



## Short Report

# Combined Assessment of Arterial and Venous Anatomy in Lower Limb Ischaemia Using a Single Contrast-Enhanced Magnetic Resonance Scan

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## ABSTRACT

Contrast-Enhanced Magnetic Resonance Angiography (CE-MRA) is a non-invasive investigative modality for patients with lower limb arterial insufficiency. When infra-inguinal arterial reconstruction is indicated autologous great saphenous vein is the conduit of choice and adequacy of the vein is often assessed by an additional Duplex ultrasound.

We evaluated whether single, high-resolution steady state MR imaging with blood pool contrast agent could generate a sufficiently informative assessment of both venous and arterial anatomy to plan surgery potentially avoiding the need for an additional venous duplex.

There was good correlation between CE-MRA, venous duplex and subsequent operative findings.

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## Introduction

Imaging of critical limb ischaemia by Contrast-Enhanced Magnetic Resonance Angiography (CE-MRA) is robust.<sup>1</sup> Some patients will require infra-inguinal bypass for limb salvage, the conduit of choice being ipsilateral great saphenous vein (GSV). Therefore, in addition to arterial imaging, assessment of superficial lower limb veins is beneficial. Typically, evaluation is by duplex ultrasound.

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venous imaging.<sup>2</sup> A logical progression therefore is to combine CE-MRA with Magnetic Resonance Venography (MRV) allowing complete evaluation with a single investigative modality.

This study evaluated MRI using a contrast agent that remained in the blood pool for sufficient time to allow both standard CE-MRA imaging of the arterial tree followed by imaging of the venous vasculature.<sup>3</sup> The anatomical information was then correlated with venous duplex imaging and subsequent operative findings.

## Report

A local ethics committee granted approval for a prospective pilot study of patients presenting with critical lower limb ischaemia. Twenty consecutive patients consented to participate.

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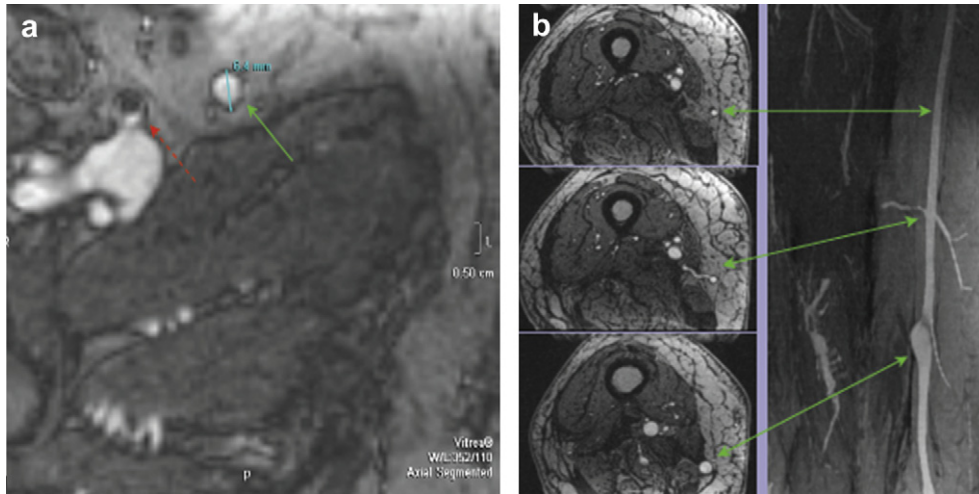
E-mail address: [keithhussey79@hotmail.com](mailto:keithhussey79@hotmail.com) (K. Hussey).

Lower limb MRA was performed with a blood pool contrast agent (total 9 ml *gadofosveset*, ~0.03 mmol/kg)<sup>4</sup> in first pass using a hybrid dual injection technique with a dynamic MRA initially at the tibial station (3 ml *gadofosveset*) and subsequent stepping station bolus chase MRA (6 ml *gadofosveset*) to cover the aortoiliac and lower limb arterial run-off. Subsequent high spatial resolution steady state gradient echo imaging of the thigh and calf stations from groins to ankles was performed with phased array coils and

patient size. Imaging was performed at 1.5 T with either a Philips Gyroscan ACS NT (Intera equivalent) or a Siemens Avanto scanner. On the steady state MRA image quality was assessed on a simple five-point Likert scale (1 = non-diagnostic, 5 = excellent).

Datasets were interactively reviewed with Multiplanar Reconstruction (MPR) and Maximum Intensity Projection (MIP) plus standard workstation measurement tools. Patency, quality and calibre of the short and great saphenous veins throughout their lengths were recorded for each leg along with sites of division, perforators and major tributaries. Deep veins were assessed for patency and evidence of deep vein thrombosis (DVT). Patients also underwent independent duplex venous assessment for the leg in question as per standard protocol in the vascular laboratory and a descriptive report was generated.

