Can we use Color Doppler to diagnose sacroiliitis in juvenile SpA patients?

Poster No.: C-1770
Congress: ECR 2016
Type: Scientific Exhibit
Authors: M. Skender¹, D. Bajramović¹, K. Potočki², K. Štekić Nova², M. Jelusic¹; ¹Zagreb/HR, ²Zagreb, Gr/HR
Keywords: Bones, Ultrasound-Colour Doppler, MR, Diagnostic procedure, Arthritides
DOI: 10.1594/ecr2016/C-1770

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Aims and objectives

Juvenile idiopathic arthritis is an autoimmune disease that affects children under the age of 16 and is the most common rheumatic disease in pediatric population with an estimated prevalence of 2-20, and an incidence of 16-150 on 100,000\(^1\). ILAR (International League of Associations for Rheumatology) classifies 7 types of disease\(^2\). Juvenile spondyloarthropathy (jSpA) or enthesitis-related arthritis (ERA) is one of the seven types of the disease and is a clinical diagnose that refers to a group of inflammatory diseases with common clinical characteristics, often associated with the presence of human lymphocyte antigen HLA-B27. It predominantly affects the axial skeleton causing pain and stiffness. Up to 30% of jSpA patients develop clinical and MRI signs of sacroiliitis\(^3\) with early signs being the number of the inflamed joints and entheses at the disease onset, positive HLA-B27 serotyping and signs of hip joint inflammation within the first six months\(^4,5\). jSpA research conducted in Croatia showed no sex predilection and disease manifestation around the age of 13\(^6\). Sacroiliitis can be present even when there are no detectable clinical symptoms which usually manifest in the later course of the disease. While sacroiliitis is the hallmark feature of jSpA the delay in its detection remains one of the major problems to prompt the diagnosis. Imaging modalities play an important role in the diagnostic process, evaluation and assessment of disease extension. Previous clinical practice relied mostly on radiological findings based on conventional radiographs on which early signs of acute sacroilitis such as synovitis and bone marrow edema could not be demonstrated. In the past decade, this field of rheumatology has undergone major changes, largely driven by the development of new more effective drugs. The lack of valid biochemical markers for disease activity and the low sensitivity of conventional radiography have necessitated the use of other diagnostic methods to support clinical assessment. In patients with suspected jSpA and clinical symptoms of low back pain magnetic resonance imaging (MRI) is considered the "golden standard" in detecting acute sacroilitis due to its high sensitivity and specificity. Its main disadvantages are low availability, high cost, possible need for patient sedation and the long waiting list. Unfortunately, in Croatia as well as in many other countries the waiting lists for a MRI are quite long thus preventing clinicians to acquire diagnostic information in reasonable time period. That is primarily the reason why we get frequent request from our pediatric rheumatologists to perform the ultrasound/Color Doppler examination of sacroiliac joints in patients with clinical signs of sacroilitis. The reasoning behind these requests lies in a fact that the result of the US examination can be obtained quickly as well as in the results of the previous studies of peripheral joints where ultrasound examination proved to be highly effective method. Based on these experiences we conducted a survey as a pilot project to determine the value of Color Doppler in detecting acute sacroilitis in patients being observed for juvenile spondyloartropathy.
Methods and materials

Ultrasound/Color Doppler and contrast enhanced MRI of sacroiliac joints were performed on 89 patients observed for jSpA. All patients had low back pain and clinically suspected acute sacroiliitis. Out of 89 patients 38 were male and 51 female with average age being 14.6. Patients age at the beginning of the disease, number and sequence of joint involvement, history of rheumatic diseases in the family and results of HLA serotyping were recorded.

Ultrasound examination of SI joints was performed on high quality device (Logic 9, GE Medical system, USA) with the appropriate probe (C1-5-D 2D convex probe/9L-D 2D linear probe/ML6-15-D 2D matrix linear probe, GE Medical system, USA) depending on the age and child's body type (Figure 1). Ultrasound B-mode was used to visualize the joints. After proper identification of the joint space Power and Color Doppler were used in order to detect increased synovial vascularization (Figure 2). All imaging parameters were adjusted for every patient in order to get an optimal view and avoid Doppler artefacts (Figure 3 and 4). A semiquantitative scoring system was used to grade Doppler signals corresponding to blood flow detected (Figure 5). Resistance index (RI) was recorded in all cases when increased vascularization was detected (Figure 6). This procedure was performed on both SI joints.

