» **Original Article** «

MR Venography for the Assessment of Deep Vein Thrombosis in Lower Extremities with Varicose Veins

Kiyoshi Tamura, MD, PhD, and Hideki Nakahara, MD, PhD

Objective: To assess the performance of magnetic resonance venography (MRV) for pelvis and deep vein thrombosis in the lower extremities before surgical interventions for varicose veins.

Materials and Methods: We enrolled 72 patients who underwent MRV and ultrasonography before stripping for varicose veins of lower extremities. All images of the deep venous systems were evaluated by time-of-flight MRV.

Results: Forty-six patients (63.9%) of all were female. Mean age was 65.2 ± 10.2 years (37–81 years). There were forty patients (55.6%) with varicose veins in both legs. Two deep vein thrombosis (2.8%) and three iliac vein thrombosis (4.2%) were diagnosed. All patients without deep vein thrombosis underwent the stripping of saphenous veins, and post-thrombotic change was avoided in all cases.

Conclusion: MRV, without contrast medium, is considered clinically useful for the lower extremity venous system.

Keywords: magnetic resonance venography, varicose vein, stripping

Introduction

Varicose veins (VV) are disability condition, representing a critical public health problem with economic and social consequences. Prevalence is high, being about 20% to 73% in females and 15% to 56% in males.^{1–5} Elastic compression stockings are the initial treatment. Anti-platelet and/or anticoagulation drugs can bring some relief of symptoms. Surgical stripping or endovascular ablation is typically the treatments of choice.

Generally, ultrasonography (US) is the current gold standard imaging modality for evaluation of the venous system in the lower extremity. However, conventional venography has been considered the gold standard for detection of deep vein thrombosis in

patients with VV. The venography of the lower extremity veins has been used for various reasons, including: (1) exclusion of deep venous thrombosis (DVT); (2) observing of post-thrombotic changes in deep veins; (3) presentation of venous malformations; (4) preoperative imaging for saphenous venous stripping, and (5) determination if the saphenous vein is suitable to serve as a coronary bypass vessel.⁶ However, this procedure is time-consuming, invasive, and necessitates the use of ionizing radiation. Complications associated with the use of iodinated contrast material were informed to occur in 2%–5% of patients.^{7–10}

Magnetic resonance venography (MRV) has been revealed to be a quick and non-invasive examination that presents visualizations of the low extremity blood flow dynamics. In the pelvic region, this technique was shown to be even more accurate than was conventional venography. MRV has been shown to be highly sensitive for detecting pathology in a variety of blood vessels and body parts when compared with conventional angiography.^{11–14}

The purpose of this study was to evaluate the utility of MRV for detecting DVT and to describe its associated imaging characteristics.

Department of Cardiovascular Surgery, Soka Municipal Hospital, Soka, Saitama, Japan

Received: June 8, 2014; Accepted: September 16, 2014
Corresponding author: Kiyoshi Tamura, MD, PhD. Department of Cardiovascular Surgery, Soka Municipal Hospital, 2-21-1 Soka, Soka, Saitama 340-8560, Japan
Tel: +81-048-946-2200, Fax: +81-048-946-2211
E-mail: tamura.cvsg@tmd.ac.jp

Seventy-three patients underwent US at outpatient department of our institution between December 2012 and September 2013. One of them was detected DVT by US, and then the patient was excluded in this study. So, seventy-two patients (26 men and 46 women; mean age 65.2 years; age range, 37–81 years) were enrolled in our study, and underwent both ultrasonography (US) and MRV. VV with both lower extremities were in forty patients (40%). In our institution, surgical intervention for VV was short stripping of saphenous veins.

MR imaging was acquired with a 1.5-T MR imaging unit (Vantage Titan ver.2.2; Toshiba, Tochigi, Japan). Patients underwent imaging in a supine position. All images of the deep venous systems were evaluated by two-dimensional (2D) time-of-flight (TOF) -MRV (Fig. 1). In the imaging with the 2D TOF-MRV, the following ranges of parameters were used: 2D fast imaging with steady procession; repetition time repetition (TR), 40 msec; echo time (TE), 9 msec; flip angle, 70°; effective section thickness, 3 mm–6 mm; field of view (FOV), 22 × 35; and 256 × 120 matrix. MRVs were performed without intravenously administered gadolinium in all cases.

