



# MR Venographic Patterns in Chronic Intractable Headache

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## Introduction

MR imaging (MRI) and MR venography (MRV) were performed in 110 consecutive patients referred for chronic intractable headache (ChiHA). This study was prompted by a number of incidental findings in this group showing abnormalities of cerebral venous return (CVR). MRV was therefore included in the workup of patients with ChiHA. The synchronicity of this study with the worldwide renewed interest in CVR as a result of the Zamboni hypotheses about the role of obstruction of CVR in multiple sclerosis (MS) and the suggested improvement by venous dilation or stenting ("liberation" therapy)<sup>1,2,3,4</sup>, is coincidental. The concept of a venous cause for MS is not new<sup>5</sup>, but felt always short in explaining many of the features of MS<sup>6</sup>.

In our study a link with another group of patients seemed more relevant, the group of patients with "idiopathic" intracranial hypertension (IICH); synonyms: "benign" intracranial hypertension, and pseudotumor cerebri. Most authors on this subject state that the prevalence of IICH is low; but estimations vary from 1 to 22 per 100.000, depending on population selection. Some causes have been identified or suggested such as hypervitaminosis A, use of antibiotics such as tetracycline, CSF hyperproduction, and many thrombophilic factors<sup>7</sup>. MRI or CT were initially mainly used to exclude intracranial tumors.

Friedman and Jacobsen (2002) described the diagnostic criteria of IICH<sup>8</sup>.

MR signs of the condition include widening of the optic nerve sheath, (partial) empty sella, and an increase of CSF spaces.

Of special interest in this group is the growing acceptance of disorders of CVR as a possible cause of IICH, and the introduction of therapeutic stenting of the transverse and sigmoid sinus<sup>9</sup>.

Reports on IICH and venous stenting are still sporadic and include only small numbers of patients<sup>10,11,12,13</sup>.

The inclusion criteria, however, are sometimes ambiguous, and others need reconsidering. In a recent article (Bussière et al. 2010)

the selection criteria include: papilledema and/or chronic headache, indicating an assumed link between these conditions.

In the patients with a venous obstruction of the transverse-sigmoid junction venous stenting was performed, sometimes with amazing (100%!!) success. Some of these results are shown in Table 1.

**Table 1** (adapted from Bussière et al.)

| <i>Results reported on venous stenting in IICH</i> |                 |                  |                 |
|--|-----------------|------------------|-----------------|
| <i>Reference</i>                                   | <i>stenting</i> | <i>no change</i> | <i>improved</i> |
| Higgins, et al. 2003                               | 12              | 5                | 7               |
| Donnet, et al. 2008                                | 10              | 2                | 8               |
| Bussière, et al. 2010                              | 10              | 0                | 10              |

The link between "idiopathic" intracranial hypertension and chronic headache is also demonstrated in one of our patients, referred for chronic intractable headache (Figure 1), showing all the MR criteria of "idiopathic" intracranial hypertension.

## Material and Methods

The patient group consisted of 110 patients (51 male, 59 female) referred for MRI because of chronic intractable headache.

