MR Venography in the Detection of Pelvic Venous Congestion

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Abstract  Purpose: To investigate the feasibility of using magnetic resonance venography (MRV) to detect pelvic venous congestion (PVC).
Methods: A prospective study of 23 female patients with signs and symptoms of PVC, who underwent duplex sonography, MRV and phlebography (P). Examinations were interpreted in a blinded fashion. Visualization of venous anatomy, presence of venous incompetence and congestion grade were evaluated. Sensitivity and specificity of MRV using P as reference were calculated.
Results: MRV agreed with P in 96% (Cohen-K-value 0.646) and in 70% (K 0.555) of the cases respectively in the venous anatomy and congestion grade. Sensitivity and specificity of MRV were 88% and 67% for ovarian veins, 100% and 38% for hypogastric veins and 91% and 42% for the pelvic plexus.
Conclusions: In this prospective study MRV showed high sensitivity in the evaluation of patients with suspected PVC. Routine use of this diagnostic method requires further studies in larger patient cohorts.

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table

Introduction

Pelvic congestion syndrome (PCS) is a frequently overlooked gynaecological complaint, which often produces chronic pelvic pain (CPP). This is characterized by persisting dull pelvic pain for more than 6 months1 in multiparous women. The symptoms may be exacerbated by postural changes, walking, prolonged standing, or other activities that increase abdominal pressure, such as lifting. Congestive dysmenorrhoea, dyspareunia, postcoital ache, and urinary symptoms are also common.

Most patients are referred by the gynaecologist to the vascular surgeon with a history of CPP and vulval varices. These are often in connection with the saphenous and femoral veins through anastomosis with the deep and superficial external pudendal veins.

Removal of the superficial varicosities without treatment of the source of reflux will result in recurrence. The same is true in cases of severe gonadal and/or internal iliac
vein dilatation, known as pelvic vein congestion (PVC), where only the external varicosities are removed.

Since anatomical venous variations in the pelvis are common,\textsuperscript{2,3} it is important to know the anatomy of these vessels for treatment planning.\textsuperscript{4–6} Imaging is critical in the evaluation of pelvic varices, both to differentiate them from other conditions and also because pelvic varices may be secondary to serious underlying pathology, such as inferior vena caval obstruction, portal hypertension, increased pelvic blood flow, and vascular malformations.

The diagnosis of PCS has usually been suggested by duplex ultrasound (US), but ultrasound imaging does not readily show the gonadal veins. Phlebography is the "gold-standard" for anatomic diagnostic studies. Related mortality and morbidity are low, but patient discomfort and costs make this an unattractive routine method of diagnosis. Magnetic resonance imaging (MRI) can usually demonstrate pelvic and ovarian varices, as well as the gonadal veins.

MRI allows complete examination of the pelvic anatomy because of its multiplanar imaging capability. Dynamic subtraction MR angiograms can provide an overview of the vessels and demonstrate abdominal vascular anatomy and vessel occlusions.\textsuperscript{7–9}

In this prospective study, we investigated the feasibility of using magnetic resonance venography (MRV) in the diagnosis of PCS and evaluated its accuracy and reliability in comparison to US and P.

Materials and Methods

Patient population

From May 2006, the diagnostic protocol in our vascular centre was modified to include MRV in addition to clinical and duplex US examinations for patients suspected of having PCS. Included in this prospective study were all patients who had signs or symptoms of PCS. Suspicion of PCS was based on clinical features as well as US findings of the saphenofemoral junction, the deep and superficial veins system of the lower limbs.

At the time of patient hospital admission, comorbidities as well as standard physical examination findings, were recorded. Clinical data and staging of PCS were assessed in all patients. The clinical evaluation included a history of congestion symptoms and a physical examination of the pelvic region and the lower limbs in order to demonstrate signs of venous incompetence. Clinical signs of PVC which we evaluated included prominent varices in the thigh and varicose veins with a proximal distribution.

