The Role of MR Imaging and MR Angiography in the Evaluation of Patients with Headache

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Abstract

BACKGROUND: Headache is one of the most common complaints in medical practice and the most often neurological symptom.

AIM: The aim of our study was to estimate the frequency of abnormal magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) findings in patients with non-acute headache without focal neurological abnormalities.

MATERIAL AND METHODS: The results of the MRI and MRA were retrospectively analyzed. As major abnormalities, we took into account tumor, stroke, extraaxial collection, Chiari malformations, and vascular pathology (aneurysm and arterial-venous malformation).

RESULTS: Two hundred twenty-five patients fulfilled the criteria. Out of 225 patients with median age of 37 (18–85) years, 78% of the patients were female and 22% were male. In total, we found 8.4% of major abnormalities. On MRI head scan without MRA analysis, we found 50.7% of normal finding, 47.1% of minor abnormalities and 2.2% of major abnormalities. On MRA scan, we found 52.9% of normal finding, 40.9% of minor abnormalities, and 6.2% of major abnormalities.

CONCLUSION: Our study demonstrates a low but important diagnostic yield of MRI and MRA examination for patients with non-acute headache without focal neurological abnormalities.

Introduction

Headache is one of the most common complaints in medical practice and the most often neurological symptom. The prevalence of headache during the lifetime varies from 31% to 96% [1,2]. About 4% of adults have daily or near daily headache [3]. Almost 20% of the adult population experiences frequent headache [4]. According to the 3rd edition of the International Classification of Headache Disorder, headache are divided into primary and secondary [5]. Primary headaches are defined as those headaches that are not caused by a specific medical condition. Secondary headaches are those caused by specific medical condition. Neuroimaging is used to distinguish between primary and secondary headaches. Neuroimaging should be used according to clinical warning criteria which include change of headache character, focal neurological abnormality, headache of sudden onset, onset of headache after 50 years, and no response to therapy. Non-acute headache is defined as any type of headache that has begun at least 4 weeks before [6]. Many patients undergo evaluation of headache because of fear of a secondary headache, usually with computed tomography (CT) and today very often also with magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA). MRI is more sensitive that CT in the evaluation of the intracranial pathology [7]. The frequency of pathology presenting only with headache is low. CT studies of the evaluation of the patients with headache showed that the yield of significant abnormalities is low, between 1.0% and 6.9% [8], [9], [10], [11], [12]. Studies in patients with isolated chronic headache with MRI also showed that the yield of major abnormalities is low [13]. A common reason for neuroimaging is to detect treatable pathology.

The aim of our study was to estimate the frequency of abnormal MRI and MRA findings in patients with non-acute headache without focal neurological abnormalities. We also wanted to evaluate whether patients would benefit from additional MRA examination in the case of non-acute headache.

Material and Methods

The results of the MRI scans of the head performed in the St. Catherine Specialty Hospital, Zabok, Croatia from September 2018 until September 2019...
were retrospectively analyzed. Patients were older than 18, they were referred for MRI because of the non-acute headache. Before MRI examination every patient was examined by one of the neurologists and only patients with normal neurological examination were analyzed in the study. All MRI examinations were analyzed by the one radiologist with 10 years of experience. All scans were obtained with 1.5T scanner (Siemens Achieva), the imaging protocol included standard T1-weighted, T2-weighted, diffusion-weighted imaging (DWI), and fluid-attenuated inversion recovery–weighted images in axial, sagittal, and coronal plane with a slice thickness of 5–6 mm. MRA was performed using 3D TOF sequence. All patients underwent an MRI brain scan with MRA, whether they were referred only to an MRI brain scan or an MRA brain scan with MRA. Exclusion criteria were: Focal neurological deficit, head trauma, malignant tumors (primary or secondary), brain operation, dizziness, nausea, vomiting, fever, and coagulopathy. We divided the results of the MRI examination into three categories: A completely normal finding, minor abnormalities – a positive finding but clinically insignificant and major abnormalities – a positive finding but clinically significant. Tumor process, hemorrhage, acute ischemia, extraaxial collection, Chiari malformations, and vascular pathology (aneurysm and arterial-venous malformation) were considered as clinically significant findings. Anatomical variants such as ventricular asymmetry, cavum vergae, cavum septi pellicudi, and mega cisterna magna were not considered as pathological findings. For statistical analysis, MedCalc (16.2.0, MedCalc Software Bvba, Ostend, Belgium) was used. Results were shown with descriptive statistics. Normality of the distribution of numeric variables was tested with Kolmogorov–Smirnov test. Pearson ˙Chi-squared test was used for comparison of categorical variables differences. The results were considered statistical significant at p<0.05. The study was approved by ethic committee of the hospital.

Results

After data analysis, 225 patients fulfilled the set criteria, present with non-acute headache. Out of 225 patients with median age of 37 (18–85) years, 175 (78%) were women with median age of 36 (18–85) years and 50 (22%) of them were men with a mean age of 41 (18–83) years. Of the 225 patients who presented with headache, we found 8.4% of major abnormalities. Classification of the MRI scans with MRA reports according to its results are shown in Table 1. A major abnormalities were more common in women, it was found in 15 women (6.7%) compared to 4 men (1.8%), but the difference was not statistically significant p = 0.87.

By age group, we have 171 (76%) patients under 50 and 54 (24%) over 50 years, which is a statistically significant difference p < 0.0001. MRI scan reports without MRA analysis according to the age group are shown in Table 2.

