, and where symptoms such as pain or stiffness may be poorly localized or under-reported by younger patients. Imaging thus becomes a vital objective outcome measure, helping clinicians make informed decisions about treatment escalation, tapering, or switching.

The integration of imaging into routine care also improves early diagnosis, a known determinant of long-term outcomes in pediatric rheumatology. Subclinical disease activity often undetectable by physical examination alone can be visualized with imaging, allowing for timely interventions before irreversible damage occurs. This is particularly relevant in oligo articular JIA, where children may appear clinically quiescent despite ongoing inflammation visible on imaging. Similarly, in enthesitis-related arthritis, where physical exam findings can be subtle, imaging often confirms the presence and extent of disease with much greater accuracy.

Transforming radiology: AI enhances diagnostic accuracy

Perhaps the most transformative development on the horizon is the integration of artificial intelligence into imaging analysis. AI-powered tools promise to revolutionize image interpretation by increasing accuracy, reducing inter-observer variability, and accelerating diagnostic workflows. Machine learning algorithms are already being trained to identify key imaging biomarkers, segment joint structures, and even predict disease flares. As these technologies mature, they will become critical allies for clinicians, particularly in resource-constrained settings where experienced musculoskeletal radiologists may not be readily available.

Still, challenges remain. The use of imaging, especially MRI, is limited by cost, availability, and access to sedation services in some centers. For ultrasound, operator dependency and variability in training remain significant hurdles to consistent implementation. These limitations underscore the need for continued investment in training, technology dissemination, and interdisciplinary collaboration between rheumatologists, radiologists, and pediatricians. Further research into age-specific

Correspondence to: Marco Matteo, Department of Neurosciences, University of Genoa, Genova, Italy Email: marco@gmail.com

Received: 24-Jan-2025, Manuscript No. RCR-25- 37685; **Editor assigned:** 27-Jan-2025, PreQC No. RCR-25- 37685 (PQ); **Reviewed:** 10-Feb-2025, QC No. RCR-25- 37685; **Revised:** 17-Feb-2025, Manuscript No. RCR-25- 37685 (R); **Published:** 24-Feb-2025, DOI: 10.35841/2161-1149.24.15.443

Citation: Matteo M (2025). Imaging in Pediatric Rheumatology from Visual Aid to Clinical Cornerstone. Rheumatology (Sunnyvale). 15: 443.

normal imaging findings, especially for growing bones and joints, is also essential to avoid misinterpretation and overtreatment.

Moreover, while standardized scoring systems are a major step forward, their adoption in everyday clinical practice remains uneven. Tools such as the JAMRIS (Juvenile Arthritis MRI Scoring System) or the OMERACT ultrasound definitions for synovitis provide much-needed frameworks, but they require time, expertise, and often sophisticated software platforms that are not universally available.

Despite these challenges, the progress is undeniable. Imaging has evolved from a diagnostic luxury to an essential component of precision medicine in pediatric rheumatology. As we continue to refine our tools and expand access, we move closer to a model of care that is proactive rather than reactive where early identification, targeted treatment, and ongoing monitoring are the norm rather than the exception.

CONCLUSION

In conclusion, the dual utility of ultrasound and MRI has redefined how pediatric rheumatologists approach the diagnosis and management of inflammatory musculoskeletal diseases. When combined with clinical assessment and laboratory findings, these modalities provide a comprehensive, nuanced view of disease activity that can guide more effective and individualized care. The ongoing integration of artificial intelligence and continuous improvements in standardization and accessibility will only strengthen this foundation. Pediatric rheumatology is entering a new era one in which imaging not only reflects disease but helps us transform its course.