MRV and P were undertaken in patients in whom no infragingual source was found for varices on US and there was a clinical history and signs of PVC, including vulvar varices during pregnancy, increase of venous insufficiency symptoms in intercourse, dyspareunia, dull pelvic ache of unclear origin, or a history of surgery for recurrent varices of the saphenofemoral junction. On duplex ultrasonography we detected the presence of reflux at the sapheno-femoral junction and evaluated flow direction with colour Doppler imaging.

Patients included in this study were those in whom: informed consent was given; no contraindication to MR imaging and phlebography, such as a pacemaker, claustrophobia or a known contrast medium allergy; absence of pregnancy. A positive history for deep vein thrombosis (DVT) of the lower limb was also seen as an exclusion criterion since a previous DVT would preclude further invasive diagnostic examination with phlebography in order to confirm MR findings.

All studies were performed with agreement our institutional ethics committee and written informed consent was obtained from all patients. 23 female patients (see Table 1) with a median age of 51 years (range 29–71) years were included in the study and underwent MRV as well as phlebography. 3 patients were nulliparous, 9 uniparous, 11 pluriparous, 7 had undergone hysterectomy and 2 oophrectomy. All had dull pelvic pain of variable intensity that persisted for more than 6 months increased with prolonged standing, particularly following intercourse in 3 patients.

Associated symptoms were: leg pain in 22 cases, dyspareunia in 5 patients, leg heaviness in 18 cases. 15 patients (11 with one previous operation and 4 with more than one operation) had recurrent and 8 patients primary veins of the great saphenous vein, in 20 cases needing redo surgery. In 22 cases the varicosities were localised to the lower limb and in 3 cases at the buttock and in 6 cases in the vulval region.

Duplex US

All Duplex US scans of the lower limbs were performed in the standing position and interpreted prospectively by a single experienced vascular surgeon. Duplex scans were performed with an Acuson Antares SW 3.5 scanner (Siemens, Erlangen, Germany) using a 7 MHz transducer. Duplex examinations in all patients included the superficial and deep venous system from the sapheno-femoral region to the ankle vessels.

In particular, attention was given to signs of reflux at the sapheno-femoral junction due to cranial (epigastric) and medial (pudendal) veins. We considered that in these cases investigation with MRV and phlebography was appropriate, even in the absence of symptoms.

MRV

All patients underwent imaging in the supine position. The MRI examinations were performed with a 1.5 T imaging unit (Magnetom Symphony, Siemens, Erlangen, Germany) with use of a commercially available body phased-array coil.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Demographic data</th>
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<tr>
<td>Age (median)</td>
<td>51 years (range 29–71)</td>
</tr>
<tr>
<td>Weight (median)</td>
<td>50.1 kg (range 45–80)</td>
</tr>
<tr>
<td>BMI (median)</td>
<td>26.1 (range 23–31)</td>
</tr>
<tr>
<td>previous vein surgery</td>
<td>15 (65%)</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Comorbidity</th>
<th></th>
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<tbody>
<tr>
<td>Hypertension</td>
<td>7 (30%)</td>
</tr>
<tr>
<td>Adiposity (BMI &gt; 30)</td>
<td>6 (26%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>3 (13%)</td>
</tr>
<tr>
<td>Thyroid dysfunction</td>
<td>2 (8%)</td>
</tr>
<tr>
<td>Heart ischaemic disease</td>
<td>1 (4%)</td>
</tr>
<tr>
<td>Heart congestive failure</td>
<td>1 (4%)</td>
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<tr>
<td>Arrhythmia</td>
<td>1 (4%)</td>
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MRV included the deep and superficial system from the V. cava inferior to the groin including the renal and the ovarian veins. Administration of the contrast medium gadopentetate dimeglumine (Magnevist™, Schering, Berlin, Germany) was done via an 18-gauge needle inserted in an antecubital vein with the help of an MRI compatible injector (Spectris MR-injector, Medrad, Maastricht, the Netherlands).

The injection of contrast medium was followed by a bolus injection of 20 ml saline at 2 ml/sec.

To achieve maximum contrast signal in the arteries, the transit time of contrast medium was determined with the use of a test bolus of 2 ml at a rate of 2 ml/sec, followed by 20 ml saline at 2 ml/sec. Repeated measurements using a t1-weighted two-dimensional gradient-echo-sequence were performed each second to determine the arrival of the test bolus.

