

FRI0580 **QUANTITATIVE MRI OF SINGLE VS. MULTIPLE JOINTS IN JUVENILE IDIOPATHIC ARTHRITIS AS PREDICTIVE MEASURE OF CLINICAL OUTCOMES**

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Background: Clinical examination of juvenile idiopathic arthritis (JIA) patients does not always adequately reflect disease activity, whereas quantitative Dynamic Contrast Enhanced (DCE)-MRI based biomarkers extracted from images of multiple joints have been shown to reliably predict the course of the disease¹.

Objectives: To investigate the association between DCE-MRI measures of inflammation in a single and in multiple joints and the treatment related clinical changes.

Methods: 18 patients (12 girls, med. age 12.6 years, med. disease 1.2 years) with polyarticular JIA with more than 3 affected joints or intolerance to more than 3 months of MTX were given Etanercept. Their most clinically affected hand was imaged with DCE-MRI (0.2T Esaote C-Scan) at baseline, 3 and 6 months following the treatment. DCE-MRI was analysed using dedicated software package (DYNAMIKA, IAG). Dynamic Enhanced MRI Quantification (DEMRIQ-V) was calculated as the volume of enhancing voxels within Region of Interest placed around a single or multiple MCPJs. DEMRIQ-V was also weighted by the mean of Maximum Enhancement (ME) and Initial Rate of Enhancement (IRE), the parameters corresponding to the height and slope of the signal intensity vs time curves extracted from the enhancing voxels.² Clinical scores included active joint (AJ) count. Involvement of less than 3 AJ was considered a clinical response. The differences in DEMRIQ-V between the visits were analysed using t-test, assuming $p < 0.05^*$ to be statistically significant and $p < 0.025^{**}$ to be clinically meaningful.

Results: In all patients, in clinically unaffected joints, MRI was able to detect sub-clinical disease, and in all but 3 patients, significant and/or clinically meaningful changes were documented for DEMRIQ-ME. In 4 patients, DEMRIQ-V scores showed corresponding clinical changes whereas all other patients these markers were non-concordant. DEMRIQ-V score was predictive of clinical outcome:

- in 5 patients, improvement of DEMRIQ-V at month 3 predicted response to treatment at month 6;
- in 4 patients, increase or persistence of a high DEMRIQ-V at month 3 predicted non-response to treatment at month 6;
- DEMRIQ-V measured in a single most affected joint was as predictive as when it was measured in all MCPJs.

Conclusions: We conclude that DCE-MRI's ability to detect early disease can reliably support clinical examination. Use of DEMRIQ-V and DEMRIQ-ME scores, which either followed clinical response (DEMRIQ-ME) or predicted clinical outcomes at 6 months (DEMRIQ-V) in most patients can support early clinical and research decisions.

REFERENCES:

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FRI0581 **ULTRASONOGRAPHY IN THE DETECTION OF JOINT DESTRUCTION IN RA PATIENTS: A COMPARISON WITH CONVENTIONAL RADIOGRAPHY**

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Background: RA evolves erosive polyarthritis resulting in destructive changes in the joints. Ultrasonography (US) is used in current practice as early diagnostic modality for identification of structural damage to the articular surfaces.

Objectives: To compare US and radiographic assessment of hands and feet joint destruction in RA patients, and to evaluate the contribution of early US detection of damage into long-term RA outcomes.

Methods: 75 patients with RA, mean age 54.0,^{44.0;} 62.0 disease duration 7^{4;} 20 months, were treated with MTX and biologics according to Treat-To-Target concept. Hands and feet US were analysed before initiation of treatment and in 3, 6, 9 and 12 months after. Deepening of the bony contour >2 mm in width and >1 mm

in depth, visualised in 2 orthogonal planes, was considered as the key US sign of destructive changes (erosions) according to OMERACT criteria. A binary scoring system (presence/absence of erosions) of the joints examined was used. Radiographs were obtained at baseline, at 12 month and 4 years, radiographic changes were assessed using Sharp/van der Heijde modified scoring method. Radiographic progression was documented based on Sharp/Van der Heijde modified score changes during the follow up.