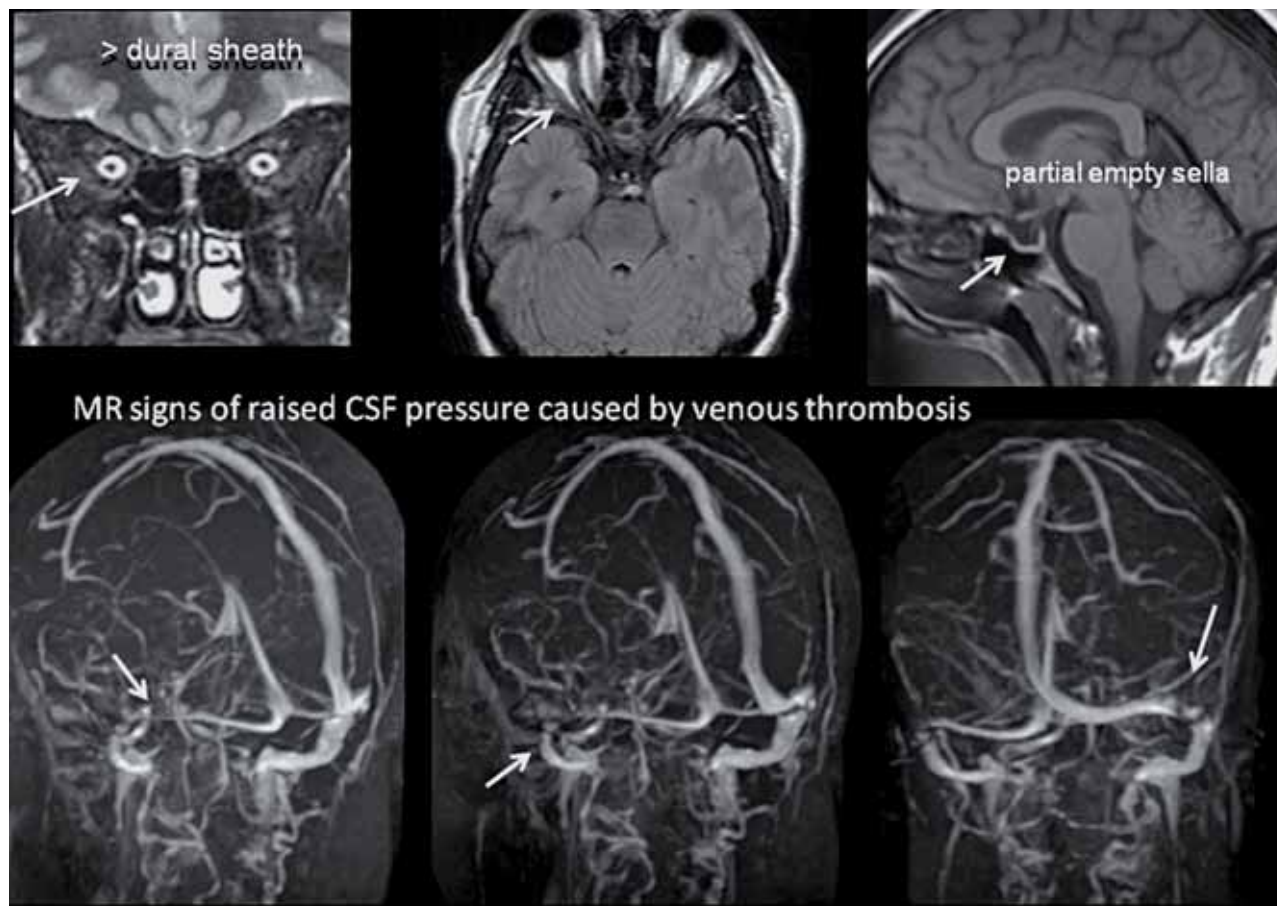


Figure 1 33 year old female with chronic intractable headache: the images suggest the diagnosis of raised intracranial CSF pressure; TOF-CE images show thrombosis on both sides (arrows).

#### Inclusion criteria

Chronic intractable headache longer than 6 months, on a subjective 1-10 scale > 7

Medication effect on a subjective 1-5 scale < 3

Age: all ages > 14 years

#### Exclusion criteria

co-morbidity

special groups of headache: migraine, cluster headache, temporal arteritis

(In most of our patients funduscopy was not performed or not mentioned).

MR studies were performed on 1.5 Tesla Symphony systems (Siemens Erlangen).

