Accurate Quantitative Assessment of Synovitis in Rheumatoid Arthritis Using Pixel by Pixel, Time-Intensity Curve Shape Analysis

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[TARGET AUDIENCE] Doctors, radiological technologists and researchers engaged in musculoskeletal radiology.

[PURPOSE] In rheumatoid arthritis (RA), magnetic resonance imaging (MRI) provides important clinical information with respect to the extent of the disease and the degree of activity of the inflammatory tissue. Although inflamed synovial tissue (pannus) has been evaluated using the semi-quantitative scoring systems, it is subjective and requires interpretation of experts. In an effort to improve on the reproducibility and sensitivity of scoring systems, various techniques have been put forward for the direct measurement of the volume of enhancing pannus (VEP).Pixel by pixel, time-intensity curve (TIC) shape analysis is objective with an advantage of precise tissue characterization. We hypothesized that this analysis can accurately quantify the pannus.

In this study, we compared area of enhancing pannus (AEP) measurement via segmentation using thresholding (AEP_THRES)[1] and via pixel by pixel TIC analysis (AEP_TIC)[2] by setting VEP by manual contouring (AEP_MANUAL) as gold standard to evaluate accuracy of VEP quantification.

[METHODS] Five patients with RA of the wrist or finger joints participated in this study. Dynamic contrast-enhanced LAVA sequences (TR/TE 7.769~9.114/2.368~2.512 ms, slice thickness 2 mm, matrix 512×512, FOV 160 mm×160 mm, number of slices 40-52, phases 26, temporal resolution 13.29 sec) was applied at 3T (GE MEDICAL SYSTEMS, DISCOVERY MR750w). Using all the imaging slices of 5 patients (212 slices), AEP_THRES and AEP_TIC were calculated using MATLAB, and AEP_MANUAL was determined using a viewer system of EV Insite, PSP company Japan. These processes were performed at the entire hand region as well as the wrist and the finger regions, separated by the line connecting the center of 1st through 5th metacarpal bones. Spearman's rank correlation coefficient was used to compare AEPs with the following benchmarks; r<0.2: poor, r=0.2-0.4: fair, r=0.41-0.6: moderate, r=0.61-0.8: good, and r>0.81: excellent.

[RESULTS] Correlation coefficient between AEP_TIC and AEP_MANUAL was evaluated as better than that of AEP_THRES and AEP_MANUAL in the wrist region, while these were the same for the entire hand and the finger regions (Table 1).

[DISCUSSION] Segmentation using thresholding tended to overestimate pannus area because other high-intensity tissues, such as vessels and skin surface, were regarded as the pannus. Since pannus was strictly distinguished from surrounding tissue in pixel by pixel TIC analysis, pannus area was assessed accurately and showed better correlation with manual segmentation.

[CONCLUSION] Pixel by pixel TIC analysis may be an alternative to manual contouring for pannus quantification in the hand.

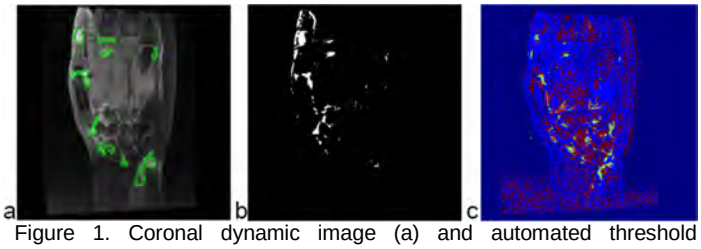

Figure 1. Coronal dynamic image (a) and automated threshold segmentation image (b) and pixel by pixel analysis image (c) in the rheumatoid hand. Pannus is indicated as green pixels in the pixel by pixel analysis image.

		r	P	correlation
entire hand	AEP _THRES	0.652	<0.001	good
	AEP_TIC	0.791	<0.001	good
finger region	AEP _THRES	0.498	<0.001	moderate
	AEP_TIC	0.490	<0.001	moderate
wrist region	AEP _THRES	0.637	<0.001	good
	AEP_TIC	0.815	<0.001	excellent

Table 1. Comparison of AEP_THRES and AEP_TIC with AEP_THRES as gold standard (r; Spearman's rank correlation coefficient).

[REFERENCES]1. Ostergaard M. Different approaches to synovial membrane volume determination by magnetic resonance imaging: manual versus automated segmentation. Br J Rheumatol. 1997 Nov;36(11):1166-77.

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