MRI steady state phase image quality of both the arterial and venous circulation was judged as excellent or good in all but one patient (imaging corrupted by motion artefact as a result of



**Figure 1.** (a) Measurement of veins. Transverse localised MPR of right groin just below saphenofemoral junction showing normally patent great saphenous vein, calibre measured (green arrow). Note extensive plaque disease in stenosed superficial femoral artery (red dashed arrow) with normally patent femoral vein adjacent. (b) Varying vein calibre. Transverse MPRs of high-resolution steady state imaging right thigh and corresponding MIP showing normal long saphenous vein of 4 mm calibre with short focal dilation inferiorly up to 9 mm, exactly as per ultrasound report. Also shown is small perforator vein not reported at ultrasound. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

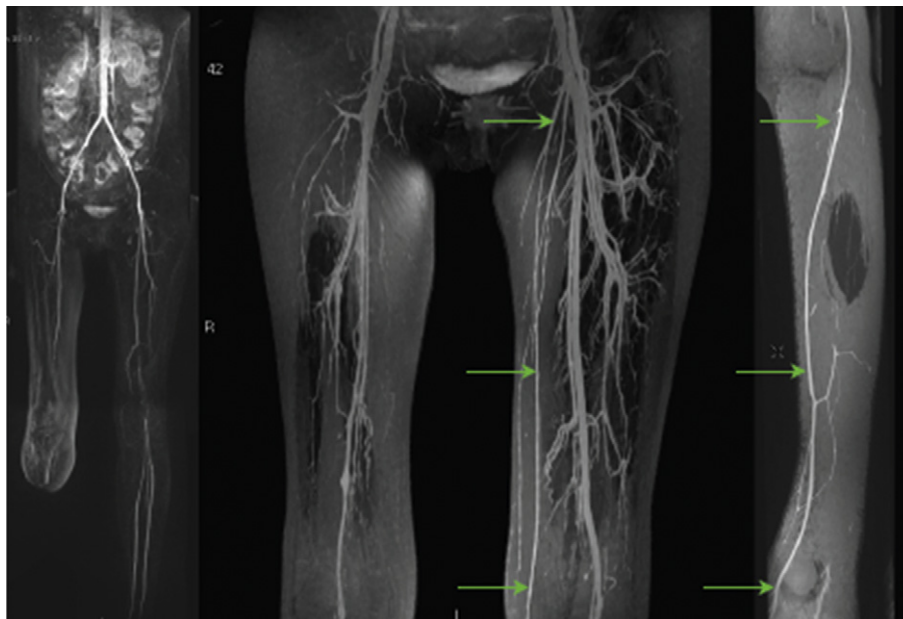
ischaemic rest pain). All patients had patent deep veins. Superficial vein diameters measured by MRI were consistently assessed as similar calibre to duplex ultrasound measurements (Fig. 1). MRI did demonstrate more superficial veins, divisions and large perforating tributaries than were commented on in the ultrasound reports (Fig. 2). MRI images of the venous circulation were consistently rated as of greater or equal utility for the purposes of operative planning.

There is no validated or standardised system for assessment between the investigative modalities and developing a scoring system was outwith the scope of this feasibility study. There was good correlation between the MR assessment and venous duplex in terms of vein diameter and subsequent suitability for bypass surgery. In our practice a GSV diameter of 2.5 mm or more on

venous duplex without the use of a tourniquet would be considered suitable for bypass. MR assessment matched the findings of duplex in all cases, accurately predicting when the GSV would be suitable for bypass. Where patients progressed to revascularisation procedures all veins correlated with pre-operative imaging findings and all were technically successful.

## Discussion

MRI of superficial veins performed well compared to duplex assessment, with congruent calibres at measured sites in both modalities. MRI studies were judged to be more informative than descriptive ultrasound reports in all patients except for the single patient with poor MRI image quality as, in addition to vein calibre,



**Figure 2.** Coronal MIP of first pass 3 station CE-MRA in patient with previous right below knee amputation and now critical ischaemia left leg. Coronal overview MIP of high spatial resolution steady state imaging of thighs plus thin slab sagittal MIP of medial left calf show normal but small calibre left long saphenous vein throughout (green arrows) measured consistently 3mm as per ultrasound. (Note that the long saphenous vein is absent on the right from where it had been previously harvested). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

overview and thin slab MIP images allowed “at a glance” assessment of superficial veins, which surgeons appreciated.

This initial study demonstrates that lower limb MRA performed with blood pool contrast agent and steady state imaging can generate excellent images of both the arterial and venous circulation in the same investigation. The venous images generated were as useful as venous duplex in terms of planning for surgery.

The combined scanning added approximately 20 minutes on to the usual MRI scanning time but was tolerated well by patients.

Although we acknowledge that some surgeons will have a preference for duplex imaging in the context of pre-operative marking, it is our policy to surgically explore the great saphenous vein if imaging suggests that it will be suitable as a conduit (none of the patients in this series considered suitable for surgery had the vein marked prior to surgery).

This single investigation has the potential to obviate additional ultrasound examination in the assessment of patients with lower limb ischaemia who are being assessed for bypass surgery, which has additional significant clinical implications in our centre where there is substantial pressure on our vascular laboratory service.

### Conflict of Interest/Funding

None.

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