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Magnetic Resonance Venography of chronic cerebrospinal venous insufficiency in patients with associated multiple sclerosis

Marcin Hartel[1], Ewa Kluczewska[1,2], Marian Simka[3], Tomasz Ludyga[3], Jacek Kostecki[4], Maciej Zaniewski[4]

[1] MCD Voxel, MRI Department, Zabrze, Poland
[2] Radiology Department in Zabrze, Medical Uniwersity of Silesia, Katowice, Poland
[3] EUROMEDIC Specialist Clinics, Department of Vascular & Endovascular Surgery, Katowice, Poland
[4] General and Vascular Surgery Department in Tychy, Medical University of Silesia, Katowice, Poland

Author's address: Marcin Hartel, Reta 39G Str., 43-190 Mikołów, Poland, e-mail: hartel@voxel.pl

Summary

Background: Multiple sclerosis (MS) is a chronic disease with not well understood etiology. Recently, a possible association of MS with compromised venous outflow from the brain and spinal cord has been studied (chronic cerebrospinal venous insufficiency – CCSVI). Angioplasties of internal jugular veins (IJV) and azygous vein (AV) have given promising results, with improvements in patients' clinical status.

Material/Methods: 830 patients with clinically defined MS were scanned from the level of sigmoid sinuses to the junction with brachiocephalic veins, as well as at the level of AV. T2-weighted, 2D TOF and FIESTA sequences were used.

Results: The examination revealed a slower blood flow in IJVs, in 98% of patients: on the right side – in 6%, on the left side – in 15%, on both sides with right-side predominance – in 22%, on both sides with left-side predominance – in 34%, bilaterally with no side predominance – in 19%. In 2%, there was a slower blood flow in IJVs, vertebral veins and subclavian veins and also in the left brachiocephalic vein. Moreover, in 5% of patients there was a decreased blood flow in the azygous vein.

Conclusions: Abnormal flow pattern in IJVs is more common on the left side. Less often it can be found in azygous vein and in brachiocephalic veins. Further research is needed to investigate the significance of CCSVI in MS patients. The protocol we described can be used for most of modern magnetic resonance units.

Key words: CCSVI • chronic cerebro-spinal venous insufficiency • multiple sclerosis • magnetic resonance venography

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Background

Multiple sclerosis (MS) is a well known chronic disease of the central nervous system. Despite decades of research on MS, its etiology is not well understood [1–5]. Recently, a new paradigm of MS has been studied intensively: a possible association of MS with compromised venous outflow from the brain and spinal cord, the so called chronic cerebrospinal venous insufficiency (CCSVI) [6–12]. Angioplasties of internal jugular veins (IJV) and azygous vein (AV), performed since 2007, have given promising results, with improvements in patients' clinical status [13–16]. This report focused on one of the pre-procedural tests that are used to diagnose CCSVI, namely magnetic resonance venography (MRV) [17–19].

Material and Methods

Between July 2009 and December 2010, we scanned 830 patients (623 women and 207 men, with a mean age of 46 years). All the patients presented with clinically defined MS. They had also been previously diagnosed for CCSVI using color Doppler sonography with a protocol of the test proposed

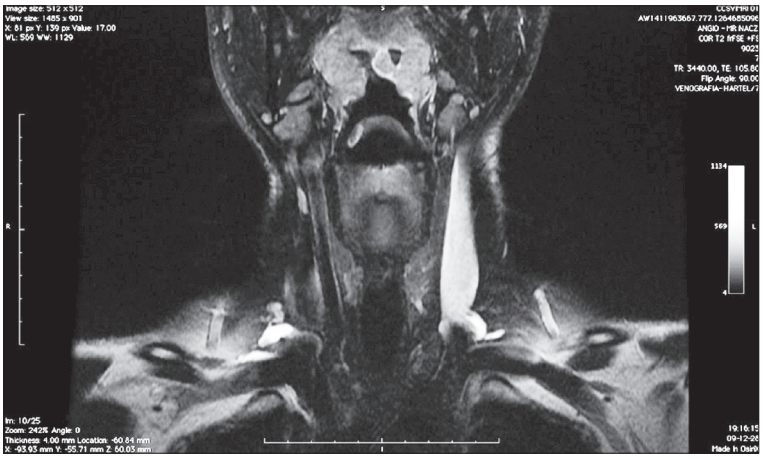

Figure 1. T2FatSat; slow blood flow in the internal jugular vein on the left.