Before administration of contrast medium true-FISP-images were obtained in coronal and transverse orientation (transverse: 2 x 19 slices, FOV 360, slice thickness 8 mm, gap 25%, TR 4.65 msec, TE 2.33 msec, matrix 256 x 256; coronal: 19 slices, FOV 400, slice thickness 8 mm, gap 25%, TR 4.95 msec, TE 2.28 msec).

In addition, two-dimensional t1-weighted gradient-echo sequences in coronal and transverse orientation (transverse: 20 slices, FOV 360, slice thickness 8 mm, gap 25%, TR 188 msec, TE 4.7 msec; coronal: 20 slices, FOV 400, slice thickness 8 mm, gap 25%, TR 172 msec, TE 4.7 msec) and a three-dimensional t1-weighted gradient-echo sequence (64 slices, FOV 350, slice thickness 2.5 mm, gap 20%, TR 3.7 msec, TE 1.77 msec) were performed with a breath hold.

A t1-weighted coronal three-dimensional gradient-echo sequence (72 slices, FOV 400, slice thickness 1.4 mm, gap 20%, TR 2.96 msec, TE 1.21 msec) was obtained before and after administration of contrast medium in arterial, early and late venous phase. The first measurement served for subtraction, the second to visualize the arteries, the third to depict veins and the fourth to detect venous filling. The data were linearly acquired. No zero-filling was used.

After subtraction of native and contrast-enhanced images an MIP was done. In addition, two-dimensional gradient-echo sequences with fat-saturation were performed in coronal and transversal orientation (transversal: 20 slices, FOV 360, slice thickness 8 mm, gap 25%, TR 190 msec, TE 4.07 msec; coronal: 20 slices, FOV 400, slice thickness 8 mm, gap 25%, TR 172 msec, TE 4.07 msec) and a three-dimensional t1-weighted gradient-echo sequence (64 slices, FOV 350, slice thickness 2.5 mm, gap 20%, TR 3.7 msec, TE 1.77 msec) were conducted. The duration of complete examination was 30 to 40 minutes.

Phlebography

Examinations were undertaken using a standard digital fluoroscopy unit with a tilting table (Polystar, Siemens, Erlangen, Germany). Sequential images (1/sec) were acquired with use of a 48 cm field of view. The examination table was tilted by 35 degrees into a reverse-Trendelenburg position.

A 5-french vessel sheath was inserted into the right femoral vein using a Seldinger technique. A 5-french Levin catheter (Boston Scientific, Watertown, MA, USA) was then advanced over a floppy-tipped guidewire and positioned into the right external, internal and common iliac veins. At each position 15 ml diluted contrast medium (7.5 ml iopromide-Ultravist 300, Schering, Berlin, Germany: 7.5 ml saline solution) was manually administered though the catheter during a Valsalva manoeuvre.

Images were obtained in a 25 degree LAO-projection. The catheter was then positioned in the left external, internal and common iliac vein. Images were obtained in a 25 degree RAO-position.

Then the catheter was directed into the left renal vein, followed by injection of diluted contrast medium during a Valsalva manoeuvre. Images were obtained in p.a.-view. If an incompetence of the left ovarian vein was detected, the catheter was positioned in the proximal part of the vein and a venography was conducted. The examination was concluded after injection of contrast medium into the inferior vena cava in order to detect incompetence of the right ovarian vein.

Incompetence and extent of the reflux of the OV and IIV were recorded. The criteria we have used to define incompetence were: dilated ovarian vein, retrograde filling of the principal tributaries of the IV (gluteal, sciatic, obturator vein). Communication with other structures (e.g. the contralateral ovarian plexus, the isilateral or contralateral internal iliac veins, etc) was noted and recorded. If necessary, coiling of the ovarian vein was performed as part of treatment of these veins.

At the end of the examination, patients were observed for about 4 hours and then discharged home. Patients requiring varicose vein surgery underwent the procedure the same day.

