MRI-based Morphometrics of hand+wrist Joint Spacing in a Patient with Juvenile Idiopathic Arthritis

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INTRODUCTION

- Juvenile Idiopathic Arthritis (JIA) is the most common subtype of inflammatory arthritis afflicting children under the age of 16.
- In JIA, autoreactive antibodies and T-cell maturation dysregulation lead to increased levels of proinflammatory cytokines and chemokines and ultimately, destruction of tissue.
- Magnetic Resonance Imaging (MRI) can be used to identify changes in the synovium, cartilaginous structures, and bone degradation within joint spaces of patients with inflammatory arthritis.

OBJECTIVE

- To assess joint space morphometrics of the hand and wrist of a patient with JIA utilizing MRI.

METHODS

- MRI scans in coronal and sagittal planes were taken of the right hand of a 23-year old caucasian female with an 11 year history of JIA.
- Image series were analyzed with software programs “Horos” and “CT Slicer.” These programs allowed for full 3D volume rendering and distance analysis between articular surfaces of multiple carpal joints.
- Next, data was extracted by using software tools to measure joint spaces between carpal bones and phalanges.
- Data extracted via this process included: radiocarpal, ulnocarpal, radioulnar, radius-scaphoid, radius-lunate, ulnar-lunate, ulnar-triquetrum.
- Lastly, individual phalangeal joint spaces were captured within digits I-V (metacarpophalangeal, proximal interphalangeal, distal interphalangeal).
- We then averaged six transects with equivalent spacing within each joint.

RESULTS

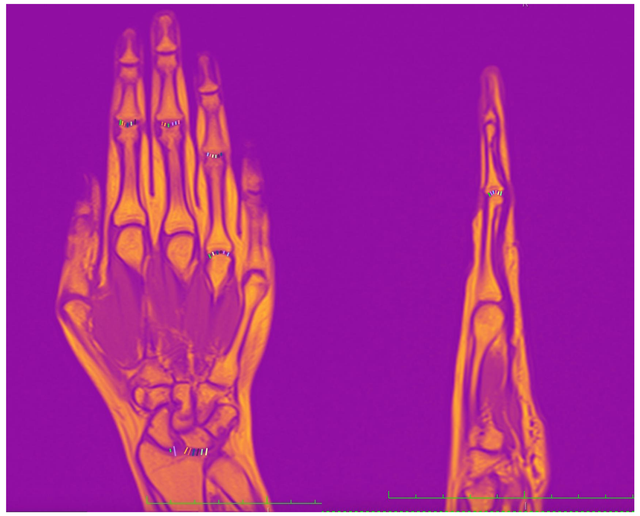

Figure 1: Coronal (left) and sagittal (right) view of the right hand of a 23-year-old Caucasian female with an 11-year history of JIA in PPU Magma with six line measurements crossing the joint space.

- The smallest measurement in both the sagittal and coronal planes was 0.778 mm in the fifth digit DIP joint in the coronal plane
- Narrow coronal joint spacing (under 1mm)
  - PIP joint on the third digit measured 0.973 mm, the PIP on the fourth digit 0.839 mm, and the DIP on the fourth digit 0.954 mm.
- Narrow sagittal joint spacing (under 1mm)
  - PIP on the second digit 0.862 mm, the DIP on the third digit 0.993 mm, the DIP on the fourth digit 0.819 mm, the PIP on the fifth digit 0.881 mm, and the DIP on the fifth digit 0.830 mm.
- The widest joint spacing occurred in the coronal view between the ulna and triquetrum bones at 8.831 mm.
- Other wide joint spacing can be seen in Table 1 (greater than 1 mm).

