

High-Resolution Magnetic Resonance Lymphangiography in patients with primary and secondary lymphedema

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INTRODUCTION

A major obstacle in understanding the pathophysiology of lymphedema, the differentiation from other types of edema, and in treatment planning is the difficulty of visualizing lymphatic vessels in human beings [1]. Lymphoscintigraphy is the primary imaging modality. Despite recent refinements in this technology an improved depiction of the lymphatic system with high resolution is desired. Interstitial Magnetic Resonance Lymphography has shown promising results with administration of various lymphotropic paramagnetic contrast agents. However, these lymphotropic contrast agents are still in the preclinical phase with an uncertain safety profile [2]. Interstitial Magnetic Resonance Lymphography with administration of a commercially available contrast agents has been proposed as a safe and effective method to image lymph nodes and lymphatic vessels in animals and humans [3,4]. The purpose of this study was to evaluate the feasibility of High-Resolution Magnetic Resonance Lymphangiography (HR MRL) with intracutaneous injection of gadodiamide (Omniscan, Nycomed Amersham, Cork, Ireland) in patients with primary and secondary lymphedema.

MATERIALS AND METHODS

Contrast agent Gadodiamide is a commercially available, extracellular, water-soluble paramagnetic contrast agent with a gadolinium (Gd) concentration of 0.5 mmol. **Study design** Between March and October 2005, 25 patients with lymphedema of the lower extremities were referred for HR MRL (20 primary and 5 secondary after malignant lymph node extirpation and radiation therapy; mean age, 43 years; range, 19-80 years; 16 women, 9 men). **Contrast material administration** A single contrast agent dose (0.2 mL/kg) and 2 mL of mepivacainhydrochloride 1% were subdivided into 10 portions. 4 portions were injected intracutaneously into the interdigital webs of each foot; one portion was injected medial to both first proximal phalanges. **MR imaging examinations** MR imaging was performed at 1.5T (Magnetom Symphony/Avanto; Siemens Medical Systems, Erlangen, Germany). Three stations were examined with a phased array body coil and a peripheral surface coil: first, the lower leg and foot region; second, the upper leg and the knee region; and third, the pelvic region and the proximal upper leg. The extent and distribution of the lymphedema were evaluated using a heavily T2-weighted 3D-TSE sequence (TR/TE: 2000/694; bandwidth: 247 Hz/pixel; 6/8 rectangular field of view 480 mm; slices: 96; voxel size: 2.0 x 1.9 x 1.7 mm; 4 min 04 sec). For HR MRL a 3D spoiled gradient-echo sequence (VIBE) was used (TR/TE: 3.4/1.47; flip angle: 25; bandwidth: 490 Hz/pixel; 6/8 rectangular field of view of 500 mm; slices: 128; voxel size: 2.2 x 1.1 x 1.2 mm; 44 sec). All stations were imaged before and subsequently repeated 5, 15, 25, 35, 45, and 55 minutes after injection. To emphasize the Gd containing structures, baseline images were subtracted before 3D maximum-intensity-projection (MIP) reconstruction. The enhancement in the lymphatic pathways, and inguinal/iliac lymph nodes was evaluated qualitatively and quantitatively on the source images and MIP reconstructions.

RESULTS

The lymphedema was bilateral in 18 and unilateral in 7 patients. In all patients the lymphedema demonstrated an epifascial distribution with high signal intensity on T2-weighted images. In 23 patients (92%) the beaded appearance of the lymphatic vessels extending from the injection site was reliably detected 15 minutes after injection. In all patients (100%) concomitant venous enhancement was detected in the lower and upper leg 5 minutes after injection. In 21 patients (84%), the lymphatic vessels in the upper leg could be detected. In 20 patients (80%) the inguinal lymph nodes with external iliac lymphatic pathways were depicted. Collateral vessels with dermal back-flow between lymph vessels, indicating proximal lymph flow obstruction with alternate pathways of transport, were seen in 18 patients (72%).

DISCUSSION

The proposed HR MRL strategy with a three station protocol provided a non-invasive, high-resolution display of the lymphatic vessels and accompanying complications like dermal back-flow in patients with lower lymphedema. MIP images provided detailed outlines of the lymphatic pathways, and allowed differentiation from veins based on their beaded appearance. If the beaded appearance of the lymphatic vessels was not uniquely recognized, the time course of enhancement provided additional information. Caused by the higher flow, the enhancement diminished faster in veins. To further increase patient acceptance, a reduction of the injected contrast material volume is desirable, e.g. by the use of a more concentrated Gd formulation such as gadobutrol (Gadovist; Schering, Berlin, Germany). This method is not aimed at the depiction of lymph node morphology but can provide complementary information about the lymphatic vessels when lymph nodes are examined with super-paramagnetic iron oxide particles in cancer patients. Clearly, the clinical utility of the proposed MR protocol will require further validation in larger patient cohorts.

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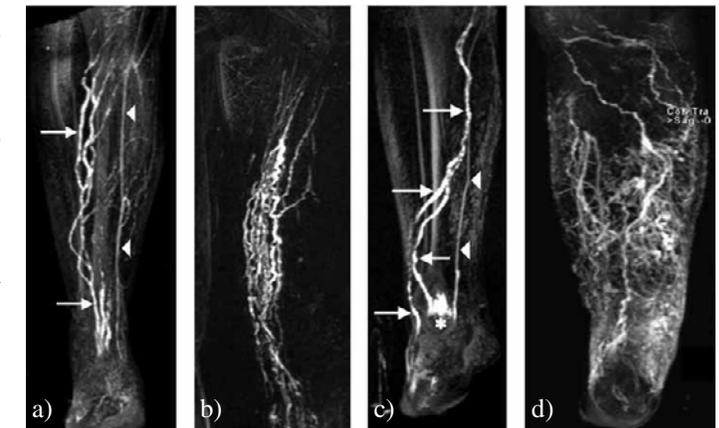


Fig. 1: a) Frontal HR MRL delineates slightly enlarged lymphatic vessels in the right lower leg of a 33 y/o man with primary lymphedema (arrows). Note the concomitantly enhanced vein that shows lower signal intensity (arrowheads). b) Angled HR MRL shows multiple large and tortuous lymphatic vessels in the left upper leg of a 20 y/o woman with primary lymphedema. c) Frontal HR MRL delineates two enlarged lymphatic vessels in the right lower leg of a 51 y/o man with primary lymphedema (arrows). An area of dermal back-flow is demonstrated at the ankle joint (asterisk). Note the concomitantly enhanced vein that shows lower signal intensity (arrowheads). d) Frontal HR MRL sequence in a 80 y/o woman with a history of malignant melanoma and secondary lymphedema due to lymph node extirpation in the left inguinal region. Image reveals delayed lymphatic flow with an extensive reticular pattern of dilated lymphatic vessels indicating neovascularization due to obstruction.

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