for patients affected by RA and PsA. Based on these promising findings, we aim to extend the approach to seronegative RA as well as early RA and PsA.

REFERENCES:

- [1] Le, L. et al. (2018). Supervised autoencoders: Improving generalization performance with unsupervised regularizers. In *Advances in Neural Information Processing Systems*.
- [2] Springenberg, J. T. et al. (2015). Striving for simplicity: The all convolutional net. 3rd International Conference on Learning Representations, ICLR 2015 - Workshop Track Proceedings.
- [3] Simon, D. et al. (2017). Age- and Sex-Dependent Changes of Intra-articular Cortical and Trabecular Bone Structure and the Effects of Rheumatoid Arthritis. *Journal of Bone and Mineral Research*, 32(4), 722–730.
- [4] Folle, L. et al. (2021). Fully Automatic Bone Mineral Density Measurements using Deep Learning. Manuscript submitted for publication.

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OP0146

TENOSYNOVITIS, SYNOVIAL HYPERTROPHY AND FEET BURSTITIS ARE USEFUL ULTRASOUND BIOMARKERS FOR PREDICTING ARTHRITIS DEVELOPMENT IN A POPULATION AT-RISK FOR RHEUMATOID ARTHRITIS

Y. Kisten¹, A. Circumaru¹, M. Loberg¹, N. Vivar-Pomiano¹, A. Antovic², H. Rezaei¹, E. Af Klint¹, A. Hensvold^{1,2}, A. Catrina^{1,2}. ¹Karolinska Institute, Department of Medicine, Rheumatology Unit and Early Arthritis Clinic of the Karolinska University Hospital, Stockholm, Sweden; ²Academic Specialist Center, Center for Rheumatology, Stockholm Health Region, Stockholm, Sweden

Background: Musculoskeletal ultrasound (MSUS) evaluation of individuals at risk for developing rheumatoid arthritis (RA) having Anti-Citrullinated Protein Antibody (ACPA) positivity and musculoskeletal complaints, may play an important role in the very early detection of RA.

Objectives: We aimed to identify which ultrasound markers could predict arthritis development.

Methods: Individuals with musculoskeletal complaints with a positive anti-CCP2 test were referred to the rheumatology department for a detailed clinical (68 joint count) and MSUS examination of the hands, feet and any symptomatic joints. Only those without clinical and/or MSUS detected arthritis were included in the RISK RA prospective cohort and followed-up over 3 years/ or until arthritis onset. Using EULAR-OMERACT guidelines¹, MSUS markers for synovial hypertrophy (SH) and hyperemia (Doppler activity) were documented for each visit. Finger and wrist tendons were screened for any signs of tenosynovitis (TS), and between metatarsal joints for bursitis. Association of MSUS biomarkers with arthritis development was tested (comparing proportions) using Chi-Squared or Fisher's exact tests.

Results: 288 individuals were included from January 2014 to October 2019 (79% female, 35% RF positive, median age 48 years: IQR: 36-58). Within a median of 38 months (IQR: 1-72) since recruitment, 84 individuals (28%) developed an arthritis diagnosis.

Prior to obtaining any diagnosis (at inclusion and/or follow-up visit), 95 of the 288 individuals (33%) had at least one type of MSUS anatomical modification present (around the tendons, joint synovium and/or within bursal cavities), and 56% (53/95) of these individuals eventually developed arthritis. Of the remaining 193 that did not present with any obvious MSUS changes, 16% progressed towards arthritis development.

The presence of tenosynovitis was detected in 64 of 288 individuals scanned prior to diagnosis and were more frequent in those developing arthritis (44%, 37/84) as compared to those with TS not developing arthritis (13%, 27/204), $p < 0.0001$. The extensor carpi ulnaris wrist tendons were mostly involved. Sonographic changes within the synovium were noted in 11% (32/288) of all individuals, mostly affecting the metacarpophalangeal (MCP) and metatarsophalangeal

(MTP) joints. There was a higher incidence of synovial hypertrophy detected in those developing arthritis (22%, 18/24), as compared to those that remained arthritis free (7%, 14/204), $p < 0.0001$. The MCP joints with synovial hypertrophy were more prone to arthritis development as compared to the MTP's. Furthermore, we observed a higher frequency of bursitis between the MTP joints in individuals developing arthritis, as compared to individuals having a bursitis who did not develop arthritis (13%, 11/84 versus 7%, 14/204, $p = 0.009$).

