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Source / Izvornik: **Open Access Macedonian Journal of Medical Sciences, 2020, 8, 815 - 819**

Journal article, Published version
Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

https://doi.org/10.3889/oamjms.2020.4842

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:184:432157

Scientific Foundation SPIROSKI, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2020 Aug 20; 8(B):815-819.
https://doi.org/10.3889/oamjms.2020.4842
eISSN: 1857-9655
Category: *B - Clinical Sciences*
Section: *Radiology and Radiotherapy*

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

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Edited by: Sinisa Stojanoski
Citation: Pavlović T, Trtica S, Milošević M, Budinčević H, Borić I. The Role of MR Imaging and MR Angiography in the Evaluation of Patients with Headache. Open Access Maced J Med Sci. 2020 Aug 20; 8(B):815-819. https://doi.org/10.3889/oamjms.2020.4842
Keywords: Headache; Magnetic resonance imaging; Magnetic resonance angiography
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Received: 25-Apr-2020
Revised: 09-May-2020
Accepted: 29-May-2020

Funding: This research did not receive any financial support
Competing Interests: The authors have declared that no competing interests exist

Abstract

BACKGROUND: Headache is one of the most common complaint 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 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 complaint 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 3th 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 pellucidi, 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's Chi-squared test was used for comparison of category 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 $p = 0.87$.

Table 1: MRI with MRA scan reports according to the results

MRI examination results	Male n = 50 (%)	Female n = 175 (%)	All patients n = 225 (%)	p
Normal finding	16; 7.1	49; 21.8	65; 28.9	0.71
Minor abnormalities	30; 13.3	111; 49.3	141; 62.7	0.78
Major abnormalities	4; 1.8	15; 6.7	19; 8.4	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 18 – 49 (%)	Age >50 (%)	All patients n = 225 (%)	p
Normal finding	103; 45.8	11; 4.9	114; 50.7	<0.0001
Minor abnormalities	64; 28.4	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 18 – 49 (%)	Age >50 (%)	All patients 225 (%)	p
Hyperintensive 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	5; 2.2	2; 0.9	7; 3.1	0.87
Arachnoid cyst	3; 1.3	0; 0	3; 1.3	0.76
Empty sella	1; 0.4	1; 0.4	2; 0.8	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.

MRA 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: MRA scan reports according to whether an MRA scan is requested or not

MRA examination results	Requested MRA (%)	Non-requested MRA (%)	All patients n = 225 (%)	p
Normal finding	79; 35.1	40; 17.8	119; 52.9	0.61
Minor abnormalities	56; 24.9	36; 16	92; 40.9	0.43
Major abnormalities	10; 4.4	4; 1.8	14; 6.2	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 a need for neuroimaging evaluation