Results

The veins of lower extremities were clearly visualized in all cases. In two of 72 patients (2.6%), DVTs were diagnosed with MRV (Fig. 2). Both patients were obese, and DVTs were not detected well by US. One patient did not undergo surgical intervention, and she was clinically followed up on conservative management using elastic stockings. However, the other patient did undergo surgical intervention because the DVT was in the contralateral limb which did not have visible varicose veins.

In three patients of all (4.2%), iliac vein thrombosis was detected with MRA (**Fig. 3**). However, numerous collateral veins were well-developed, so iliac vein occlusion was thought to be chronic lesions. Those patients were underwent surgical intervention because there were reverse flow of valves at sapheno-femoral junction.

Discussion

The presented MRV strategy provides a comprehensive display of the venous system in lower extremities. This study showed that MRV might detect DVTs which were not detected by US in the patients with VV. The incidence of DVT in the study was 2.6% and the incidence of iliac vein thrombosis 4.2%. A number of studies have reported that the incidence of first-time DVT ranged between 38 and 95 per 100,000 per year.^{15–21)} The relation between VV and DVT is not well known, our study demonstrated that there were more DVTs in patients with VV compared with this data.

Fig. 2 MRV image with DVT in common femoral vein. MRV: magnetic resonance venography; DVT: deep vein thrombosis.

Fig. 3 MRV image with DVT in iliac vein. MRV: magnetic resonance venography; DVT: deep vein thrombosis.

In the past, contrast venography has been the reference technique for diagnosing DVT. The diagnosis of DVT is established as constant intraluminal filling defects on at least two views are observed. However, this procedure is time-consuming, invasive, and necessitates the use of ionizing radiation. Therefore, contrast venography is today seldom used.²²⁾ Actually, conventional venography is hardly performed anymore in our institution.

In routine clinical care, US had become the first choice accepted imaging method in the diagnostic procedure of DVT for clinically suspected patients. US devices are available in most medical institutions. Using this device, the femoral and popliteal veins are direct-visualized easily. Cogo and colleagues demonstrated

that all proximal DVTs were located as follows for the distribution of DVT: in the popliteal vein only (10%); in popliteal and superficial femoral vein (42%); in popliteal, superficial femoral vein and common femoral vein (5%); in entire proximal venous system (35%); and in common femoral and superficial vein or iliac vein (8%).²³⁾ US techniques are simple, easy, accurate and non-invasive diagnostic methods, and these devices act as a first-line imaging modality in the diagnostic examination of clinically suspected DVT of the lower extremities. These techniques are very useful, and are routinely performed in the consultation room of our outpatient department.

However, in contrast to proximal DVT of the lower extremities, distal DVT has been less well detected. Regardless of US or other methods, accurate diagnosis for distal DVT is substantially lower compared with proximal DVT. The sensitivities of US were reported to be just over 70% (73%; 95% CI, 54–93).²⁴⁾ In addition, the false-positive findings sometimes happen due to the different and variable distal veins.

Enhanced Computed tomography (ECT) may serve as an alternative or complementary imaging tool to US. However, compared with US, this modality is less well evaluated. In a recent meta-analysis, a pooled sensitivity for ECT venography was 96% (95% CI, 93–98), with a pooled for specificity of 95% (95% CI, 94–97).²⁵⁾ Moreover, ECT venography is invasive, and involves the injection of contrast material as well. Although ECT venography is useful for diagnosis of pulmonary embolism in patients with or without symptoms or signs of thrombosis of the legs, this

method cannot be recommended as first-line imaging approaches for detecting DVT compared with US. ECT venography could be performed for the patients with morbid obesity or the patients with a suspected deep vein thrombosis in the iliac or inferior cava vein or suspected venous anomaly.²²⁾ US cannot be performed or is less reliable for these patients.

