

CT and MRI Findings in Cerebral Aspergilloma

CT- und MRT-Befunde zerebraler Aspergillome

Authors

Friederike Gärtner¹, Julia Forstenpointner², Birgit Ertl-Wagner³, Babak Hooshmand³, Christian Riedel¹, Olav Jansen¹

Affiliations

- 1 Department of Radiology and Neuroradiology, Universitätsklinikum Schleswig-Holstein, Campus Kiel, Germany
- 2 Division of Neurological Pain Research and Therapy, Department of Neurology, UKSH Kiel, Germany
- 3 Institute for Clinical Radiology, Ludwig-Maximilians-Universität München, Munich, Germany

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Correspondence

Miss Friederike Gärtner

Radiologie und Neuroradiologie, UKSH Kiel, Arnold-Heller-Str.

3, 25105 Kiel, Germany

Tel.: ++40/4 31/500–165 00

friederike.gaertner@uksh.de

ZUSAMMENFASSUNG

Ziel Zerebrale Aspergillose betrifft meist immunsupprimierte Patienten und weist aufgrund der oftmals unspezifischen Klinik ein hohes Morbiditäts- und Mortalitätsrisiko auf. Eine frühe Diagnosestellung ermöglicht die effektivere Einleitung der Therapiemaßnahmen und die Verbesserung des Outcome.

Material und Methoden Die CT- und MRT-Aufnahmen von neun Patienten aus zwei Zentren wurden ausgewertet. Die Diagnose der zerebralen Aspergillose wurde mittels Biopsie und histopathologischer Begutachtung verifiziert. Die MRT wurde an 1,5T- und 3T-Geräten durchgeführt, die Untersuchungsprotokolle enthielten jeweils DWI, T2- und T1-gewichtete Bilder mit und ohne Kontrastmittel.

Ergebnisse In der CT wiesen die Aspergillome kein typisches Erscheinungsbild auf. In der MRT waren die Aspergillome zu 100% randständig diffusionsgestört (9/9). Mehrere hypointense Schichten in der Aspergilluswand, insbesondere an der

Innenseite, waren typisch in den Aufnahmen mit T2-Wichtung (100%, 9/9). Die Aspergillome waren sowohl T1-hypointens (66%, 6/9), sowie in 33% anteilig T1-hyperintens (3/9). In 78% (7/9) der Fälle fand sich ein randständiges Enhancement nach Gadoliniumapplikation.

Schlussfolgerung Aspergillome weisen typischerweise eine kräftige, ringförmige Diffusionsrestriktion auf (9/9). Typische Befunde in Aufnahmen der T2-gewichteten Bilder sind zwiebelschalenartig angeordnete hypointense Schichten, die innere Zone der Aspergilluswand ist aufgrund paramagnetischer Effekte besonders signalarm (9/9). Der Großteil der Aspergillome weist nach Kontrastmittelapplikation ein ringförmiges Enhancement auf (7/9).

Kernaussagen

- Es gibt typische Bildbefunde in der Darstellung intrakranieller Aspergillome in der MRT, diese variieren jedoch in Abhängigkeit des Immunstatus des Patienten.
- Die Kenntnis der MR-Morphologie der Aspergillome ermöglicht die zügige Einleitung adäquater Therapien.

ABSTRACT

Purpose Invasive aspergillosis usually affects immunocompromised patients. It carries a high risk of morbidity and mortality and usually has a nonspecific clinical presentation. Early diagnosis is essential in order to start effective treatment and improve clinical outcome.

Materials and Methods In a retrospective search of the PACS databases from two medical centers, we identified 9 patients with histologically proven cerebral aspergilloma. We systematically analyzed CT and MRI imaging findings to identify typical imaging appearances of cerebral aspergilloma.

Results CT did not show a typical appearance of the aspergillomas. In 100% (9/9) there was a rim-attenuated diffusion restriction on MRI imaging. Multiple hypointense layers in the aspergillus wall, especially on the internal side, were detected in 100% on T2-weighted imaging (9/9). Aspergillomas were T1-hypointense in 66% of cases (6/9) and partly T1-hyperintense in 33% (3/9). In 78% (7/9) of cases, a rim-attenuated diffusion restriction was detected after contrast agent application.

Conclusion Nine cases were identified. Whereas CT features were less typical, we observed the following imaging features on MRI: A strong, rim-attenuated diffusion restriction (9/9); onion layer-like hypointense zones, in particular in the innermost part of the abscess wall on T2-weighted images (9/9).

Enhancement of the lesion border was present in the majority of the cases (7/9).

Key points

- There are typical MRI imaging features of aspergillomas.
- However, these findings could be affected by the immune status of the patient.

- Swift identification of aspergilloma imaging patterns is essential to allow for adequate therapeutic decision making.

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Introduction

Candida ssp (subspecies), *Aspergillus* ssp and *Cryptococcus* ssp are the most common pathogens to cause fungal infections of the central nervous system (CNS) [1]. The source of infection is either a local process such as paranasal sinusitis, otogenic or odontogenic sources, or results from hematogenous spread, usually from the lung or the intestine [2]. A fungal infection of the CNS is rare in immunocompetent persons and is mostly observed in immunosuppressed patients, e. g. with AIDS or patients under medical immunosuppression after organ or bone marrow transplantation [3]. Another risk factor for acquiring cerebral fungal infections is long-standing diabetes.