	Coronal View	Sagittal View
1st Digit MCP	1.501 mm	0.787 mm
1st Digit IP	2.176 mm	1.039 mm
2nd Digit MCP	1.4735 mm	1.610 mm
2nd Digit PIP	1.392 mm	0.862 mm
2nd Digit DIP	1.411 mm	1.047 mm
3rd Digit MCP	1.0285 mm	1.2135 mm
3rd Digit PIP	0.973 mm	1.162 mm
3rd Digit DIP	1.261 mm	0.993 mm
4th Digit MCP	1.020 mm	1.141 mm
4th Digit PIP	0.839 mm	1.024 mm
4th Digit DIP	0.954 mm	0.819 mm
5th Digit MCP	1.000 mm	1.233 mm
5th Digit PIP	1.024 mm	0.881 mm
5th Digit DIP	0.778 mm	0.830 mm
Radius-Scaphoid	2.727 mm	-
Radius-Lunate	2.478 mm	-
Ulnar-Lunate	5.536 mm	-
Ulnar-Triquetrum	8.831 mm	-
Distal Radioulnar	2.253 mm	-

Table 1: Measurements of joint spaces in digits 1 through 5 in mm in coronal and sagittal planes from an MRI scan of the right hand of a 23-year-old caucasian female.

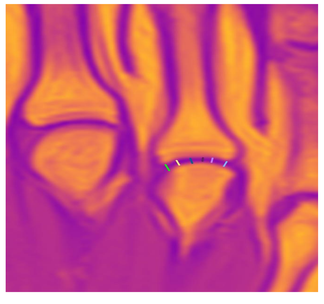

Figure 2: Zoomed in coronal view of the 4th digit MCP joint space of a 23-year-old Caucasian female’s right hand showing the six measurements taken to calculate mean joint space. Image was taken in PPU Magma setting.

SIGNIFICANCE OF FINDINGS

- The findings identified the morphology and joint space measurement of a 23-year old patient with JIA.
- The study suggests the possibilities of utilizing MRI imaging to evaluate the progression of inflammatory arthritis. If a baseline image is taken early on, it can then be compared to future imaging as the disease progresses. In addition, there is potential for it to be used in monitoring treatment efficacy.
- These findings also identify a gap in research in how to identify inflammation on an MRI, paving the way for future research opportunities with a longitudinal case report.
- The downside to this study was that the patient has had JIA for 11 years, and there was not a baseline imaging to identify space narrowing.

REFERENCES

1. Rheumatoid arthritis. Accessed January 24, 2024. https://rheumatology.org/patients/rheumatoid-arthritis
2. Smolen JS, Aletaha D, McInnes IB. Rheumatoid arthritis. *Lancet*. 2016;388(10055):2023-2038.
3. Firestein GS, McInnes IB. Immunopathogenesis of Rheumatoid Arthritis. *Immunity*. 2017;46(2):183-196.
4. Guo Q, Wang Y, Xu D, Nossent J, Pavlos NJ, Xu J. Rheumatoid arthritis: pathological mechanisms and modern pharmacologic therapies. *Bone Res*. 2018;6:15.
5. Bullock J, Rizvi SAA, Saleh AM, et al. Rheumatoid Arthritis: A Brief Overview of the Treatment. *Med Princ Pract*. 2018;27(6):501-507.
6. Kadura S, Raghu G. Rheumatoid arthritis-interstitial lung disease: manifestations and current concepts in pathogenesis and management. *Eur Respir Rev*. 2021;30(160). doi:10.1183/16000617.0011-2021
7. Sidhu N, Wouters F, Niemantsverdriet E, van der Helm-van Mil AHM. MRI-detected synovitis of the small joints predicts rheumatoid arthritis development in large joint undifferentiated inflammatory arthritis. *Rheumatology* . 2022;61(SI):SI23-SI29.
8. McQueen FM. Magnetic resonance imaging in early inflammatory arthritis: what is its role? *Rheumatology* . 2000;39(7):700-706.
9. Punzi L, Frigato M, Frallonardo P, Ramonda R. Inflammatory osteoarthritis of the hand. *Best Pract Res Clin Rheumatol*. 2010;24(3):301-312.