MR imaging (MRI Magnetom Avanto 1.5T, Siemens, Germany) was performed with the use of body coil (Spine Matrix Coil, Siemens, and 4-Channel Flex Coils, Siemens) before and after the application of intravenous paramagnetic contrast media (Magnevist®, Bayer Schering Pharma at the recommended dose of 0.2 ml/kg body weight).

A standard set of sequences in accordance with the RAMRIS (Rheumatoid Arthritis Magnetic Resonance Imaging Studies) criteria was used (Figure 7).

All ultrasound and MRI examinations were performed by two MSK radiologists with an experience in imaging methods and protocols for rheumatic diseases.
Fig. 1: Patient positioning and imaging method

© Department of clinical radiology, University hospital centre Zagreb - Zagreb/HR
Fig. 2: After SI joint is identified with B-mode (I=iliac bone, S=sacrum, i.a.=intraarticular space) Color Doppler is used to detect synovial vascularization

© Department of clinical radiology, University hospital centre Zagreb - Zagreb/HR
**Fig. 3:** Recommended settings for Color and Power Doppler in rheumatology


<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doppler frequency</td>
<td>Lowest or highest depending on machine</td>
</tr>
<tr>
<td>Pulse repetition frequency</td>
<td>Lowest possible*</td>
</tr>
<tr>
<td>Colour priority</td>
<td>All priority to colour</td>
</tr>
<tr>
<td>Wall filter</td>
<td>Lowest possible*</td>
</tr>
<tr>
<td>Persistence</td>
<td>Lowest possible</td>
</tr>
<tr>
<td>Gain</td>
<td>On the threshold to noise</td>
</tr>
<tr>
<td>Focus</td>
<td>Placed where highest sensitivity is required</td>
</tr>
</tbody>
</table>

*Lowest possible where motion artefacts are avoided most of the time.

**Fig. 4:** US artefacts

- **Aliasing**: Occurs only while using CD and spectral Doppler. Aliased signals appear when the Doppler shift is higher than half of the PRF. Due to aliasing, the wrong colour of flow direction and incorrect relative velocity of flow are reported.
- **Blooming**: When a vessel appears larger than its actual size.
- **Focusing**: The correct focus point positioning is extremely important to improve the amplitude of the echoes produced in the focal area.
- **Mirror**: In rheumatology, mirror artefact is sometimes generated by the bone surface that creates mirror images below the bone profile.
- **Motion**: Any kind of movement (patient, probe, vessels) generates a Doppler shift, thus causing the appearance of false signal. To avoid them, both patients and operator should be comfortably positioned to remain stationary even during a long examination.
- **Pressure**: The use of abundant amount of acoustic gel is extremely important to give good acoustic adherence between the probe and the skin of the patient. This avoids the tendency to apply too much pressure thereby creating flow blockage and the generation of false negatives.
- **Random noise**: Depends on the noise caused by the electric circuits and appears, when the gain is too high, as a random colour signal in the Doppler image.
- **Reverberation**: The appearance of false colour foci may sometimes occur when a superficial vessel is imaged lower in the image either as a simple or a complex reverberation. It sometimes simulates the presence of Doppler signal within a joint.
Fig. 5: A four-grade semiquantitative scoring system for detected blood flow

Fig. 6: US and CD of sacroiliac (SI) joints. Presence of Doppler flow signals in posterior part of left sacroiliac joint. Vascular resistance index recorded in the same area shows low RI value (0.46) as a sign of acute synovitis.

© Department of clinical radiology, University hospital centre Zagreb - Zagreb/HR
Fig. 7: Subchondral bone marrow edema on STIR (left) and enhancement on postcontrast T1-weighted images with fat saturation (right) as signs of acute sacroiliitis.