The CNS manifestation is usually part of a disseminated infection [4]. Patients are often afebrile or only have a low-grade fever and present with nonspecific neurological symptoms such as stroke-like symptoms or seizures [5]. Cerebrospinal fluid (CSF) analysis typically shows a moderate elevation of CSF proteins and pleocytosis (600/mm), although CSF analysis can be normal as well. Blood cultures are frequently negative [6]. The nonspecific clinical presentation delays the diagnosis of a mycotic CNS infection and impairs the clinical outcome by a late initiation of effective treatment strategies. To increase knowledge of cerebral aspergilloma, we analyzed the imaging features of patients with this disease, which might facilitate earlier diagnosis in the future.

Case series

CT and MRI imaging data of nine patients with cerebral aspergillo- sis from two university hospitals were retrospectively analyzed in order to identify common imaging patterns. Diagnosis was confirmed by intraoperative biopsy by the neurosurgical department followed by histopathological analysis.

MR imaging examinations were performed on different MRI systems using 1.5- and 3-Tesla systems. The imaging protocols always included axial diffusion-weighted imaging (DWI), axial T2w images, axial and coronal T1w images and sagittal FLAIR images.

Results

Aspergillomas appeared as intra- or extra-axial mass lesions. The imaging findings in CT and MRI are summarized in ► **Table 1, 2.**

CT features

CT image datasets were available in 8 cases. Overall, CT did not demonstrate a characteristic appearance of the aspergillomas. The lesions were slightly hyperdense in 4 of 8 cases (50%). In a single case the aspergilloma was strongly hyperdense due to hemorrhage (13%). In 3 of 8 cases (38%) the lesions were hypodense. In the majority of the cases, slight surrounding edema was observed.

MR imaging features

MR imaging datasets were available for all 9 patients. DWI showed rim-attenuated diffusion restriction in all patients (n = 9/9). Typical findings on T2w images were a hyperintense abscess wall, containing onion-layer-like hypointense zones, in particular on the inner part of the wall in 9/9 patients (100%). After contrast media application, the majority (n = 7/9) of aspergillomas showed strong rim enhancement (78%). ► **Fig. 1.**

Discussion

Patients with an intracranial manifestation of aspergillo- sis have a poor prognosis. Therefore, fast diagnosis is essential to initiate rapid, targeted medical and surgical treatment [7]. In our case series, we describe the typical imaging patterns of this rare cerebral infection to facilitate early diagnostic decision-making and improve the patients' outcome ► **Fig. 2.**

Mycotic infections of the CNS are usually transmitted hematogenously. Lesions are therefore most commonly found in a subcortical location. Another means of infection is the transdural spread of an underlying paranasal sinus or mastoid infection [8].

In our study, all cerebral aspergillomas demonstrated pronounced diffusion restriction, in particular at the edge of the lesions. This finding is consistent with the fact that mycotic mass lesions have a peripheral fungal cell wall [9]. In contrast, intracerebral abscesses due to a bacterial infection are characterized by a strong diffusion restriction in the center of the abscess [10]. This diffusion restriction is caused by limited water diffusion as a result of the high cellularity of the pus. In T1w imaging, aspergillomas were mainly hypointense as a result of the cellular edema. T1w-hyperintense aspergillomas were seen in our study in three cases, most likely due to hemorrhage. After contrast media application, the majority of aspergillomas (78%) showed strong enhancement in the rim. However, in two cases no enhancement was seen at all. This observation was already made in prior studies, suggesting that strongly immunosuppressed patients are not able to induce

► **Table 1** Description of CT findings in 8 patients with cerebral aspergilloma.

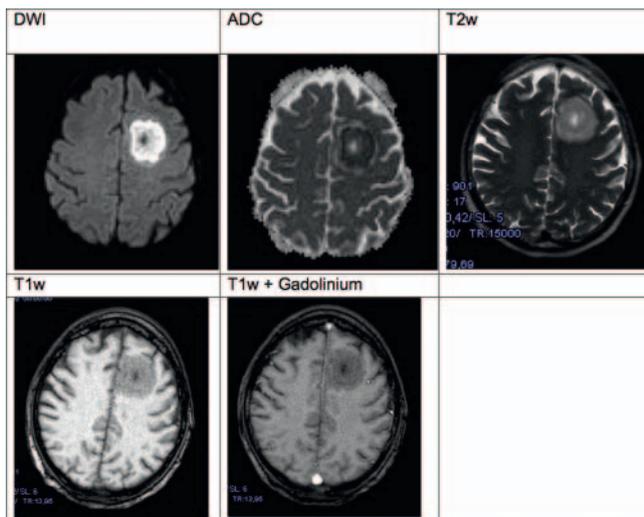
► **Tab. 1** Bildbefunde in der CT.

