Imaging in juvenile idiopathic arthritis: a clinician’s perspective

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Why imaging is important in JIA?

• In the last decade, there has been important progress in the management of JIA

• A reliable documentation of the recent advances requires sensitive methods that enable a precise monitoring of the course of the synovial inflammation process.

• It also makes desirable to be able to identify precociously patients with a high likelihood of developing erosive joint damage

• Of the diagnostic tools currently available, imaging studies are best suited for these purposes
General challenges with imaging in JIA

- Unique features of the growing skeleton (e.g. age-related variations in the thickness of the articular cartilage and incomplete ossification)
- Children with chronic arthritis may develop distinctive abnormalities (e.g. disturbance of bone growth and maturation)
- Impossibility to assess reliably joint changes in pediatric patients without the availability of normal standards
- Findings from studies in adults not applicable to children
Imaging methods in JIA

- Conventional radiography
- Magnetic resonance imaging (MRI)
- Musculoskeletal ultrasonography (US)
Conventional radiography
Advantages and limitations of conventional X-ray

**Advantages**

- Demonstration of bone damage
- Visualization of disturbances of bone growth and maturation
- Suitable for longitudinal evaluation of damage progression
- Validated scoring methods
- Widespread availability
- Low cost
Advantages and limitations of conventional X-ray

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**Limitations**

- Inability to visualize soft tissue inflammation
- Inability to visualize cartilage
- Low reliability for early diagnosis of arthritis
- Late detection of erosions
- Projectional superimposition
- Exposure to ionizing radiations
Change in bone morphology and width of joint spaces with age
Advancement in bone age
A patient with unilateral wrist disease...
Measurement of Poznanski score

RM = 21.2 mm
M2 = 35.2 mm

RM = 25.1 mm
M2 = 35.6 mm
Normative chart for Poznanski score

Left wrist

Right wrist
Calculation of Poznanski score

**LEFT WRIST:**

Expected RM = 14.1 + (0.348 x M2) = 14.1 + (0.348 x 35.2 mm) = 26.3 mm  
SD=1.65 mm

**Poznanski score** = (Observed RM – Expected RM)/SD  
= (21.2 – 26.3)/1.65 = -5.1/1.65 = **-3.09 units**

**RIGHT WRIST:**

Expected RM = 14.1 + (0.348 x M2) = 14.1 + (0.348 x 35.6 mm) = 26.5 mm  
SD=1.65 mm

**Poznanski score** = (Observed RM – Expected RM)/SD  
= (25.1 – 26.5)/1.65 = -1.4/1.65 = **-0.84 units**
Adapted SH – JSN score
Adapted SH – Erosion score
Time course of radiographic joint damage in JIA

Follow-up time

Percentage of maximum score

Total N
Total ENew
Tot OrE
Tot_NE_New
Tot_NEOr

Ravelli A et al. A&R 2007;56:3087-95
Magnetic resonance imaging (MRI)
Advantages and limitations of MRI

**Advantages**
- Demonstration of soft tissue inflammation
- Early detection of bone erosions
- Direct visualization of cartilage
- Visualization of bone marrow edema
- Suitable for assessment of axial skeleton and TMJ
- Lack of exposure to ionizing radiations
## Advantages and Limitations of MRI

### Advantages
- Demonstration of soft tissue inflammation
- Early detection of bone erosions
- Direct visualization of cartilage
- Visualization of bone marrow edema
- Suitable for assessment of axial skeleton and TMJ
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### Limitations
- High cost
- Long examination time
- General anesthesia required in younger children
- Possible allergic contrast reactions
- Evaluation limited to one target joint
- Variable availability worldwide
Hip MRI

Active synovitis

Bone marrow edema

Erosion
Sacro-iliac joint MRI
Course of MRI-detected synovitis during etanercept therapy

Baseline

After 1 year
Frequency of bone erosions by disease duration

< 3 years  | 3-5.5 years  | ≥ 5.6 years
--- | --- | ---
100.0 | 87.5 | 100.0
87.5 | 50.0 | 77.8
100.0 | 62.5 | 85.7
22.2 | 11.1 | 11.1
20.0 | 20.0 | 20.0
40.0 | 40.0 | 40.0
60.0 | 60.0 | 60.0
80.0 | 80.0 | 80.0
100.0 | 100.0 | 100.0

Malattia C et al. A&R 2008;59:1764-72
Bone edema → progression to an erosion into the distal epiphysis of the radius
Wrist MRI in healthy children

- **Bony depressions**
- **Intra-articular fluid**
- **Bone marrow edema**

Müller LS et al. Ann Rheum Dis 2011;70-605-10
Ultrasound
Advantages and limitations of ultrasound

**Advantages**

- Noninvasiveness
- Ability to scan multiple joints
- Easy repeatability
- High patient acceptability
- Relatively cheap
- Demonstration of soft tissue inflammation
- Visualization of cartilage
- Potential aid for guiding intra-articular injections
- Lack of exposure to ionizing radiations
## Advantages and limitations of ultrasound

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Limitations</th>
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<tr>
<td>• Noninvasiveness</td>
<td>• Operator dependency</td>
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<tr>
<td>• Ability to scan multiple joints</td>
<td>• Reliability dependent on equipment used</td>
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<td>• Easy repeatability</td>
<td>• Limited value in the assessment of axial skeleton and TMJ</td>
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<td>• High patient acceptability</td>
<td>• Inability to assess the whole joint space</td>
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<td>• Relatively cheap</td>
<td>• Difficult to carry out in case of joint pain</td>
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<td>• Demonstration of soft tissue inflammation</td>
<td>• Difficult to standardize and centralize for clinical trials</td>
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<td>• Visualization of cartilage</td>
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Challenges with use of US in children with JIA