### Table 2: MRI scan reports without MRA analysis according to the age group

| MRI examination results | Age | All patients |
|-------------------------|-----|--------------|
|                         | 18–49 (%) | >50 (%) | n = 225 (%) | p   |
| Normal finding          | 102; 45.8 | 11; 4.9 | 114; 50.7 | <0.0001 |
| Minor abnormalities     | 64; 29.4 | 42; 18.7 | 106; 47.1 | <0.0001 |
| Major abnormalities     | 4; 1.8 | 1; 0.4 | 5; 2.2 | 0.75 |

MRI scan reports – minor abnormalities according to the age group are shown in Table 3. MRI scan with minor abnormalities are shown in Figure 1.

### Table 3: MRI scan reports – minor abnormalities according to the age group

| MRI examination results | Age | All patients |
|-------------------------|-----|--------------|
|                         | 18–49 (%) | >50 (%) | n = 225 (%) | p   |
| Hyperintensives lesions | 24; 10.7 | 31; 13.8 | 55; 24.4 | <0.0001 |
| Sinus changes           | 23; 10.2 | 14; 6.2 | 37; 16.4 | 0.05  |
| Pineal cyst             | 14; 6.2 | 3; 1.3 | 17; 7.6 | 0.73  |
| Low-lying tonsils       | 2; 0.9 | 7; 3.1 | 8; 3.6 | 0.87  |
| Arachnoid cyst          | 3; 1.3 | 0; 0 | 3; 1.3 | 0.76  |
| Empty sella             | 1; 0.4 | 1; 0.4 | 2; 0.9 | 0.97  |
| Venous angioma          | 1; 0.4 | 0; 0 | 1; 0.4 | 0.54  |

Analyzing only vascular changes (on MRA examination), we found 6.2% of major abnormal findings. We found major vascular abnormalities in 3 males (1.3%) and 11 female patients (4.9%), the difference is not statistically significant. By age group, we found major vascular abnormalities in 12 patients under 50 (5.3%) and 2 patients over 50 years (0.9%), the difference was not statistically significant p = 0.58. MRA scan with normal finding, minor and major abnormalities are shown in Figure 2.

MRI scan reports according to whether an MRA scan is requested or not are shown in Table 4. All vascular major abnormal findings are aneurysms. Minor findings include fetal configuration of the circle of Willis, hypoplasia of communicating artery, or vertebral artery.

### Table 4: MRI scan reports according to whether an MRA scan is requested or not

| MRI examination results | Requested MRA (%) | Non-requested MRA (%) | All patients |
|-------------------------|-------------------|-----------------------|--------------|
|                         | 19; 8.4 | 104; 46.4 | 123; 54.6 | 0.78  |

Discussion

Headache is common disorder in whole population, including children and adults with estimate prevalence 6–71% [14], [15] in adults and 11–48% [16], [17] in children. Headache is a common symptom; there is need for neuroimaging evaluation
to rule out secondary headaches. Different study results on this topic are often obtained because clinically relevant findings are differently defined. There is no consensus on what constitutes a clinically relevant finding, so some authors include sinus pathology or pineal cysts in significant results. In our study of non-acute headache, there is a higher proportion of women (78%), which is consistent with previously reported results that headache is more common in women, 2–3 times [18]. In total, we found 8.4% of major abnormalities, 2.2% on MRI brain scan, and 6.2% on MRA scan. When analyzing our results without MRA examination, we found 50.7% of normal findings and 49.3% of pathological findings of which is 2.2% patients with major abnormalities. Ukamaka and Adaorah [19] reported in CT retrospective study 50.8% normal findings and 49.2% of abnormal findings what is consistent to our results. They analyzed 126 patients with chronic headache, the mean age of the patients was 37 years same as in our study. They reported 11% of intracranial tumors what is more than our results (2.2%) but their study included patients with focal neurological abnormalities. Rawal et al. [20] reported in CT study 5.7% abnormal findings, they analyzed 193 patients with history of chronic headache and found 3 cases of the brain tumors (1.56%) what is consistent to our study, we found 2.2%. They also reported that there is no statistical significance in abnormal findings according to age group what is consistent to our study; we found statistical significance in normal finding according to age which they did not analyze. Consistent to our study Tsushima and Endo [21] in retrospectively 

Figure 1: Magnetic resonance imaging (MRI) minor abnormalities, (a) MRI fluid-attenuated inversion recovery–weighted images axial view showing hyperintensive lesions (arrow), (b) MRI T2W coronal view showing retention cyst of maxillary sinus (arrow) (c) MRI T2W sagittal view showing pineal cyst (arrow), (d) MRI T1W sagittal view showing low-lying tonsils (arrow)
reported in MR study with high-resolution MR imaging (1.9T scanner) the prevalence of pineal cysts of 23%. This difference can be explained by the fact that the detection of pineal cysts depends on the quality and strength of the MR scanner. We found 6.2% of major vascular abnormalities, all were aneurysms, our results are consistent to study Kojima et al. [30], they reported in the MRA study that prevalence of aneurysms was 7%. In our study, an MRA examination was performed in all patients, analyzing the results depending on whether or not an indication for MRA was given by a neurologist, we found that there was no statistically significant difference in any category of results. The results showed a similar incidence of major vascular abnormalities in patients with non-acute headache without focal neurological abnormalities, whether or not an indication for MRA was given by a neurologist.

**Conclusion**

In patients with headache without focal neurologic disorder, the chance of finding major abnormalities is rare. In total, we found 8.4% of major abnormalities, 2.2% on MRI brain scan, and 6.2% on MRA scan. Our study demonstrates a low but important diagnostic yield of MRI and MRA examination for patients with non-acute headache without focal neurological abnormalities.

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