Results: There was a significant correlation between the counts of joints with erosions obtained with two diagnostic methods – US and radiography. This correlation was moderate before initiation of therapy ($r=0.37$; $p=0.0008$), and weak – after 12 month follow up ($r=0.28$ $p=0.016$). During one year US showed increase in the count of joints with erosions (from 1 [0; 2] to 2^{1; 3}) while radiography did not show any significant change (from 0 [0; 1] to 0 [0; 1]).

Bland-Altman analysis showed statistical agreement between the results obtained by two methods. Mean difference between the two modalities before initiation of treatment was -0.42 (95% CI -0.68 ; -0.16), and at 12 month follow up -1.16 (95% CI -1.52 ; -0.80), which is comparable with actual values. We identified the relationship between the difference in variables and the count of affected joints before and 12 month after initiation of treatment ($r=-0.35$, $r=-0.53$ respectively). 8% of variables were outside 2 standard deviations at baseline, and 4% – at 12 month. Logistic regression analysis showed no relationship between annual radiological progression and US diagnosed increasing count of joints with erosions at 3, 6 and 9 months follow up. However, dynamic radiographs assessment at 4 years revealed a correlation with US diagnosed count of joints with erosions at 6 month and 9 month follow up ($r=0.24$, $p=0.03$; $r=0.24$, $p=0.04$, respectively). Quality indicator of US diagnosed count of erosions at 6 month follow up: OR=2.8 95% CI 1.05–7.5, $p=0.037$, with 71% sensitivity and 54% specificity; Quality indicator of US diagnosed count of erosions at 9 month follow up: OR=2.73 95% CI 1.02–7.27, $p=0.041$, with 64% sensitivity and 61% specificity. Quantitative assessment of the dynamics at these time periods did not show any relationship.

Conclusions: Therefore, our study confirms the relevance of US in assessment of bone erosions in spite of weak agreement with radiography data. We found a prognostic value of US-diagnosed erosions during the first year of follow up for long-term (4 years) clinical outcomes, and the relevance of control assessment at 6 month after initiation of treatment.

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FRI0582 **CHANGE IN MUSCLE VOLUME AND MUSCLE FAT FRACTION AS POTENTIAL NON-INVASIVE BIOMARKERS OF DISEASE PROGRESSION: MACHINE LEARNING FRAMEWORK FOR QUANTITATIVE ANALYSIS OF MRI DATA**

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Background: Change in muscle volume and muscle fat fraction are potential non-invasive biomarkers of disease progression in a number of diseases, including sporadic inclusion body myositis¹ and osteoarthritis². Their measurement from magnetic resonance images (MRI) usually involves time consuming manual segmentations of the images by trained readers, which limits the use of these biomarkers in clinical research and practise.

Objectives: In this study, we present a novel unsupervised k-means-classifier based image processing framework, developed for machine learning approach to segmentation of thigh muscles from MRI and the subsequent calculation of fat fraction from Dixon images. Further, we present validation of the new approach against manual segmentation using longitudinal retrospectively acquired data.

Methods: Axial MR images from the upper thighs including in-phase and out of phase sequences were recorded in a group of 8 subjects at baseline and at a follow up. The 16 imaging time points were manually segmented by an expert reader, who delineated the muscle. For these regions the mean fat fraction was calculated from the in-phase and out of phase Dixon images. The fully automated segmentation was then run on the same images and the resulting fat fractions compared with the manual results. The proposed k-means approach classifies each image pixel according to signal intensity and creates image masks for bone, muscle and fat in three dimensions. The pixel counts from bone, muscle and fat are automatically measured to produce the volume and mean fat fraction.

Results: We compared the mean fat fraction for the two approaches and found linear correlation was good ($R^2=0.9396$). Manual segmentations typically took 40 min or more to execute, compared to the automated segmentations, which required less than 5 min on a standard desktop computer