Our basic MR protocol (for all chronic neurological conditions) includes:

– sagittal T1-weighted (sella!), transverse pro-

**Table 2** Classification of CVR variants

| venous variants   | classification |
|---|----------------|
| 1: classic (normal)   |                |
| 2: classic, predominant one-sided return                    |                |
| 3: predominant one-sided, separate deep-superficial return  |                |
| 4: torcular variants  |                |
| 4a: displaced S5S   |                |
| 4b: return of deep and superficial structures to one side   |                |
| 4c: high split of SSS, variable return of DVS               |                |
| 5: persistent occipital sinus                               |                |
| 5a: persistent occipital sinus without loop                 |                |
| 5b: persistent occipital sinus with loop                    |                |
| 6: presence of giant granulation of Pacchioni               |                |
| 7: diverticulum ST-55 junction                              |                |
| 8: invisible UV with posterior cervical collaterals         |                |
| 9a: subacute or chronic thrombosis in classic venous return |                |
| 9b: subacute or chronic thrombosis in variants              |                |

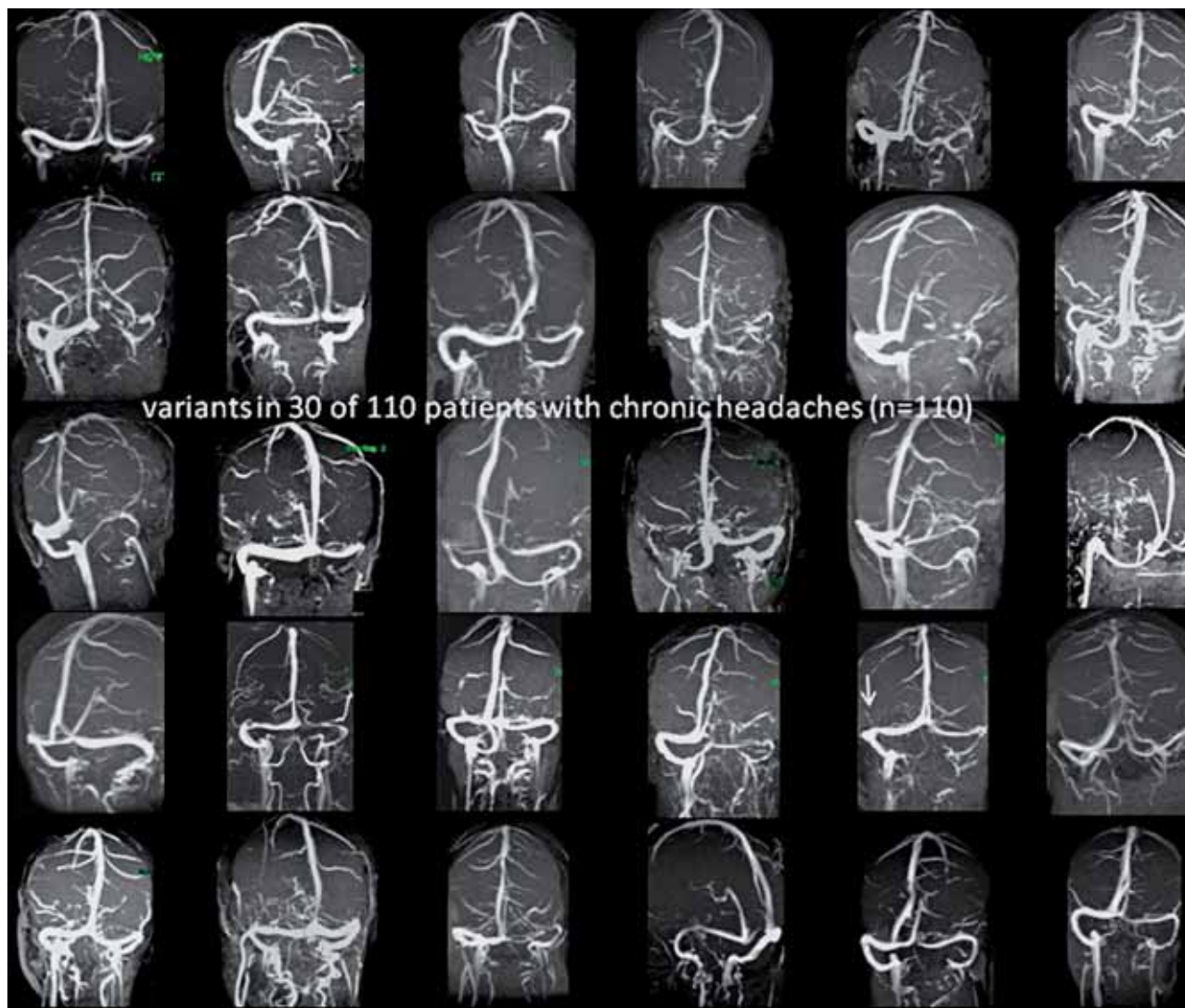


Figure 2 Numerous variations of CVR were seen, as demonstrated in 30 patients of the ChIH population.

ton density (PD), T2- and T2\*-weighted and FLAIR images, coronal T2-weighted images (including the paranasal sinuses and optic nerve sheaths. MR venography (TOF – or + contrast, 3D-phase contrast –all vessel- angiography). Other sequences are added depending on request and findings , namely T1-weighted, fat saturated images or CE-MRV, true FISP cardiac gated cine oblique sagittal images to depict the azygos system.

## Results

The great variability in CVR is demonstrated in Figure 2. A pragmatic “on appearance” classification was used to organize the data (Table 2).

This classification is not based on possible embryologic explanations of the anomaly, what serves another purpose. Our main interest was the search for a possible explanation of the intractable headache. One of the features of CVR, the predominant one - sided venous return was common knowledge, as was the separated deep- and superficial venous return . The frequency of persistent occipital sinus with loop formation, a possible thrombogenic factor was a surprise, as was the high number of patients with a chronic thrombosis.

“Classic” venous return was only seen in 31 of 110 patients. There was a great variability in CVR, a fact already well known to neurosurgeons operating in the posterior fossa. A number of these variations may be unrelated