CT features	n	(%)
Hypodense	3/8	38 %
Slightly hyperdense	4/8	50 %
Strongly hyperdense (hemorrhagic lesion)	1/8	13 %

► **Table 2** Description of MRI findings in 9 patients with cerebral aspergilloma.

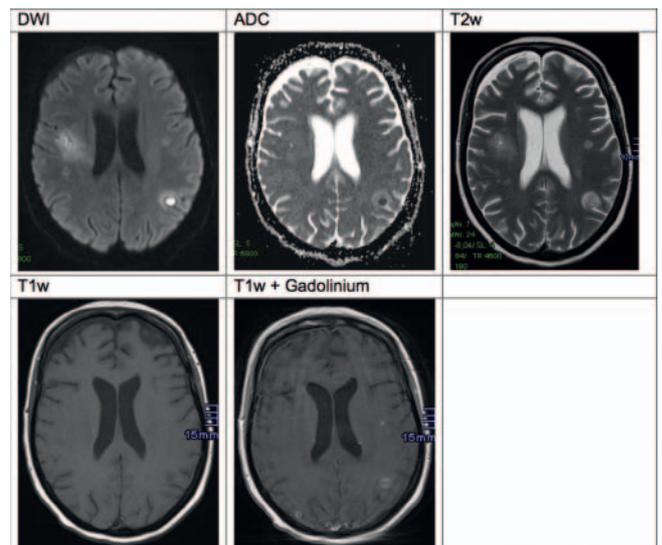
► **Tab. 2** Beschreibung typischer Bildbefunde in der MRT.

MRI sequence	MRI features	n	%
DWI	Strong diffusion restriction in the rim	9/9	100 %
ADC	Reduced ADC in the rim	9/9	100 %
T2w	Inhomogeneous abscess wall with onion-layer-like, strongly hypointense zones	9/9	100 %
T1w	Slightly hypointense	4/9	44 %
	Moderately hypointense	2/9	22 %
	Partly hyperintense	3/9	33 %
T1w+ Gadolinium	Strong enhancement in the rim	7/9	78 %
	No enhancement	2/9	22 %



► **Fig. 1** Aspergilloma in the left frontal lobe with strong, rim-attenuated diffusion restriction, T2w-hyperintense abscess wall with a hypointense zone at the inner part of the wall. There is slight surrounding edema. No enhancement is seen after contrast media application.

► **Abb. 1** Aspergillom im linken Frontallappen mit starker wandständiger Diffusionsstörung. Die Abszesswand ist T2w-hyperintens und weist an der Innenseite hypointense Schichten auf. Es findet sich lediglich ein geringes perifokales Ödem. Nach Kontrastmittelapplikation lässt sich kein Enhancement beobachten.



► **Fig. 2** There are multiple small aspergillomas with variable diffusion restriction and slight surrounding edema. The lesions show a hypointense center on T2w imaging and strong, rim-attenuated enhancement after contrast.

► **Abb. 2** Multiple kleine Aspergillome mit in Signalintensität variierender Diffusionsstörung und geringen perifokalen Ödemen. Zentral sind die Aspergillome hypointens in den Aufnahmen mit T2w-Bildgebung. Nach Gadoliniumgabe lässt sich ein kräftiges randständiges Enhancement abgrenzen.

a sufficient inflammatory response at the blood-brain barrier to allow passage of the contrast agent [11]. The observation that aspergillomas are characterized by diverging hypointense layers in T2-weighted images was also made before [12]. The T2-hypointensities correlate with the grade of fungal proliferation. Since it is essential for fungal growth, the hyphae accumulate iron and magnesium, leading to a paramagnetic effect. It can be assumed that the strongly hypointense layers correlate with areas of active proliferation in the interior part of the abscess wall where the fungal proliferation encounters less host immune defense [13].

Differential diagnoses of ring enhancing intracranial mass tumors include metastases, primary or secondary brain tumors and abscesses caused by different types of infection. Anamnesis, as well as further extracranial examination with ultrasound, X-ray or CT helps to identify metastases. Typical image patterns have been described for various intracranial infections, which help to discriminate between the types of infection. Differential diagnoses for the cases examined in this study are bacterial abscesses, which are characterized by a typical general diffusion restriction, as well as tuberculomas or toxoplasmosis [14]. Cerebral blood volume maps obtained by CT and MR perfusion are useful to identify primary brain tumors or lymphomas. The latter is characterized by the typical leakage in MR perfusion due to higher vascular permeability [15].

In summary, our case series demonstrates typical MR imaging, while CT features were less typical. There was generally a strong diffusion restriction in the rim. On T2-weighted images the abscess wall was typically hyperintense with onion-layer-like hypointense zones, which were particularly prominent at the innermost part of the abscess wall. Rim enhancement was seen in the majority of the cases. However, these findings can vary, e. g. due to the immuno-status of the patient.

CLINICAL RELEVANCE

Cerebral aspergillosis is an often fatal complication with a subtle clinical presentation. The aim of this study was to describe typical imaging findings of cerebral aspergillomas in order to facilitate early diagnosis and initiate rapid and effective anti-fungal treatment.

Conflict of Interest

The authors declare that they have no conflict of interest.

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