Using *in vivo* high resolution finger MRI to study scleroderma – A feasibility study and preliminary results

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Introduction:

Scleroderma (systemic sclerosis) is a lethal disease that causes systemic proliferation of connective tissue in the skin and internal organs such as gastrointestinal tract, lungs, heart and kidneys [1]. There are, however, only few attempts that have been made to study this disease with imaging approaches [2, 3]. As scleroderma has been known to start from the finger tip and progress proximally thereafter, it is important to study the changes in patients' fingers for early and accurate diagnosis. High resolution MRI has the potential to study this disease through the evaluation of soft tissue and vascular involvements. The goal of this study is to establish a comprehensive high resolution MRI technique that can study sub-skin layer soft tissue condition, blood supply and vascular integrity in scleroderma fingers.

Material and Methods:

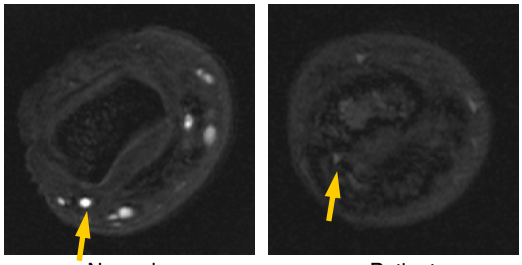
Hardware All images presented in this study were acquired on a 3T MRI scanner (Philips Achieva R1.5.4, Best, Netherlands). A custom-made solenoid coil was used as the dedicated finger coil. The finger coil has a bore size of 25.4mm to accommodate diseased finger. It also possesses a sensitive length of more than 60 mm in the longitudinal direction to cover at least two terminal inter-phalangeal joins of the index finger.

Patient Four healthy volunteers (Mean age 40, 3M1F) and one scleroderma patient (Female, age 58, disease type: Limited) were scanned after obtaining their informed consents. Two terminal inter-phalangeal joins of the index finger were scanned for each subject.

MRI Protocol Proton-density weighted images (TR/TE 2300/9.1ms, FOV 100*100mm, matrix 256*256, thickness 1mm, NSA 1) were acquired along the longitudinal direction of the finger, serving as the reference image. Then, the following MRI pulse sequences were used to acquire transversal images of the finger,

- Time of Flight (TOF) TR/TE 15/5.4ms, FA 15º, FOV 40*40mm, matrix 256*256, thickness 1.5mm, NSA 1
- Dual echo TSE TR/TE_1/TE_2 4000/20/100ms, FOV 35*35mm, matrix 256*256, thickness 1.5mm, NSA 1

Image Analysis Contours of the lumen of digital artery were manually drawn on the MR images around first terminal inter-phalangeal joint by experienced MR image reviewer. Lumen area was quantified with custom-made image analysis software Cascade [4]. $T2_{eff}$ values have been used as a tissue specific value for tissue characterization. In this study, $T2_{eff}$-values of the sub-skin soft tissue were quantified based on dual-echo TSE images, as described previously [5].



Normal Patient

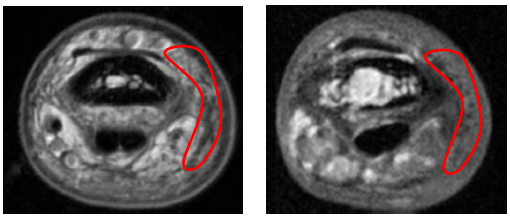
Figure 1 Digital artery (arrow) comparison, both images have the same window and level settings

Results and Discussion:

Vessel narrowing From Fig. 1, it can be clearly seen that scleroderma patient possesses much narrowed blood vessels. Quantitative data shows that the average lumen area of the digital artery drops from 0.32mm^2 to 0.25 mm^2. Moreover, the signal intensity of scleroderma blood vessels is also lower than that of the normal volunteer, which indicating a possible reduced blood flow.

Tissue $T2_{eff}$ change Tissue $T2_{eff}$ values from the ROI (Fig. 2) also change in scleroderma fingers. The average $T2_{eff}$ values decreases from 56.1 to 43.6, indicating a possible connective tissue proliferation.

Thickened skin and joint deformation Fig. 3 shows the skin layer of the index finger from both patient and volunteer. The thickness increases from 0.51mm of the normal skin to 0.96mm of the scleroderma skin (arrow). Besides, some of the patients will lose the flexibility of freely extending their fingers due to the calcification of soft tissue (Dystrophic Calcification). On MR images, this effect is exhibited as deformed finger joints in the patient fingers (arrow head).

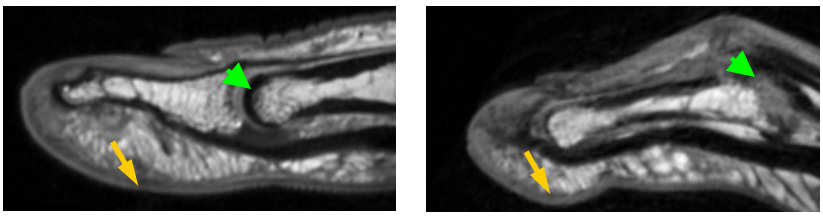


Normal Patient

Figure 2 ROI of $T2_{eff}$ mapping, possible indication of connective tissue proliferation

Conclusion:

The feasibility of using *in vivo* high resolution MRI (up to137μm, in-plane) to study scleroderma finger was demonstrated for the first time. Differences between soft-tissue condition, skin thickness, finger joints, and blood vessel morphology between scleroderma patient and normal volunteers were revealed by using MRI. The result suggests that MRI has a great potential to be used as a powerful tool to study extremity disease like scleroderma.



Normal Patient

Figure 3 Longitudinal view of the finger, thickened skin (arrow) and joints deformation (arrow head)

Reference:

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4. F Liu et al., *MRM*, 2006; 55:659-668
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