Conclusion: Ultrasound biomarkers such as tenosynovitis of the extensor carpi ulnaris, synovial hypertrophy of the MCP joints and feet bursitis have good potential to predict arthritis development in a population at-risk for rheumatoid arthritis.

REFERENCES:

- [1] Maria-Antonietta D'Agostino et al. *RMD Open* 2017;3:e 000428

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OP0147

RHEUMATIC? - A DIGITAL DIAGNOSTIC DECISION SUPPORT TOOL FOR INDIVIDUALS SUSPECTING RHEUMATIC DISEASES: A MULTICENTER VALIDATION STUDY

R. Knevel¹, J. Knitza^{2,3,4}, A. Hensvold^{5,6}, A. Circumaru^{5,6}, T. Bruce⁷, S. Evans⁸, T. Maarseveen¹, M. Maurits¹, L. Beart-van de Voorde¹, D. Simon^{2,3}, A. Kleyer^{2,3}, M. Johannesson⁹, G. Schett^{2,3}, T. Huizinga¹, S. Svanteson⁸, A. Lindfors⁷, L. Klareskog⁵, A. Catrina⁵. ¹LUMC, Rheumatology, Leiden, Netherlands; ²Universitätsklinikum Erlangen, Friedrich-Alexander-University Erlangen-Nürnberg (FAU), Department of Internal Medicine 3 – Rheumatology and Immunology, Erlangen, Germany; ³FAU Erlangen-Nuremberg and Universitätsklinikum, Deutsches Zentrum fuer Immuntherapie (DZI), Erlangen, Germany; ⁴Université Grenoble Alpes, AGEIS, Grenoble, France; ⁵Karolinska Institutet, Karolinska University Hospital, Division of Rheumatology, Department of Medicine, Stockholm, Sweden; ⁶Academic Specialist Center, Center for Rheumatology, Center for Rheumatology, Stockholm Region, Sweden; ⁷Ocean Observations, a Design Consultancy, Stockholm, Sweden; ⁸Elsa Science, A Digital Health Company, Stockholm, Sweden

Background: Digital diagnostic decision support tools promise to accelerate diagnosis and increase health care efficiency in rheumatology. *Rheumatic?* is an online tool developed by specialists in rheumatology and general medicine together with patients and patient organizations for individuals suspecting a rheumatic disease.^{1,2} The tool can be used by people suspicious for rheumatic diseases resulting in individual advice on eventually seeking further health care.

Objectives: We tested *Rheumatic?* for its ability to differentiate symptoms from immune-mediated diseases from other rheumatic and musculoskeletal complaints and disorders in patients visiting rheumatology clinics.

Methods: The performance of *Rheumatic?* was tested using data from 175 patients from three university rheumatology centers covering two different settings: A.Risk-RA phase setting. Here, we tested whether *Rheumatic?* could predict the development of arthritis in 50 at risk-individuals with musculoskeletal complaints and anti-citrullinated protein antibody positivity from the KI (Karolinska Institutet) B.Early arthritis setting. Here, we tested whether *Rheumatic?* could predict the development of an immune-mediated rheumatic disease in i) EUMC (Erlangen) n=52 patients and ii) LUMC (Leiden) n=73 patients.

In each setting, we examined the discriminative power of the total score with the Wilcoxon rank test and the area-under-the-receiver-operating-characteristic curve (AUC-ROC).

Results: In setting A, the total test score clearly differentiated between individuals developing arthritis or not, median 245 versus 163, $P < 0.0001$, AUC-ROC = 75.3 (Figure 1). Also within patients with arthritis the *Rheumatic?* total score was significantly higher in patients developing an immune-mediated arthritic disease versus those who did not: median score EUMC 191 versus 107, $P < 0.0001$, AUC-ROC = 79.0, and LUMC 262 versus 212, $P < 0.0001$, AUC-ROC = 53.6.

Figure 1. (Area under) the receiver operating curve for the total *Rheumatic?* score

Conclusion: *Rheumatic?* is a web-based patient-centered multilingual diagnostic tool capable of differentiating immune-mediated rheumatic conditions from other musculoskeletal problems. A following subject of research is how the tool performs in a population-wide setting.

REFERENCES:

[1] Knitza J. et al. Mobile Health in Rheumatology: A Patient Survey Study Exploring Usage, Preferences, Barriers and eHealth Literacy. JMIR mHealth and uHealth. 2020.