MRV can be performed with intravenously administered gadolinium and this technique has been evaluated for its accuracy.

TOF-MRV quickly evolved as a clinically reliable method for detecting DVT.^{26–28)} In TOF-MRV, blood flow is used as the intrinsic contrast agent and signal is based on an in-flow effect. The signal in the vessel depends on the flow up to a threshold speed defined by the slice thickness (mm) divided by repetition time (ms). Vessels are best seen when they are orthogonal to the 2D plane, as in-plane vessels will generally have a loss of signal due to saturation effects.^{29,30)} So, a vessel may show no signal in MRV. This may be indicative of several things: anatomically, the vessel may be stenosed or occluded, abnormally closed (atresia) or undeveloped (aplasia); there may be flow abnormalities such as no flow, or retrograde flow, or the slice in question may be subject to a binding or zipper artifact.²⁹⁾ However, MRV is less invasive than conventional venography and ECT (avoidance for side effect of iodinated contrast material and renal damage), and less operator-dependent than US. MRV could detect DVT in middle femoral veins that might be difficult to be created by US. This technique is able to evaluate easily and globally the anatomic and morphologic features of the venous system in lower extremities.

The results of this study should be interpreted in the light of certain limitations. Firstly, ours is a retrospective study. Secondly, the present study was a single-center experience, and as a result was limited by the relatively small number of patients included. Despite these limitations, our study shows the usefulness of MRV for detecting DVT with VV and we are still comparing this technique and the other methods specially US.

Conclusions

MRV has a role as the definitive examination for detecting DVT. The results of this study demonstrated that the deep venous system of the lower extremities

might be depicted by MRV in a manner superior to that of conventional venography.

Disclosure Statement

There is no conflict of interest for this article.

References

- 1) De Backer G. Epidemiology of chronic venous insufficiency. *Angiology* 1997; **48**: 569-76.
- 2) Carpentier P, Priollet P. [Epidemiology of chronic venous insufficiency]. *Presse Med* 1994; **23**: 197-201.
- 3) Fowkes FG, Evans CJ, Lee AJ. Prevalence and risk factors of chronic venous insufficiency. *Angiology* 2001; **52** Suppl 1: S5-15.
- 4) Cesarone MR, Belcaro G, Nicolaides AN, et al. 'Real' epidemiology of varicose veins and chronic venous diseases: the San Valentino Vascular Screening Project. *Angiology* 2002; **53**: 119-30.
- 5) Uema RT, Dezotti NR, Joviliano EE, et al. A prospective study of venous hemodynamics and quality of live at least five years after varicose vein stripping. *Acta Cir Bras*. 2013; **28**: 794-9.
- 6) Ruehm SG, Wiesner W, Debatin JF. Pelvic and lower extremity veins: contrast-enhanced three-dimensional MR venography with a dedicated vascular coil-initial experience. *Radiology*. 2000; **215**: 421-7.
- 7) Shehadi WH, Toniolo G. Adverse reactions to contrast media: a report from the Committee on Safety of Contrast Media of the International Society of Radiology. *Radiology* 1980; **137**: 299-302.
- 8) Shehadi WH. Contrast media adverse reactions: occurrence, recurrence, and distribution patterns. *Radiology* 1982; **143**: 11-7.
- 9) Bettmann MA, Robbins A, Braun SD, et al. Contrast venography of the leg: diagnostic efficacy, tolerance, and complication rates with ionic and nonionic contrast media. *Radiology* 1987; **165**: 113-6.
- 10) Lensing AW, Prandoni P, Büller HR, et al. Lower extremity venography with iohexol: results and complications. *Radiology* 1990; **177**: 503-5.
- 11) Kim CY, Mirza RA, Bryant JA, et al. Central veins of the chest: evaluation with time-resolved MR angiography. *Radiology* 2008; **247**: 558-66.
- 12) Masunaga H, Takehara Y, Isoda H, et al. Assessment of gadolinium-enhanced time-resolved three-dimensional MR angiography for evaluating renal artery stenosis. *AJR Am J Roentgenol* 2001; **176**: 1213-9.
- 13) Froger CL, Duijm LE, Liem YS, et al. Stenosis detection with MR angiography and digital subtraction angiography in dysfunctional hemodialysis access fistulas and grafts. *Radiology* 2005; **234**: 284-91.