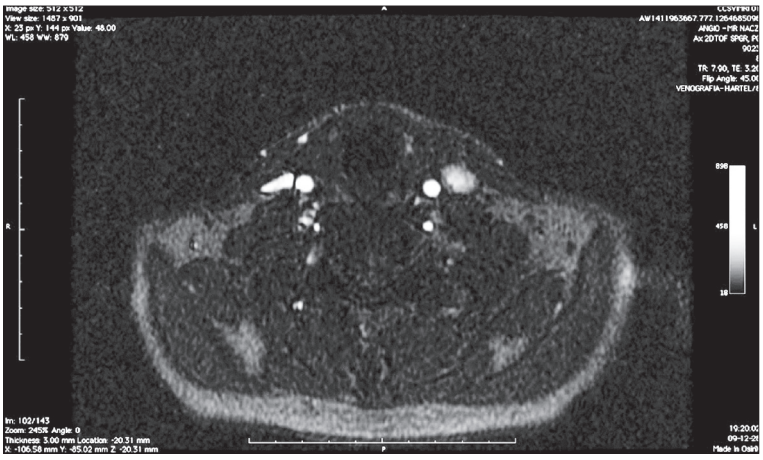

Figure 2. 2DTOF; slow blood flow in the left IJV.

by Zamboni et al. [20]. Magnetic resonance venographies were performed on a General Electric 1.5T Signa HDx system. We scanned the IJVs from the level of sigmoid sinuses to the junction with brachiocephalic veins. We applied the following sequences: coronal fast spin-echo T2-weighted sequences with fat saturation (T2 FatSat, TE/TR/slice thk. 106,6/3500/4), axial two-dimensional time-of-flight (2D TOF, TE/TR/slice thk. 3,7/8,6/3) and two-dimensional fast imaging employing steady-state acquisition (2D FIESTA, TE/TR/slice thk. 2/4,5/4). FIESTA and 2DTOF sequences were also used to visualize the AV. During imaging of the latter vein, we applied Valsalva maneuver to reduce compression of the vein by the mediastinum, which made the AV a little wider on the scans.

For the assessment of the morphology of IJVs and their possible anomalies or variants (also of external and anterior jugular veins, as well as other cervical veins), we used FIESTA imaging in 3 planes. With this technique, a functional narrowing of IJV, often present at the level of transverse process of C1, is well visible. A similar narrowing is sometimes found in the lower part of the IJV, at about 3–5 cm above the level of the junction with the subclavian vein. Here, the IJV is compressed between sternocleidomastoid and anterior scalene muscle. It should be emphasized that such narrowings are usually functional since they are not visible during catheter venography. Still, they can reflect a decreased pressure in veins and in this context they may constitute an indirect sign of CCSVI. To demonstrate the decreased flow, we used the T2FatSat and 2DTOF sequences. The first one showed a bright (fluid-like) signal (Figure 1) and the second one, a decreased signal inside the vein, with a slower outflow (Figure 2).

Table 1. Results.

Total number of patients	830	
Slower blood flow in IJV on the right side	50	(6%)
Slower blood flow in IJV on the left side	124	(15%)
Slower blood flow in IJVs on both sides with right-side predominance	182	(22%)
Slower blood flow in IJVs on both sides with left-side predominance	282	(34%)
Bilaterally with no side predominance	158	(19%)
Slower blood flow in IJVs, vertebral, subclavian and brachiocephalic veins	17	(2%)
NO change	17	(2%)
Additionally: slower blood flow in the AV	42	(5%)

Results

We performed MRV in 830 patients. The examination revealed a slower blood flow in IJVs. Only 17 patients (2%)

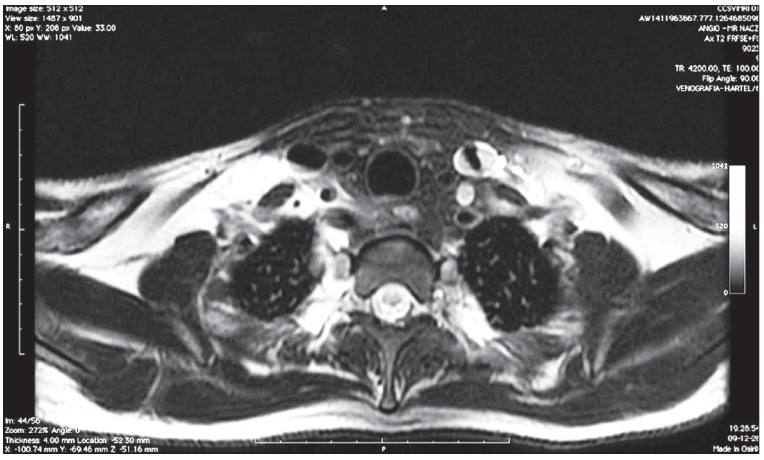

Figure 3. T2FatSat; pathologic valve/stenosis in the junction of the left IJV with brachiocephalic vein.

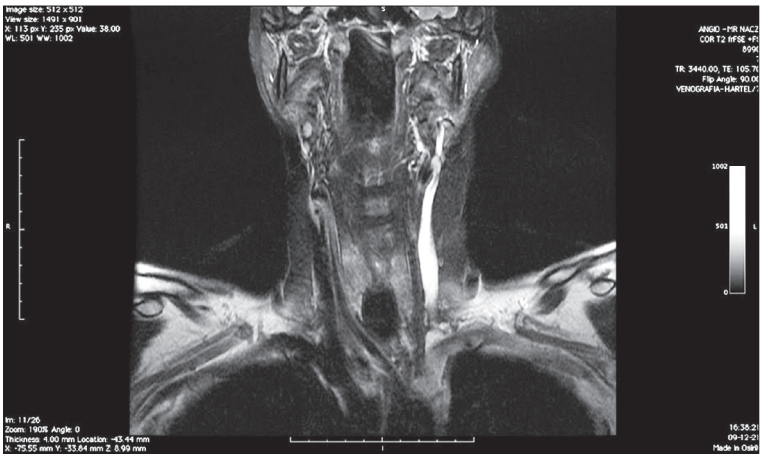

Figure 4. T2FatSat; slower flow in the IJV, as well as subclavian and brachiocephalic veins, on the left side.

