Leibniz Institute for Natural Product Research and Infection Biology - Hans Knöll Institute In vivo Quantification of Arthritis Severity in a Murine Model by µCT Imaging

Bianca Hoffmann^{1,2,3}, Carl-Magnus Svensson², Ingo Irmler⁴, Thomas Kamradt⁴, Marc Thilo Figge^{2,3}, Hans Peter Saluz^{1,3}

¹Cell and Molecular Biology, Leibniz Institute for Natural Product Research and Infection Biology - Hans Knöll Institute ²Applied Systems Biology, Leibniz Institute for Natural Product Research and Infection Biology - Hans Knöll Institute ³Friedrich Schiller University Jena ⁴Immunology, University Hospital Jena

I. Introduction

As shown previously, inflammation in Glucose-6-phosphate isomerase induced arthritis in mice can be examined by visual scoring or positron emission tomography [1, 2]. We want to have a deeper look inside erosive processes leading to bone damage via μ CT imaging using the following methods:

• Texture based segmentation and quantification of cortical bone





seit 1558

thickness

• Surface reconstruction and quantification of cortical bone surface roughness



The raw data consists of one image stack for each paw. The images show 5 consecutive slices of such a stack and surface renderings of a healthy and a diseased hind paw.



diseased

2.2. Methods - Surface Roughness



The calculation of local surface roughness follows [4]. In a first step a high resolution surface reconstruction is performed with the marching cubes algorithm



The original CT images are convolved with a set of filters shown left [3]. Pixels are clustered using K-means algorithm based on their filter responses into foreground and background pixels.



The slices in the original CT dataset are parallel to the xy plane. We are looking for slices that are orthogonal to the bone in the coordinate system x'-y'-z'. The orthogonal slices are used to determine the thickness of the cortical bone.

The resulting model consists of triangular facets with each facet having a normal vector. For the calculation of local roughness for each facet the average angle between its normal vector and all normal vectors of facets in a given vicinity is computed. A high value denotes a rougher region while a low value denotes a smoother region with minimum and maximum being 0° and 180°, respectively.

8 11 14 18 25 28 35 39 50	-2 8 11 14 18 25 28 35 39 50	
day	day	

Outlook

- Validation of bone thickness and roughness measures by longitudinal studies with control animals
- Combination of the measures and construction of an algorithm for evaluation of disease diagnosis and progression
- Adaptation of the algorithm for rheumatoid arthritis for clinical use

References

[1] Irmler et al., Arthritis Res Ther., 12(6):R203, 2010. [2] Irmler et al., Arthritis Res Ther., 16(4):R155, 2014. [3] Malik *et al.*, *IJVC*, 43(1):7–27, 2001. [4] Silva et al., Mol Imaging, 5(4):475–484, 2006.

[5] Lorensen *et al.*, *Computer Graphics*, 21(4):163–169, 1987.



Bundesministerium für Bildung und Forschung

grant number 0316040A

Contact: bianca.hoffmann@hki-jena.de; carl-magnus.svensson@hki-jena.de