- 14) Swan JS, Carroll TJ, Kennell TW, et al. Time-resolved three-dimensional contrast-enhanced MR angiography of the peripheral vessels. *Radiology* 2002; **225**: 43-52.
- 15) Naess IA, Christiansen SC, Romundstad P, et al. Incidence and mortality of venous thrombosis: a population-based study. *J Thromb Haemost* 2007; **5**: 692-9.
- 16) Braekkan SK, Mathiesen EB, Njølstad I, et al. Family history of myocardial infarction is an independent risk factor for venous thromboembolism: the Tromsø study. *J Thromb Haemost* 2008; **6**: 1851-7.
- 17) Ho WK, Hankey GJ, Eikelboom JW. The incidence of venous thromboembolism: a prospective, community-based study in Perth, Western Australia. *Med J Aust* 2008; **189**: 144-7.
- 18) Isma N, Svensson PJ, Gottsäter A, et al. Prospective analysis of risk factors and distribution of venous thromboembolism in the population-based Malmö Thrombophilia Study (MATS). *Thromb Res* 2009; **124**: 663-6.
- 19) Oger E. Incidence of venous thromboembolism: a community-based study in Western France. EPI-GETBP Study Group. Groupe d'Etude de la Thrombose de Bretagne Occidentale. *Thromb Haemost* 2000; **83**: 657-60.
- 20) Silverstein MD, Heit JA, Mohr DN, et al. Trends in the incidence of deep vein thrombosis and pulmonary embolism: a 25-year population-based study. *Arch Intern Med* 1998; **158**: 585-93.
- 21) Spencer FA, Emery C, Joffe SW, et al. Incidence rates, clinical profile, and outcomes of patients with venous thromboembolism. The Worcester VTE study. *J Thromb Thrombolysis* 2009; **28**: 401-9.
- 22) Huisman MV, Klok FA. Diagnostic management of acute deep vein thrombosis and pulmonary embolism. *J Thromb Haemost*. 2013; **11**: 412-22.
- 23) Cogo A, Lensing AW, Prandoni P, et al. Distribution of thrombosis in patients with symptomatic deep vein thrombosis. Implications for simplifying the diagnostic process with compression ultrasound. *Arch Intern Med* 1993; **153**: 2777-80.
- 24) Kearon C, Julian JA, Newman TE, et al. Noninvasive diagnosis of deep venous thrombosis. McMaster Diagnostic Imaging Practice Guidelines Initiative. *Ann Intern Med* 1998; **128**: 663-77.
- 25) Thomas SM, Goodacre SW, Sampson FC, et al. Diagnostic value of CT for deep vein thrombosis: results of a systematic review and meta-analysis. *Clin Radiol* 2008; **63**: 299-304.
- 26) Spritzer CE, Sostman HD, Wilkes DC, et al. Deep venous thrombosis: experience with gradient-echo MR imaging in 66 patients. *Radiology* 1990; **177**: 235-41.
- 27) Erdman WA, Jayson HT, Redman HC, et al. Deep venous thrombosis of extremities: role of MR imaging in the diagnosis. *Radiology* 1990; **174**: 425-31.
- 28) Lanzer P, Gross GM, Keller FS, et al. Sequential 2D inflow venography: initial clinical observations. *Magn Reson Med* 1991; **19**: 470-6.
- 29) Ayanzen RH, Bird CR, Keller PJ, et al. Cerebral MR venography: normal anatomy and potential diagnostic pitfalls. *AJNR Am J Neuroradiol* 2000; **21**: 74-8.
- 30) Spritzer CE. Progress in MR imaging of the venous system. *Perspect Vasc Surg Endovasc Ther* 2009; **21**: 105-16.