Automated Classification of Erosions in MRI Sequences of Patients with Rheumatoid Arthritis

Introductory Presentation

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1 Outline

- Motivation
- State of the Art & Related Work
- Data
- Methods
- Evaluation

Motivation

Rheumatoid Arthritis

The disease pattern is characterized by 3 symptoms

Synovitis

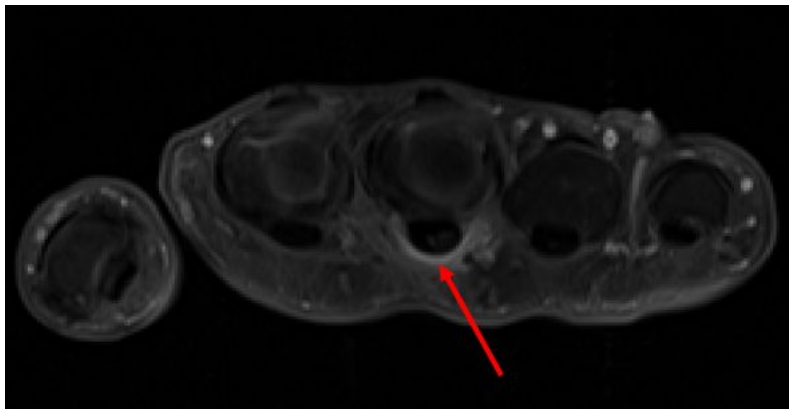

Fig. 1: Synovitis

Edema

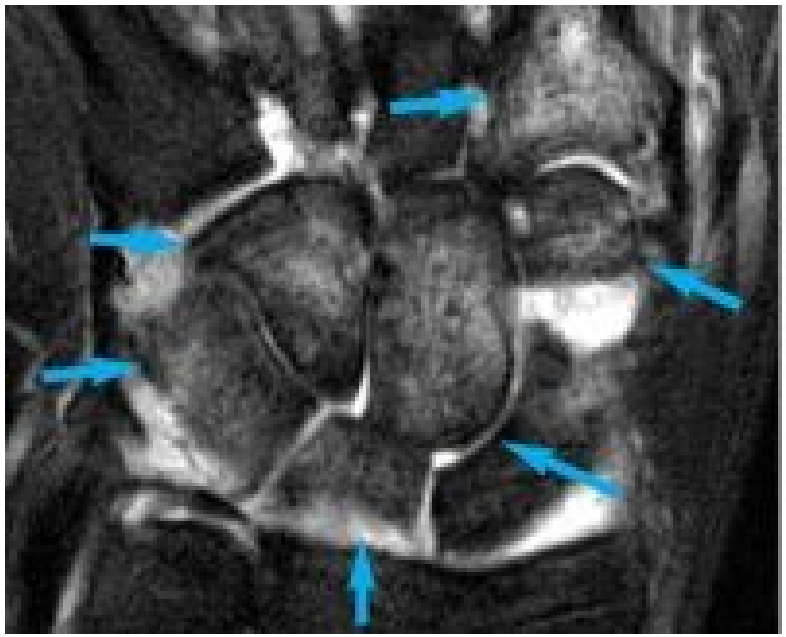

Fig. 2: Edema

Erosion

Fig. 3: Erosion

Purpose of the Project

Focus on erosion detection and classification

- Reduce time for diagnosis
- Reduce time during follow up
- Reduce interobserver variability
- Increase the graduation of assessment

State of the Art & Related Work

State of the Art

Classification using the EULAR-OMERACT system

- Assessment of 3 symptoms for each bone
- Based on proportion between ideally healthy bone and unhealthy structure
- Erosion graduation in 10% steps
- Scoring of 1 cm of bone from the joint for long bones
- Scoring of the whole bone for wrist bones

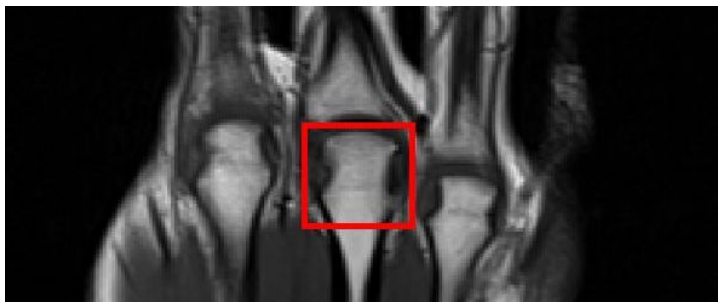

Fig. 4: Region of Interest

Related Work

Segmentation of the wrist bones by a marginal space learning based approach

- 100 manually segmented training samples
- Only for carpal bones
- Higher quality data $0.365 \times 0.365 \times 0.734$ mm
- Accuracy of $83.2 \pm 10.6\%$

Data

Given Training Data

10 MRI Sequences

- T1 weighted sequences with turbo spin echo
- Right hands only
- Similar relaxed hand position
- Voxel spacing of $0.5 \times 0.5 \times$ **2.75 mm**
- Manually segmentation required

Ground-Truth

Segmentation

- Manually segmented MRI sequences

Erosion Detection

- Expert labeled erosion
- Expert classified erosion after EULAR-OMERACT

Problems

- Inter-slice gap of 2.75 mm
- Not the whole bone is visible in MRI
- Similarity between erosions and cysts
- The head of the bone can completely disappear by an erosion
- Bones can be displaced

Fig. 5: Slices of 2.75 mm

Difference MRI vs CT

Fig. 6: CT of the hand bones

Fig. 7: MRI of the hand bones

Fig. 8: The bright white cortical bone in the CT image stays black in the MRI

Methods

Bone Segmentation

Finding the Joints

- Calculation of MPR
- Using Weka workbench to train classifier
- Using 2D joints to find joints in the MRI volume

Segmenting the Bones

- Training of active shape model for each bone
- Training of active shape model for the position in between the bones
- Create a bone model for each bone in between the joints

Scoring after EULAR-OMERACT

Classifier for Erosion

- Use manual bone segmentations
- Train a classifier for bone based on voxel value

Result

- Calculate ratio between erosion and bone
- Compare to ratio by an expert

Evaluation

Evaluation

Evaluation of bone Segmentation

- Leave one out cross validation with manual segmentations

Evaluation of Classification and Scoring

- The results of the algorithm with the ground truth

Thank you.

Any questions?

The End