© Department of clinical radiology, University hospital centre Zagreb - Zagreb/HR
Results

Active disease or acute sacroiliitis was noted using ultrasound/Color Doppler examination in 23 patients, 66 showed no signs of synovitis. MRI detected 22 patients with active disease. Only five patients had ultrasound signs of disease activity confirmed on MRI (Figure 8). Based on preliminary results sensitivity of ultrasound/Color Doppler examination in detecting acute sacroiliitis in jSpA patients is 22.7% and specificity is 73.1%. Positive predictive value is 0.22 while negative predictive value is 0.74. Out of 36 patients with sacroiliitis confirmed on the MRI (both active and chronic) 7 of them had positive HLA- B27 serotyping, 8 had hip joint inflammation at the disease onset and only 4 had positive family history of rheumatic diseases (Figure 9).

The average age of the patient with MRI confirmed sacroiliitis was 14.7.
**Fig. 8:** Comparison of US CD and MRI results.

© Department of clinical radiology, University hospital centre Zagreb - Zagreb/HR

<table>
<thead>
<tr>
<th>jSpA (N=89)</th>
<th>US CD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>positive</td>
</tr>
<tr>
<td>MRI</td>
<td>true positive 5</td>
</tr>
<tr>
<td>positive</td>
<td>false positive 18</td>
</tr>
<tr>
<td>negative</td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 9:** Results of HLA serotyping, previous hip affection and family history in patients with sacroiliitis

© Department of clinical radiology, University hospital centre Zagreb - Zagreb/HR
Conclusion

Ultrasound is an available, cheap and relatively easy method to perform and it doesn't have the harmful effects of radiation which is especially important in the pediatric population. It can be used to quickly assess a number of joints and to correlate the findings with clinical data. Changes of articular cartilage, synovia, joint effusion and tenosynovitis can be analyzed. Thickened synovia as a result of the inflammatory process shows increased vascularity which can be demonstrated with the use of Color and Power Doppler. Previous research on ultrasound/CD imaging of peripheral joints like knees, ankles and small joints of hands and feet which are most commonly affected showed that the presence of Doppler signals is in high correlation with clinical signs of synovitis. It also demonstrated the advantages of ultrasound over clinical examination in disease activity assessment. Ultrasound examination is user dependent and has to be performed by experienced personnel.

In sacroiliac joints imaging ultrasound has serious limitations due to the complex joint anatomy and a relatively small imaging "window" that enables us to visualize and analyze only the dorsal aspect of the joint. Evaluator has to make sure to that the Doppler signals acquired are the result of the increased vascularity within the synovia in the intraarticular space itself, and not the result of imaging of the blood vessels in the periarticular soft tissues. Optimizing the image parameters is extremely important as well as imaging experience. As mentioned before, MRI is a method of choice for detection of acute sacroiliitis but due to the waiting lists it can take a substantial amount of time before the examination can be performed. In order to get the diagnostic information as soon as possible ultrasound examination is often indicated. As our preliminary results show such approach is questionable due to the low sensitivity and specificity of the method resulting from limitations mentioned above.

Due to the low number of positive US results, measured RI values are not relevant in this survey so far and cannot serve as a cut-off value for determining acute sacroiliitis in this group of patients.

Next phase of this project will include calculation of inter and intra-observer differences between two investigators concerning Doppler signal detection and grading.

In conclusion, based on these preliminary results ultrasound is not the adequate method for demonstrating acute sacroiliitis and re-thinking of the diagnostic procedure is needed to ensure that patients with high clinical suspicion of sacroiliitis perform the MRI as soon as possible in order to confirm the diagnosis.
**Personal information**

Mateja Skender, MD  
Department of Diagnostic and Interventional Radiology, University Hospital Centre Zagreb, Croatia  
skender.mateja@gmail.com

Dubravko Bajramovi#, MD  
Department of Diagnostic and Interventional Radiology, University Hospital Centre Zagreb, Croatia  
dubravko.bajramovic@kbc-zagreb.hr

Prof. Kristina Poto#ki, MD, PhD  
Department of Diagnostic and Interventional Radiology, University Hospital Centre Zagreb, Croatia  
kristina.potocki@zg.t-com.hr

Ksenija Šteki#/Nova#ki, MD  
Department of Diagnostic and Interventional Radiology, University Hospital Centre Zagreb, Croatia  
ksenijanovacki@gmail.com

Prof. Marija Jeluši#, MD, PhD  
Department of Pediatrics, University Hospital Centre Zagreb, Croatia  
marija.jelusic.drazic@gmail.com
References