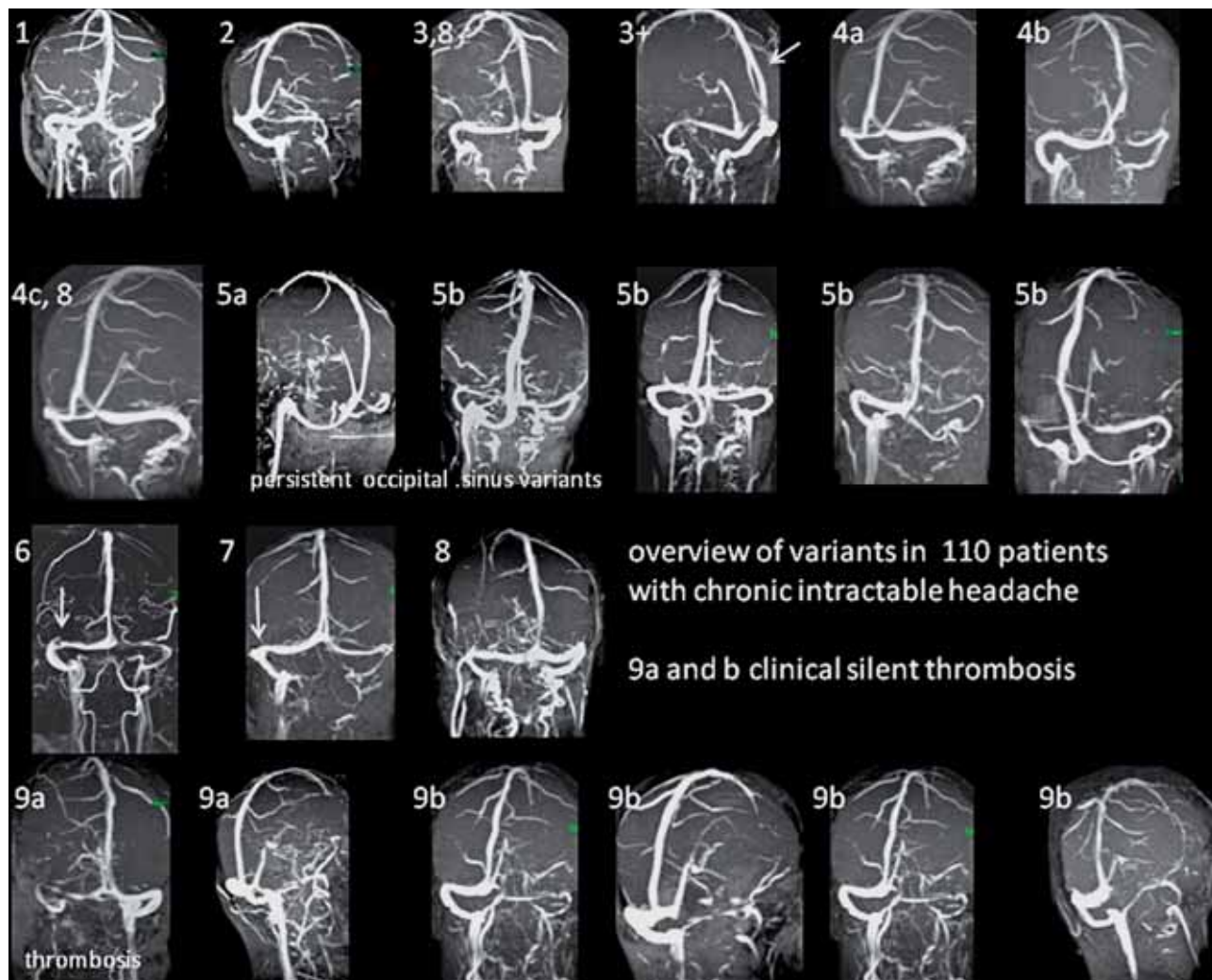


Figure 3 Illustration of the classification in the examined group.

**Table 3** Distribution of variants in the male population. Note that 11 of 51 patients were classified as (clinical silent??) thrombosis males,  $n=51$ , mean age 43 years (9-73)

| venous variants   | age (years) | <18   | 18-45  | >45    |
|---|-------------|-------|--------|--------|
|   |             | (n=5) | (n=26) | (n=20) |
| 1: classic (normal)   |             | 3     | 4      | 3      |
| 2: classic, predominant one-sided return                    |             | –     | 2      | 1      |
| 3: predominant one-sided, separate deep-superficial return  |             | 1     | 2      | 5      |
| 4a: displaced SSS   |             | 2     | 7      | 11     |
| 4b: return of deep and superficial structures to one side   |             | 1     | 2      | 2      |
| 4c: high split of SSS, variable return of DVS               |             | –     | 2      | 2      |
| 4d: fenestration SSS  |             | 1     | 2      | –      |
| 5a: persistent occipital sinus without loop                 |             | –     | –      | –      |
| 5b: persistent occipital sinus with loop                    |             | –     | –      | 1      |
| 6: presence of giant granulation of Pacchioni               |             | –     | –      | –      |
| 7: diverticulum ST-SS junction                              |             | –     | 1      | –      |
| 8: invisible IJV with posterior cervical collaterals        |             | 1     | 3      | 1      |
| 9a: subacute or chronic thrombosis in classic venous return | →           | –     | 2      | 1      |
| 9b: subacute or chronic thrombosis in variants              | →           | 2     | 2      | 4      |

