Micro MR angiography of the finger as a potential biomarker in systemic sclerosis

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Introduction:

Scleroderma (systemic sclerosis) is a potentially lethal disease that causes systemic proliferation of connective tissue in the skin and internal organs such as gastrointestinal tract, lungs, heart and kidneys [1]. Vascular involvement in scleroderma has drawn a special clinical interest due to its early involvement and high incidence rate [1]. Vascular lesions characteristic of scleroderma include intimal hyperplasia, capillary rarefaction and telangiectasia. The earliest manifestation of vascular changes in scleroderma typically occurs in the finger microvasculature and vascular involvement progresses backwards to the upper level vessels. We hypothesize that vascular imaging of the finger can quantitatively detect changes caused by scleroderma and provide useful information for evaluation of disease progression and treatment effects. In this abstract, we report the initial experience in high resolution MR angiography of scleroderma digital vasculature imaging (micro MR angiography), and describe a methodology for quantitative characterization of finger angiograms.

Methods and Materials

Population In this study, 8 patients (Age range: 41-62) and 7 healthy volunteers (Age range: 21-43) were evaluated using Micro MR angiography. Among the patients, 7 were diagnosed with diffuse type scleroderma and one had limited type scleroderma.

MR Imaging All images were acquired on a clinical 3T scanner (Philips Achieva, R2.1.1, Best, Netherlands). A custom-made multi-turn solenoid coil with diameter of 2.5cm and longitudinal coverage of 6.5cm was used for the finger imaging. Subjects were scanned in a prone position with the coil positioned in the center of the magnet. The right index finger was scanned in all participants. MR angiography was performed using a 2D time-of-flight (TOF) technique with the following parameters: imaging sequence T1-FFE, TR/TE 16/5.9ms, flip Angle 35º, FOV 40×28mm, Matrix 256×135, in-plane resolution 0.16x0.21mm, slice thickness 1.2mm, 32 slices, NSA=1, scan time 3.5 min. The first distal interphalangeal joint was used as a landmark for future registration, and both distal interphalangeal joints were covered by an imaged volume. A separate TOF image with sat-band was also used to suppress signal from arteries, so they could be differentiated from veins.

Image analysis Images were displayed and analyzed using a custom-written image processing software package, CASCADE [2]. The overall integrity of the digital vessels in each subject was assessed using a 4-point categorical scale (vascular score) [3, 4], characterizing the visibility of vessels on maximum intensity projection (MIP) images. The score was defined as follows: 1 - invisible or barely visible spotted vessels; 2 - poorly visible vessels with considerable discontinuities; 3 - visible vessels with minor discontinuity; 4. clearly continuous vessels with well defined boundaries. The status of digital arteries was quantitatively assessed using the mean lumen area of three consecutive slices around the first distal interphalangeal joint. Lumen contours of digital arteries were outlined using the semi-automatic edge detection tool provided by CASCADE. Due to the variable appearance of digital veins, the status of veins was characterized by the number of visible dorsal veins at the level of the first distal interphalangeal joint.

Statistical analysis An independent Student's t-test was used to compare all variables. P-values below 0.05 were considered significant.

Results

Dramatic differences in the visual appearance of the digital vasculature were found between scleroderma patients and healthy volunteers (Fig. 1). Scleroderma patients presented highly stenotic digital vessels when compared with the normal volunteers (Arrow in Fig.1). Digital arteries were always visible except on one patient. The number of dorsal veins was always decreased in scleroderma patients [Fig. 1(a)]. Both reduced vessel size and number of veins was observed on the MIP images (Fig. 2), based on which the vascular scores were determined. The statistical comparison between scleroderma patients and normal volunteers is summarized in Table 1. All measured variables, i.e. mean digital artery area number of dorsal veins, and the overall vascular score were significantly different.

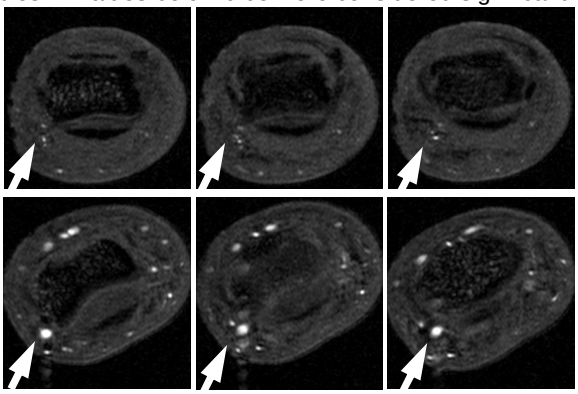

Fig. 1. Comparison of finger MR angiography between a scleroderma patient (a) and a healthy subject (b) at the level of the first distal interphalangeal joint.

Conclusion

The results of this study demonstrate that micro MR angiography can identify and quantitatively characterize the vascular involvement in scleroderma fingers. Quantitative variables derived from finger MR angiography can be used as prospective biomarkers in clinical research focused on scleroderma treatment.

Table 1 Statistical comparison between scleroderma patients and normal volunteers

	Digital artery area (mm^2)	# of Dorsal veins	Vascular Score
SSc patient	0.19±0.12	0.71±0.75	1.88±0.83
Volunteer	0.61±0.24	2.60±0.89	3.43±0.53
P-value	0.01	0.03	<0.001

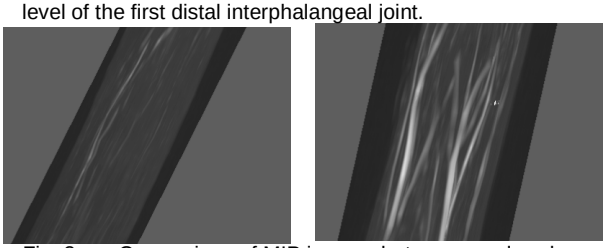

Fig. 2 Comparison of MIP images between a scleroderma patient (a) and a healthy volunteer (b). The corresponding vascular scores for both cases are 2 (a) and 4 (b).

Reference:

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