[2] <https://rheumatic.elsa.science/en/>

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OP0148

SPATIOTEMPORAL DYNAMICS OF BONE LOSS BEFORE AND AFTER THE ONSET OF RHEUMATOID ARTHRITIS

K. Tascilar¹, D. Simon¹, A. M. Liphardt¹, T. Meinderink¹, S. Bayat¹, J. Rech¹, A. Hueber², G. Krönke¹, G. Schett¹, A. Kleyer¹. ¹Friedrich-Alexander; University (FAU) Erlangen-Nürnberg and Universitätsklinikum Erlangen, 91054 Erlangen, Department of Internal Medicine 3 - Rheumatology and Immunology, Erlangen, Germany; ²Solzialstiftung Bamberg, Sektion Rheumatologie, Bamberg, Germany

Background: Rheumatoid Arthritis (RA) is preceded by a clinically silent pre-phase characterized by autoimmunity against anti-modified protein antibodies including anti-citrullinated protein antibodies (ACPA). At this pre-stage patients already experience significant loss of volumetric peripheral bone mineral density (vBMD) compared to healthy controls measured by high-resolution peripheral quantitative computed tomography (HR-pQCT) (1-2). However, the longitudinal course of vBMD changes during the preclinical phase, after diagnosis, and its association with time to disease onset have not been investigated.

Objectives: To longitudinally characterize the changes of metacarpal and radial vBMD before and after the clinical onset of RA and its association with time to onset of arthritis.

Methods: To explore the development of arthritis, we initiated a RA-at-risk cohort in 2011. (Ethics 334_16B). This prospective cohort includes adults positive for CCP-AB with or without musculoskeletal symptoms, excluding arthritis. Participants are regularly followed with clinical examination and HR-pQCT imaging of the MCP and radial bone to monitor early bone changes. HR-pQCT images with low motion grade artefacts were analyzed to obtain the total (D100), cortical (DComp) and trabecular (DTrab) vBMD (D100) in mg HA cm³. We descriptively analyzed the vBMD time course in patients who developed RA by fitting regression curves separately for the pre-clinical and clinical periods and estimated time-conditional marginal mean vBMDs for the 5-year peri-RA period. We analyzed time to diagnosis of clinical RA defined by the 2010 ACR/EULAR classification criteria using Cox regression models. Hazard ratios indicate the relative risk of clinical disease onset associated with 1 standard deviation reduction in bone density.

Results: 130 subjects (mean [SD] age 47.0 [12.2], 89 female [68%]) between 2011 and 2020 were analyzed. Median (IQR) follow-up duration for the cohort was 18.6 (4.6-47.6) months. Participants underwent 233 HR-pQCT scans and 58 (45%) underwent 2 to 6 scans with a median interval of 16.2 (12.2-21.2) months. 49 (38%) patients who developed RA had a pre-diagnosis follow-up of 4.1 (2.5-13.4) months and post-diagnosis follow-up of 22.0 (8.8-38.9) months. The time course of scaled bone mineral densities depicted in Figure 1A suggest that bone

Table 1. Relative risk of RA development in the total cohort; crude and age/sex adjusted hazard ratios for one standard-deviation reduction in vBMD.

	Crude		Adjusted	
	HR (95%CI)	P	HR (95%CI)	P
MCP.D-Comp	1.16 (0.86 to 1.57)	0.336	1.20 (0.89 to 1.63)	0.229
MCP.D-Trab	1.14 (0.83 to 1.57)	0.405	1.17 (0.85 to 1.62)	0.341
MCP.D100	1.16 (0.83 to 1.61)	0.392	1.21 (0.86 to 1.71)	0.265
Rad.D-Comp	1.42 (0.97 to 2.07)	0.071	1.66 (1.07 to 2.55)	0.023
Rad.D-Trab	1.20 (0.87 to 1.66)	0.257	1.23 (0.88 to 1.71)	0.223
Rad.D100	1.43 (0.99 to 2.06)	0.056	1.52 (1.03 to 2.25)	0.033

Figure-1 Time course of vBMD in the sub-cohort of patients who developed RA defined by the 2010 ACR/EULAR criteria. (A) Centered and scaled (z-score) peripheral vBMD values observed over time. (B) Time-conditional marginal mean vBMD values estimated using mixed models. Time zero indicates the date of clinical RA diagnosis.