**Table 4** In the female group there were 10 of 59 patients presenting with thrombosis

| <i>females, n= 59, mean age 41 years (13-84)</i>            |                    |                         |                         |                          |
|---|--------------------|-------------------------|-------------------------|--------------------------|
| <i>venous variants</i>                                      | <i>age (years)</i> | <i>&lt;18<br/>(n=5)</i> | <i>18-45<br/>(n=26)</i> | <i>&gt;45<br/>(n=28)</i> |
| 1: classic (normal)   |                    | 2                       | 1                       | 1                        |
| 2: classic, predominant one-sided return                    |                    | –                       | 2                       | 3                        |
| 3: predominant one-sided, separate deep-superficial return  |                    | –                       | 3                       | 3                        |
| 4a: displaced SSS   |                    | 2                       | 7                       | 10                       |
| 4b: return of deep and superficial structures to one side   |                    | –                       | 1                       | 6                        |
| 4c: high split of SSS, variable return of DVS               |                    | 1                       | 8                       | 4                        |
| 4d: fenestration SSS  |                    | –                       | 1                       | 2                        |
| 5a: persistent occipital sinus without loop                 |                    | –                       | –                       | 1                        |
| 5b: persistent occipital sinus with loop                    |                    | –                       | 3                       | –                        |
| 6: presence of giant granulation of Pacchioni               |                    | –                       | –                       | 2                        |
| 7: diverticulum ST-SS junction                              |                    | –                       | 1                       | –                        |
| 8: invisible IJV with posterior cervical collaterals        |                    | –                       | 5                       | 1                        |
| 9a: subacute or chronic thrombosis in classic venous return |                    | → –                     | 2                       | –                        |
| 9b: subacute or chronic thrombosis in variants              |                    | → –                     | 2                       | 6                        |

to the chronic headache complaints. In other patients the images suggest at least the possibility of a link, and a relatively large number of patients (21 of 110) showed chronic or subacute thrombosis and the trias suggesting raised intracranial CSF pressure.

The group was subdivided in males and females subdivided in 3 age groups: < 18 years, 18-45 years and > 45 years. The results are presented in Tables 3 and 4.

Chronic thrombosis was found in 21 (!) of 110 patients (20%), 10 females and 11 males.

In the age group 18-45 year there were as many males as females with chronic thrombosis, 4 in each group; in this group the influence of oral contraceptives was not evident.

Of 21 patients with thrombosis 5 were found in patients with classic venous return, and 16 within the group with variants, 9 thereof with persistent occipital sinus and loop-formation.

## Discussion:

Many of our patients with chronic intractable headache had previous MRI's or CT's, reported as normal. In none of the patients MRV or CTV was applied. There was no special attention given to the trias of raised intracranial CSF hypertension: (partial) empty sella, widened optic nerve sheaths, widened CSF spaces. It is

obvious from our study that MRV deserves a prominent place in the MR protocol for chronic intractable headache. Even more attention should be given to patients with chronic headache, visual obscurations, diplopia, and unexplained abducens nerve paresis.

The clinical examination should include fundoscopy, exclusion of other possible factors, and a clinical classification of the headache and medication effect. After a positive MR study search for thrombogenic factors and a CSF tap with pressure measurement under standard conditions (not sitting!), preferably with re-introduction of the Queckenstedt tests, should be performed (the 25 cm H<sub>2</sub>O pressure threshold is arbitrary and should be revised).

In a number of cases decisions should be made whether stenting could improve the condition. In those cases all thrombogenic factors should be considered and additional information about CVR should be obtained with 4D MRV when available, and before stenting a time-resolved intra-arterial study to visualize all veins, collaterals and mean transit time.

## Conclusions

In the examined group of patients with chronic intractable headache a great variety of CVR was found. There was a surprisingly