Imagine analysis

Conventional and MR venography images were interpreted in a prospective and blinded fashion. To avoid interpretation errors related to well-documented interobserver variations, both imaging modalities were interpreted by one experienced radiologist. To avoid any recognition bias, the studies were presented in random order.

Conventional venography was used as the standard of reference. MRV images have been reviewed first to avoid recognition bias. For the analysis, the venous system was divided into the following segments: internal iliac vein, ovarian vein, pelvic plexus.

Findings of all modalities were evaluated on the basis of qualitative criteria. We defined PVI as the presence of dilated ovarian veins (at least 1.5 times the contralateral vessel), contrast depicting the pelvic plexus or varicose dilatation of the hypogastric veins (e.g. tortuosity). The connections to the superficial venous system of the lower limbs was also recorded.

Visualization of venous anatomy was rated on a three-point scale, with 1 representing inadequate (impossible to definitively determine a treatment plan), 2 representing intermediate (image quality intermediate but sufficient for treatment planning) and 3 representing excellent (anatomic visualization excellent and more than sufficient for treatment planning).

We used the classification method proposed by Kaupilla,10 defining the venographic appearance of the ovarian...
and iliac veins as well as the parauterine venous plexus as normal (small, straight, similar in calibre and easily visualized veins), moderate congestion (vein variable in calibre, tortuous, and difficult to see separately, diameter between 0.5 and 1.0 cm), or severe congestion (wide veins, great variation in calibre, markedly tortuous, diameter greater than 1.0 cm).

Statistical analysis

The visualisation of venous anatomy and the identification of incompetence grade are described as percentages and their comparison as Cohen k-value. Sensitivity and specificity are also reported as percentages. The k-values are interpreted as suggested by Landis.11

Results

MRV and phlebography were completed in all patients and example image are shown in Figs. 1–2. We experienced no complication attributable to the contrast material, the femoral puncture site or deep vein thrombosis. No vessel trauma was observed. Varicose vein surgery was not complicated by the preceding investigations.

Of the 23 patients examined, 7 were treated by embolisation of the left ovarian vein and 1 of the right external pudendal vein. In all cases complete occlusion of the vessels was achieved. Retrograde flow was seen in 10 (43%) of ovarian veins, 3 (12%) of internal iliac veins and 7 (30%) of pelvic plexus on MRV and in 15 (65%), 7 (30%) and 13 (57%) cases on phlebography respectively.

10 (52%) out of the 19 patients with US signs of suprainguinal reflux showed incompetence of the pelvic veins on MRV, and 15 (79%) on phlebography. 18 had clinical signs and symptoms of PVC, of whom 10 (55%) showed incompetent pelvic veins on MRV and 13 (72%) on phlebography respectively.

Visualisation of venous anatomy was satisfactory on MRV. The findings are summarised in Tables 2 and 3. We defined the venous segments as normal, moderate and severely congested with the data also shown in Table 2 for MRV and phlebography. Using Phlebography as the gold standard we defined sensitivity and specificity of MRV. In 16 cases (70%) MRV defined correctly the grade of incompetence of dilated veins. In 3 patients vein dilation could not be demonstrated on MRV, even in cases where phlebography showed moderate congestion. 2 patients had no MRV signs of an incompetent plexus, even if on phlebography a severe grade of dilation was revealed. None of these patients underwent endovascular treatment.

2 dilated ovarian veins were classified as moderately congested on MRV and as severe congested on phlebography, both of which were treated by coil occlusion.

In the 10 patients with discrepancies between MRV and phlebography, MRV did not detect dilation of the hypogastric veins in 4 and of the pelvic plexus in 6 cases as well as of the ovarian veins in 5 cases. MRV gave a false positive in detecting a dilation of a left ovarian vein and of a plexus in 1 patient.

MRV gave a sensitivity for the presence of congestion of ovarian veins (88%), hypogastric veins (100%) and pelvic plexus (91%). The specificity of MRV (it did not reveal dilated vessels) was ovarian veins (67%), hypogastric veins (38%) and pelvic plexus (42%).