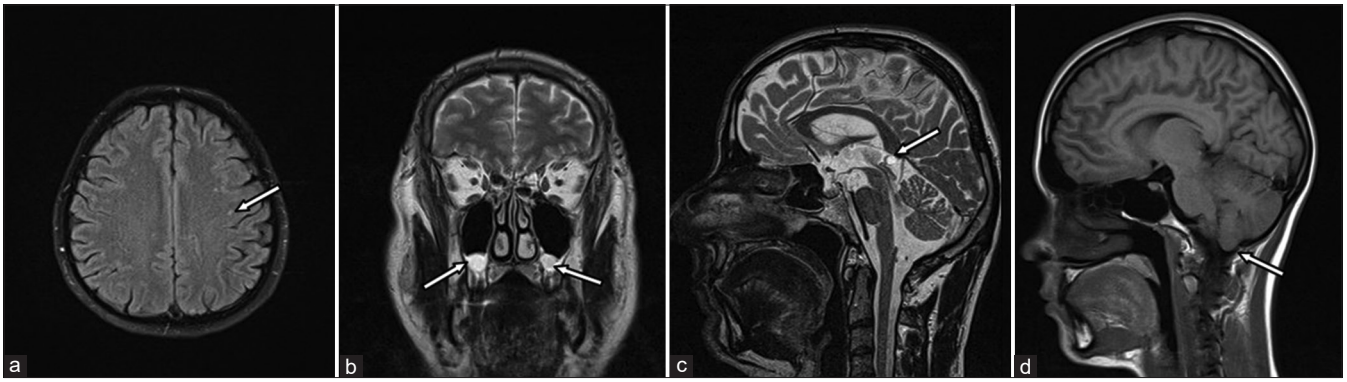

Figure 1: Magnetic resonance imaging (MRI) minor abnormalities, (a) MRI fluid-attenuated inversion recovery–weighted images axial view showing hyperintensive lesions (arrow), (b) MRI T2W coronal view showing retention cyst of maxillary sinus (arrow) (c) MRI T2W sagittal view showing pineal cyst (arrow), (d) MRI T1W sagittal view showing low-lying tonsils (arrow)

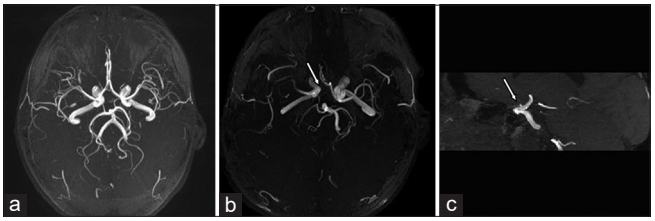

Figure 2: (a) 3D time-of-flight (TOF) magnetic resonance angiography (MRA) – normal finding, (b) 3D TOF MRA showing A1 segment hypoplasia of right anterior cerebral artery (arrow) – minor abnormality, (c) 3D TOF MRA sagittal view showing aneurysm of internal carotid artery (arrow) – major abnormality

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 MR study of 306 patients with chronic or recurrent headache with no other neurologic symptoms reported 55.2% normal findings, 44.1% of minor abnormalities and 0.7% of clinically important intracranial abnormality. Subedee [22] in CT retrospective CT study evaluated 56 patients with chronic headache without neurologic abnormality and reported 89.28% normal findings, 7.14% minor abnormalities, and 3.57% significant lesions. Significant findings are consistent with our study, while a lower proportion of minor abnormalities may be due to a lower sensitivity of CT scans compared to MRI. Wang *et al*. [13] in retrospective MR study analyzed 402 patients with history of chronic headache without other neurologic symptoms. They found 3.7% major abnormalities what is consistent to our study. Marmura and Silberstein [23] found that sphenoid sinusitis is can be present with progressive or thunderclap headache in adults and also that chronic and disabling headaches, especially if migraine features are present, are not due to sinus abnormalities. We considered only acute sinusitis as potential cause of headache while chronic sinus changes such as retention cysts were considered as minor abnormalities. Gurkas *et al*. [24] reported in the retrospective MR study in children with headache a 10% of nonspecific white matter abnormalities, 2.9% Chiari Type I and cerebellar tonsillar ectopia, and 4.1% pathology of sinus. We found 10.7% of nonspecific white matter abnormalities in patients under 49 years, 0.9% of Arnold-Chiari Type I and 3.1% of cerebellar tonsillar ectopia, 16.4% of sinus changes what is consistent to their study, whereas in patients older than 50 years, we found 13.8% of nonspecific white matter abnormalities which is statistically significant difference $p < 0.0001$. Changes in white matter are associated with aging and hypertension [25], [26]. White matter changes are foci of gliosis and ischemic demyelination [27]. We classified pineal cysts as minor abnormalities except when present with mass effect leading to compression of the superior colliculus or compression on cerebral aqueduct and cause an obstructive hydrocephalus. Our study found 7.6% of the pineal cyst. Mamourian *et al*. [28] in MRI study found 4.3% of the pineal cysts, study included 672 patients, but study was performed with 0.15T or 0.5T MR unit. Pu *et al*. [29]

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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