- High ratio cartilage/bone in the immature skeleton
- Physiologically enhanced blood flow
- Changes in US anatomy during growth
- Irregular appearance of some ossification centers
Ankle synovitis
Backer’s cyst
US assessment of therapeutic response

Before IACI

After IACI
Ultrasound-driven injection
Scoring of US features

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<thead>
<tr>
<th>Joint effusion</th>
<th>Synovial hyperplasia</th>
<th>Power Doppler</th>
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Subclinical synovitis in JIA

Detection of Active Disease in Juvenile Idiopathic Arthritis: Sensitivity and Specificity of the Physical Examination vs Ultrasound

GINGER L. JANOW, VIKASH PANGHAL, ANGELA TRINH, DAVID BADGER, TERRY L. LEVIN, and NORMAN T. ILOWITE

Comparison of Clinical and Ultrasonographic Evaluations for Peripheral Synovitis in Juvenile Idiopathic Arthritis

Sylvain Breton, MD,* Sandrine Jousse-Joulin, MD,† Claire Cangemi, MD,* Loic de Parsieu PhD,‡ Danielle Colin, MD,* Luc Bressollette, PhD,§ Alain Saux, PhD,† and Valérie Devauchelle-Pensec, PhD†

RHEUMATOLOGY

Original article

The detection of subclinical synovitis by ultrasound in oligoarticular juvenile idiopathic arthritis: a pilot study

Kirsty E. Haslam¹, Liza J. McCann², Susan Wyatt¹ and Richard J. Wakefield³

Ankle Disease in Juvenile Idiopathic Arthritis: Ultrasound Findings in Clinically Swollen Ankles

MADELEINE E. ROONEY, CATHERINE McALLISTER, and JAMES F.T. BURNS

Prospective Evaluation of Clinical and Ultrasound Findings in Ankle Disease in Juvenile Idiopathic Arthritis: Importance of Ankle Ultrasound

LAURA PASCOLI, STEPHEN WRIGHT, CATHERINE McALLISTER, and MADELEINE ROONEY
Clinical vs. US assessment

Ultrasound Findings on Patients With Juvenile Idiopathic Arthritis in Clinical Remission

MONICA REBOLLO-POLO,¹ KHALDOUN KOUJOK,¹ CAROLINE WEISSER,¹ ROMAN JURENCAK,¹ ALESSANDRA BRUNS,² AND JOHANNES ROTH¹

Do Patients With Juvenile Idiopathic Arthritis in Clinical Remission Have Evidence of Persistent Inflammation on 3T Magnetic Resonance Imaging?

AMANDA BROWN,¹ RAPHAEL HIRSCH,² TAL LAOR,³ MICHAEL J. HANNON,⁴ MARC C. LEVESQUE,⁴ TERENCE STARZ,⁴ KIMBERLY FRANCIS,² AND C. KENT KWOH⁵
Frequency of baseline US abnormalities in 39 children with JIA and clinically-defined inactive disease

- Synovial hyperplasia: 76.9%
- Joint effusion: 66.7%
- Power-Doppler signal: 33.3%
- Tenosynovitis: 15.4%

Assessment of disease course over time

1) Persistently Inactive Disease at 24 months
   No. of patients 24 (61.5%)

2) Relapse of synovitis
   No. of patients 15 (38.5%)
   Median follow-up, months 10.6 (6.3-13.7)
Comparison of US features at baseline between children with sustained ID and children with synovitis flare

- Synovial hyperplasia: p = 0.71
- Joint effusion: p = 0.49
- PD signal: p = 0.036
- Tenosynovitis: p = 0.66

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Patients with persistent ID

Patients with synovitis flare

Ultrasound-detected synovial abnormalities are frequent in clinically inactive juvenile idiopathic arthritis, but do not predict a flare of synovitis

Silvia Magni-Manzoni, Carlo Alberto Scirè, Angelo Ravelli, Catherine Klersy, Silvia Rossi, Valentina Muratore, Chiara Visconti, Stefano Lanni, Pietro Merli, Carlomaurizio Montecucco.
Future directions

• Conventional radiography will remain the most reliable modality for the demonstration of structural bone damage in children with JIA for some time to come.

• MRI and US hold great promise in identifying bone and cartilage changes much earlier than conventional radiography.

• More information is needed to establish whether the apparent changes in bone surface and the bone marrow edema seen on MRI in children with JIA are pathologic or part of normal development.

• Further investigations of the clinical meaning of US-detected features of synovitis in children are necessary.
Editorial

The Time Has Come to Include Assessment of Radiographic Progression in Juvenile Idiopathic Arthritis Clinical Trials

The Journal of Rheumatology 2008; 35:4

Advances and challenges in imaging in juvenile idiopathic arthritis

Silvia Magni-Manzoni, Clara Malattia, Stefano Lanni and Angelo Ravelli

Review

Towards a role of ultrasound in children with juvenile idiopathic arthritis

Stefano Lanni\textsuperscript{1,2}, Mark Wood\textsuperscript{3}, Angelo Ravelli\textsuperscript{4,5}, Silvia Magni Manzoni\textsuperscript{1}, Paul Emery\textsuperscript{2} and Richard J. Wakefield\textsuperscript{2}

doi:10.1093/rheumatology/kes287
The Time Has Come to Include Assessment of Radiographic Progression in Juvenile Idiopathic Arthritis Clinical Trials

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Advances and challenges in imaging in juvenile idiopathic arthritis

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Thank you

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