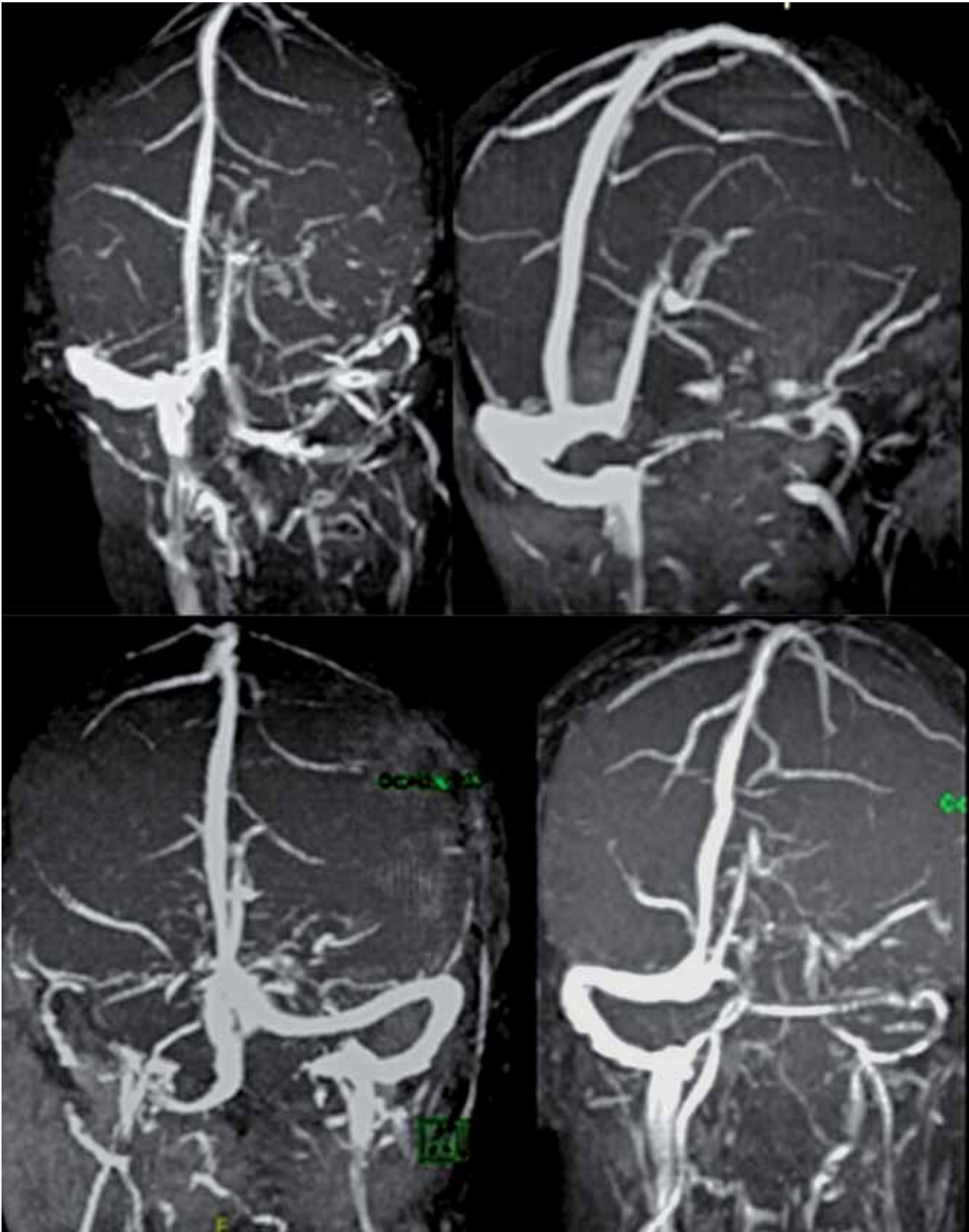


Figure 4 Four different patients with chronic intractable headache who are possible candidates for stenting. In this group one sided dominant return is present, but CVR at the non-dominant side is poor. The decision has to be made considering many factors, as mentioned above.

high percentage of patients with a subacute or chronic (clinically "silent") thrombosis; 1 of every 5 males, 1 of every 6 females. MR protocols for patients with chronic intractable headache, should include MRV with one or more methods.

Special attention in reading the images should be given to otherwise unexplained widened optic nerve sheaths, partial empty sella and widened CSF spaces. The study estab-

lished a transition zone between patients with "idiopathic intracranial hypertension", a disorder now known to be caused in a still unknown number (there are suggestions of even 93%!) of cases by venous obstruction and a group of patients with chronic intractable headache. Venous stenting, when technically possible, may also be considered in selected patients with chronic intractable headache.

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