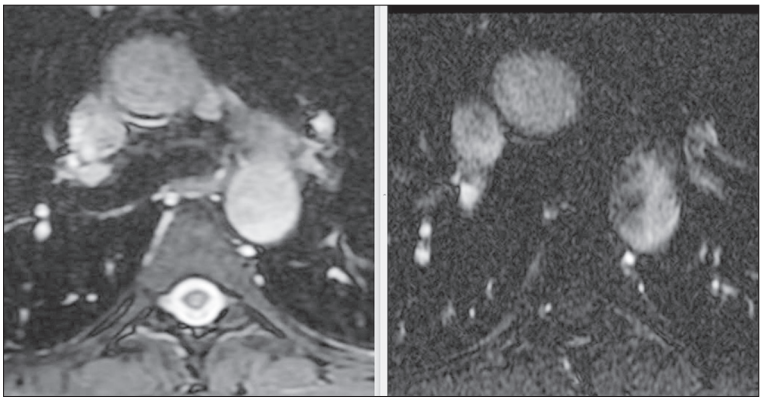

Figure 5. FIESTA and 2DTOF; the azygous vein is smaller than usually, with an abnormally low flow: breath-hold acquisition during Valsalva maneuver (the azygous vein should dilate and the mediastinum usually moves a little anteriorly).

showed no such flow patterns. The pathologies mentioned were seen: on the right side in 6% of scanned MS patients, on the left side – 15%, on both sides with right-side predominance – 22%, on both sides with left-side predominance – 34%, bilaterally with no side predominance – 19%. In 17 cases (2%), a more pronounced pathology was seen: slower blood flow in IJVs, vertebral, subclavian and also in the left brachiocephalic veins. Moreover, in 42 cases (5%), a decreased blood flow in the AV was detected (Table 1).

Discussion

The most common causes of a slower blood flow in CCSVI patients are the obstructed or malfunctioning valves (Figure 3). In our opinion, the main purpose of MRV is not to visualize such a valve, but to demonstrate the influence of such pathological structures on flow characteristics. In addition, MRV can demonstrate anatomical abnormalities (such as hypoplasia or agenesis of a vein) that may make endovascular treatment of CCSVI challenging or even impossible. The most common CCSVI pathology, namely the pathologic flow in the IJV, can be also detected with color Doppler sonography [21]. However, pathologic outflows or anatomical abnormalities in AV or brachiocephalic vein cannot be diagnosed by means of color Doppler sonography. Hence, MRV remains the only reliable diagnostic tool in case of these veins (Figures 4, 5). Importantly, a standard MRV with gadolinium contrast enhancement, which

was used in our center initially, was not found very useful in the diagnostics of CCSVI pathologies. Probably, the advanced MRV sequences, with quantitative measuring of the blood flow, will be even more useful than our protocols. However, for the time being, there are no such widely accepted and standardized MRV protocols. Our MRV protocol is simple and very efficient in diagnosing CCSVI abnormalities. Moreover, it could be implemented in the majority of MR scanners, produced after 2005.

Similarly to the already published four grades of pathologic outflow diagnosed with catheter venography, we herewith propose 4 MRV grades of CCSVI:

1. mildly decreased flow – demonstrated by a mildly increased signal on coronal T2FatSat images;
2. moderately decreased flow – demonstrated by a moderately increased signal on coronal T2FatSat images, and by a slightly decreased signal on axial 2DTOF images;
3. highly decreased flow – demonstrated by a significantly increased signal on coronal T2FatSat images and by a significantly decreased signal on axial 2DTOF images;
4. severely decreased flow – demonstrated by an increased signal on coronal T2FatSat images and by an almost totally decreased IJV signal on axial 2DTOF images (see our images at: *http://ccsvimri.blogspot.com/*).

Conclusions

Abnormal flow pattern in IJVs with the pathology being more common on the left side, showed by means of MRV, is a frequent finding in MS patients. Less often, such an anomalous outflow can be seen in AV and brachiocephalic veins. MRV, with our protocols, is a reliable diagnostic tool for the assessment of flow disturbances in IJVs and AV. Further research is needed to investigate the significance of this venous pathology and its potential impact on MS. The described protocol is not too sophisticated and can be used in most of the modern magnetic resonance units.

Ethical issues

The diagnostics of CCSVI using MRI was approved by the Bioethical Committee of the Regional Silesian Board of Physician in Katowice, Poland (approval No: 7/2010). All patients provided their written consent to undergo this procedure.

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