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¹²³I-amphetamine-SPECT in classical migraine and migraine accompagnée

Hans-Peter Schlake¹, Karl-Heinz Grotemeyer¹, Ingolf Böttger², Ingo Wilhelm Husstedt¹, and Günter Brune¹

¹ Department of Neurology, University Hospital, and ² Institute of Nuclear Medicine, Westfälische Wilhelms-Universität, Münster, West Germany

Abstract

Migraine is considered to be a functional neurological disorder. In classical migraine (headache associated with prodromal visual field disturbances) and migraine accompagnée (headache associated with transient neurological symptoms), disturbances of cerebral blood flow and amine metabolism are thought to be pathogenetic factors. However, conventional methods of neuroimaging (CAT, NMR) usually do not yield any pathological findings in patients.

Since ¹²³I-iodoamphetamine (¹²³I-IMP) crosses the intact blood brain barrier, ¹²³I-IMP-SPECT is used for the assessment of cerebral perfusion in various neurological diseases, including functional disorders.

¹²³I-IMP-SPECT was performed on 5 patients with classical migraine and 18 patients with migraine accompagnée. At the time of investigation, all patients were symptom-free.

Cerebral blood flow was decreased in all patients with migraine accompagnée, and often corresponded to the site of headache as well as to the topography of transient neurological symptoms. This reduction was most obvious in a patient with persisting neurological symptoms. Most patients with classical migraine, however, did not show any alteration of cerebral perfusion.

It appears that migraine – and in particular migraine accompagnée – is characterized by a permanent alteration not only of cerebral blood flow but also of neuronal activity. Migraine attacks may occur in connection with exacerbations of preexisting metabolic alterations.

Keywords: Cerebral perfusion, migraine, SPECT.

1 Introduction

Radiolabeled amines such as ¹²³I-iodoamphetamine are extracted by the brain in proportion to blood flow. In contrast to conventional radionuclides, ¹²³Iiodoamphetamine crosses the intact blood brain barrier. ¹²³I-iodoamphetamine imaging is therefore, used for the recording and assessment of cerebral perfusion in various neurologic diseases including functional disorders. The method provides physiologic information and complements anatomic and morphologic information provided by conventional methods of brain imaging [1, 2, 3].

Migraine, including classical migraine and migraine accompagnée, is considered to represent a functional neurologic disorder. Classical migraine is clinically characterized by a migrainous headache associated with prodromal visual field disturbances. Migraine accompagnée is characterized by migrainous headache associated with transient neurologic symptoms, i.e. hemiplegia. The pathogenesis of migraine is still obscure. Alterations of cerebral perfusion as well as disturbances of amine metabolism are considered to be pathogenetic factors.

Investigations of cerebral blood flow (CBF) in patients with migraine were generally performed during prodromal and/or headache phases using conventional methods. In spite of some remarkable exceptions, these investigations support the concept of a reduction of CBF during the prodromal stage of migraine headache [5–10, 12, 13]. Only few studies have been carried out on CBF in pain-free intervals [4, 9, 11, 12]. These studies do not show any changes of CBF between migraine attacks with the exception of one case with severe complicated migraine reported by LAURITZEN and OLESEN [4]. This patient demonstrated a minor low-flow region in the insula one week after an attack.

This paper reports on ¹²³I-iodoamphetamine imaging of patients with classical migraine and migraine accompagnée in symptom-free intervals.

2 Patients and methods

The investigation included 23 patients with migraine (14 female and 9 male patients). The average age was 28.0 ± 10.4 S.D. years (range: 17 to 53 years of age). Five patients had classical migraine, while 18 patients were diagnosed as having migraine accom-

All subjects were patients of the headache ambulance of the Department of Neurology of the University of Münster. All patients received a neurological examination. ¹²³I-IMP-SPECT and electroencephalography were performed in all patients during a headache-free interval. Additional investigations were performed when indicated by the results of the above examinations.

¹²³I-IMP-SPECT was performed according to the following method: 15 min. (occasionally 3 h.) following I.V. administration of 185 MBq ¹²³I-IMP, 64 single images were obtained within a full circle of 360° using a rotating gamma camera (General Electric 400ACT). Imaging time was 30 sec per image; the examinations lasted 40 min. Tomographic slices of 12 mm width were reconstructed in sagittal, coronal, and horizontal projections by filter-back-projection employing a Butterworth filter with a cut-off frequency of $0,2 \text{ cm}^{-1}$ (STAR hard- and software by General Electric). Interpretation was qualitative.

3 Results

Table I summarizes the results of the investigation with ¹²³I-IMP-SPECT. Only 1 of the 5 patients with classical migraine showed a reduction of perfusion, the other 4 patients showed no alterations. All 16 patients with hemiplegic migraine demonstrated a reduction of perfusion. In most of the patients a slight or marked correlation with the site of headache and the topography of the focal transient neurologic symptoms could be observed. The two patients with basilar artery migraine showed deficits of perfusion with marked correlations to the site of headache but with no correlations to the neurologic symptoms.

In the following, typical cases of the various diagnostic groups of migraine are described:

Classical migraine: This 21-year-old woman had had migraine attacks since the age of seven years. The attacks show a frequency of 5 times per month with an average duration of 2 to 3 days. The headache is always initiated by typical scintillating scotoma. Her brother and one cousin also suffer from classical migraine. Neurologic examination did not reveal any pathology. The EEG yielded an alpha rhythm with some paroxysmally generalized dysrhythmic groups without any signs of focal abnormalities. ¹²³I-IMP-SPECT showed normal cerebral perfusion (Figure 1).