Discussion

The aetiology of PCS is still unclear. It is a frequent phenomenon and its treatment places a significant burden on health care system and resources. The diagnosis of PVC is often overlooked clinically. The most commonly used investigations are ultrasound, computed tomography (CT), and more invasive methods such as laparoscopy and phlebography. Direct phlebography is the reference standard for pelvic varices.12 Park13 states that patients with a medical history compatible with PCS should first undergo transabdominal ultrasonography or transvaginal sonography to exclude other pelvic abnormalities and to show dilated uterine and ovarian vein structures, polycystic changes of the ovaries, and uterine enlargement.14,15 However, in a group of 139 patients, he identified a pelvic varicocele in only 53% of cases using transabdominal and transvaginal ultrasound.

Kim16 describes even worse results in 131 patients, with a detection rate for pelvic varicoceles of 53% with transabdominal ultrasound, of 12.5% with CT-scan and of 40% with laparoscopy.

Phlebography, though effective is invasive, uncomfortable and exposes patients to ionising radiation of the pelvis. The latter is a particular concern because many of the
women are of childbearing age. In addition, complications associated with the use of iodinated contrast material are reported to occur in 2–5% of patients.17,18

MRV can be used as a non-invasive modality to diagnose pelvic varices. Even if the safety of MRI procedures during pregnancy has not been definitively proven,19,20 the risk of exposing the developing foetus to any radiological diagnostic imaging technique that uses ionising radiation is probably greater than the theoretical risk of MRI.21 The isotonic nature of MRI contrast media eliminates the risk of thrombosis associated with conventional iodinated contrast agents.17,18 The low risk of anaphylactic reactions inherent to extra cellular paramagnetic drugs is an additional factor contributing to the attractiveness of MRV.

In our limited study population of 23 patients, MRV showed a high sensitivity compared to phlebography and visualisation of venous anatomy was excellent or more than sufficient for the treatment planning in all cases on MRV. The agreement of MRV and phlebography on venous congestion grade and on visualisation of venous anatomy was moderate, demonstrating that MRV is well-suited for the morphologic assessment of pelvic ad ovarian veins. In some cases, the incompetence grade was incorrectly assigned but this did not influence treatment.

These results accord with the experience of Ruehm,22 who showed that MRV had a sensitivity of 94% of MRV, for the presence of varicose changes in patients with PCS. In particular, he described pelvic varices appearing as dilated and tortuous parauterine tubular structures of varying calibre with high signal intensity, which may extend inferiorly to communicate with the paravaginal venous plexus. Ruehm affirms that the tubular nature of these structures and the pattern of enhancement after intravenous contrast medium administration should prevent confusion with adenopathy or adnexal masses.

Both US and clinical signs of PVC correlated to the presence of incompetent pelvic veins seen on the phlebography in 3/4 of the cases. This underlines the importance of using both clinical and US examination to detect patients with suspected PVC who will undergo further evaluation.

MRV allows assessment of the venous system in the pelvis and lower extremity with image quality comparable to that of conventional venography. However, due to its low specificity, MRV may underestimate venous pathology. This is because conventional cross-sectioned imaging studies are generally performed in the supine position and ovarian and pelvic varices may not be as prominent on such examinations.

Nascimento et al.6 recognized that during MRV performed with the patient lying supine, gravity could not be used as an adjuvant to encourage reflux. In a study on 22 patients, these authors used suspended respiration resulting in higher intra-abdominal pressure to produce reflux. However, they were not able to verify the efficacy of this manoeuvre in detecting reflux. Other authors tried better to identify dilated and incompetent vessels suggesting dynamic subtraction techniques8,9 or dedicated vascular coils,22 as well as zero-filling interpolation.6

Due to these shortcomings, MRV might be inferior to phlebography in the early stages of pelvic venous incompetence, where reflux is the only sign of the disease. However,
in later stages, where dilatation of the vein walls is also present, this limitation of MRV is probably of less importance.

Conclusions

The findings of the present study show that MRV is almost equal to phlebography in the detection of pelvic vein incompetence and that it is well-suited as screening method in the initial evaluation of patients with suspected PCS. Its cost-effectiveness and wide availability make it particularly useful.

More detailed evaluation of this technique in a larger patient cohort is justified.

References