Hemiplegic migraine: This 25-year-old man experienced his first migraine attack one year ago. The headache is localized in the left temporoparietal region and is accompagnied by a transient sensomotor paresis of the right arm and amnestic aphasia. Several attacks with the above symptoms have occurred. The mother of the patient and one brother also suffer from migraine accompagnée. The neurologic examination yielded normal results. Electroencephalography was performed one day after the first attack. It showed a focal delta activity in the left occipitotemporal area. Four days after this examination, the EEG revealed normal patterns. Doppler sonography, CAT, NMR, and cerebral angiography did not show any pathological findings. Conventional brain scan with ^{99m}Tc-glucoheptonate performed 5 days after the attack was found to be normal. ¹²³I-IMP-SPECT was carried out one month after the first attack. It showed a left-sided, occipitotemporal hypoperfusion corresponding to the localization of pain as well as to neurologic symptoms and EEG patterns (Figure 2). A repetition of the examination two months later still revealed a slight deficit of perfusion in this area.

Basilar artery migraine: This 53 year-old woman has been suffering from migraine for 35 years. The pain

Table I. Correlation between cerebral hypoperfusion and topography of symptoms in various types of migraine.

Diagnosis	n	Pathological SPECT findings (n)	Correlation					
			to headache localization marked slightly none			to neurological symptoms marked slightly none		
Classic migraine	5	1	0	0	5	0	0	5
Hemiplegic migraine	16*	16	6	5	5	8	6	2
Basilar artery migraine	2	2	2	0	0	0	0	2

* includes one patient with persisting neurologic symptoms. The symptoms indicate a combination of hemiplegic migraine and basilar artery migraine.



Figure 1. Cerebral perfusion in a patient with classical migraine; normal symmetrical distribution of cerebral blood flow.

is located in the frontal area of the left side of the head. For the last two years the headache has been initiated by transient scintillating scotoma, diplopia, vertigo, and cerebellar ataxia. Neurologic examination, EEG, Doppler sonography, visual evoked potentials and CAT revealed no abnormalities. ¹²³I-IMP-SPECT showed a slight hypoperfusion in the left-sided frontal area (Figure 3).

Migraine accompagnée with persisting neurologic symptoms (complicated migraine): This 37-year-old man had his first headache attack 5 years ago. His attacks are accompagnied by a right-sided sensomotor paresis, vertigo, and, sometimes, by dropattacks and/or loss of consciousness of short duration. The neurologic examination showed a slight sensomotor hemiparesis of the right side of the body. EEG, Doppler sonography acoustic and visual evoked potentials, electronystagmography, conven-

tional brain scintigraphy, CAT, NMR and examination of the cerebrospinal fluid did not demonstrate any abnormalities.¹²³I-IMP-SPECT revealed a marked hypoperfusion in the frontal and temporal regions of both sides of the head as well as in the right parietal area (Figure 4).

4 Discussion

¹²³I-IMP-SPECT is used to determine cerebral perfusion, including brain metabolism [1, 2]. The results of this investigation clearly demonstrate that brain imaging with ¹²³I-IMP-SPECT is able to show alterations of cerebral perfusion in functional neurologic disorders. This was possible for migraine even in symptom-free periods. There are, however, differences of perfusion in the various types of migraine. Most of the patients with classical migraine



Figure 2. Cerebral perfusion in a patient with hemiplegic migraine; left sided, occipitotemporal hypoperfusion.

did not exhibit any disturbances of cerebral perfusion. On the other hand, all patients with hemiplegic migraine showed deficits of perfusion and, in most patients, these deficits corresponded to the site of headache as well as to the topography of the transient focal neurologic symptoms. Patients with basilar artery migraine showed deficits of perfusion in the areas of headache; there was, however, no correlation to the topography of focal neurological symptoms. This may suggest that ¹²³I-IMP-SPECT does not represent the basilar artery system adequately. On the whole, the investigation indicates that reductions of cerebral perfusion are more pronounced in migraine accompagnée than in classical migraine. The deficit of cerebral perfusion was found to be most pronounced in a patient with persisting neurologic symptoms. In contrast to ¹²³I-IMP-SPECT, conventional methods of brain imaging did

not demonstrate any pathological alterations. The results obtained with ¹²³I-IMP-SPECT indicate that migraine and in particular migraine accompagnée is characterized by a permanent alteration of cerebral perfusion and, perhaps, of neuronal activity which also exist in symptom-free intervals.

5 Conclusion

This investigation of patients with migraine with ¹²³-I-IMP-SPECT demonstrates that this method is able to show alterations of cerebral perfusion and, perhaps, alterations of neuronal activity in functional neurologic disorders even at times when no symptoms are apparent. The reduction of cerebral perfusion was observed in migraine accompagnée; in classical migraine alteration of cerebral perfusion



Figure 3. Cerebral perfusion in a patient with basilar artery migraine; slight hypoperfusion of the left frontal area with a strong correlation to the site of headache but with no correlation to the topography of neurological symptoms.

was usually not seen. The most marked hypoperfusion was observed in a patient with persisting neurologic symptoms. It appears possible that migraine attacks occur in connection with exacerbations of existing metabolic alterations due to endogenous and/or exogenous factors.

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Figure 4. Cerebral perfusion of a patient with migraine accompagnée (hemiplegic and basilar artery migraine) with persisting neurologic symptoms; marked hypoperfusion of the frontal and temporal area, bilaterally, and of the right parietal region, slightly corresponding to the localization of pain and neurologic symptoms.

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Prof. Dr. Günter G. Brune Neurologische Klinik und Poliklinik Albert Schweitzer Str. 33 D-4400 Münster, West Germany