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IMAGING FEATURES OF FUNGAL RHINOSINUSITIS

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Abstract

To date, the high interest of researchers in the problem of specific lesions of the nose and paranasal sinuses by mycotic infection is observed. Because of the possibility of inaccessible localization of the pathological process, laboratory confirmation of a non-invasive fungal infection of the paranasal sinuses is difficult or even impossible. Clinical signs of fungal infection are not specific. Serological diagnostic methods have been developed for only a few forms of mycoses. Due to the above reasons, there are frequent difficulties in the diagnosis of this group of diseases.

Keywords: paranasal sinuses; mycotic infection; fungal rhinosinusitis; imaging.

Introduction

Currently, chronic inflammatory diseases of the paranasal sinuses (PNS) are one of the urgent problems of modern otorhinolaryngology. In recent years, there has been an increased interest of researchers in the problem of specific lesions of the nose and PNS with mycotic infection.

Fungal lesions of PNS are rare, however, in the presence of concomitant systemic diseases, they can sometimes threaten the life of the patient. The prevalence of fungal rhinosinusitis has significantly increased over the past ten years and tends to continue to grow. The number of patients with a high risk of developing fungal diseases continues to increase [1,2,3]. This is due to the intense development of medical technologies, which is manifested by the widespread use of cytostatic and immunosuppressive therapy, the abusive application of broad-spectrum antibacterial drugs, and an increase in the number of patients with persistent viral infection, including patients with HIV [4,5].

Because of the possibility of inaccessible localization of the pathological process, laboratory confirmation of a non-invasive fungal lesion of PNS can be

difficult or even impossible. Clinical signs of fungal infection are not specific. Serological diagnostic methods have been developed for only a few forms of mycoses. Due to the above reasons, there are frequent difficulties in the diagnosis of this group of diseases [6,7,8].

On the other hand, modern medicine is characterized by a significant development of methods of radiation imaging and the emergence of various modes that can be adapted to assess almost all anatomical areas. It is for this reason that the development of imaging methods or a deeper systematization of the available information in the aspect of radiation diagnosis of fungal rhinosinusitis is urgent.

The advent of three-dimensional X-ray computed tomography has expanded the possibilities of diagnosing pathology of the maxillofacial region. Volumetric computed tomography allows you to assess in detail the integrity of the walls of the paranasal sinuses, to identify the presence of bone destruction, and to determine the optimal surgical approach in the need of sanitizing operations [2,5,6,7,8].

Our observations carried out earlier, the presentation of the results of which was not included in the purpose and objectives of this study, showed that conventional X-ray images in typical 3 projections (nasomental, nasofrontal and lateral projections) have a number of significant disadvantages, which can be grouped as follows:

- shadowing of anatomical objects of the skull, which can impede or completely exclude the visualization of pathological processes;
- impossibility of taking any measurements;
- obtaining only two-dimensional images (2D), while any anatomical object has a measurement in three flats (3D) [8,9,10].

Due to the weakness of the results of radiographs, the MSCT method is widely used. In recent years, cone-beam computed tomography (CBCT) or 3D three-dimensional (volumetric) radiography, which was initially used only in dentistry, has begun to be widely used [11,12].

Currently, computed tomography (CT) and magnetic resonance imaging (MRI) have become firmly established in the arsenal of routine methods for assessing the state of PNS. For example, they are successfully used to diagnose mycetoma. With mycetoma, CT in the sinuses reveals the formation of soft tissue density with an X-ray absorption coefficient of 40-60 Hu. Hyperdense inclusions on CT scans usually have a density of more than 2000 HU, which distinguishes them from formations of organic origin. During MRI, ferromagnetic particles in the fungal drusen cause a slight decrease in the E1 wave and a significant decrease in the T2 wave. For other forms, X-ray signs are nonspecific: unsharp uneven darkening of the sinus, destruction of bone tissue [13,14,15].

The changes detected on CT have been studied in detail by I. S. Piskunov. The author points out that a characteristic feature of the fungal body is the presence of contents with an adsorption coefficient of 51 ± 8 U, partially or completely filling the affected sinus. As a rule, there are high-density inclusions (as a rule, single, less often - in the form of several small foci), which look like a foreign body (filling material) and have densitometric characteristics similar to it. In these cases, differential diagnosis is facilitated in the presence of a "transitional" zone of

lower density around the foreign body, which indicates the presence of fungal infection [16,17].

When reading a CT scan, the following main symptoms and signs are highlighted, allowing one to suspect the presence of a fungal infection of the sinuses: - a symptom of an inhomogeneous soft tissue density of the pathological sinus contents with an X-ray absorption coefficient of 40-60 units. HU associated with the presence of fungal masses and inflamed mucous membranes (100% of cases); - high-density inclusions in the contents of the sinuses with a density from 220 to 3050 HU and sizes from 2 to 6 mm, which are a reflection of the waste products of fungi (and / or often filling material) (in 75% of cases); - a symptom of changes in the bony walls of the sinuses: hyperostosis (due to long-term ongoing inflammation) or thinning (destruction) of the medial wall 25 of the maxillary sinus or the anterior wall and the inter-sinus septum of the sphenoid sinus, as a result of prolonged stay and pressure of the fungal body on the bone walls (in 100%). Many authors note the thickening of the bony walls of the sinuses [18,19].

At the same time, MRI is of secondary importance in the diagnosis of various rhinosinusitis. On MRI, there is no detailed understanding of the state of bone structures, but more accurately than on CT, pathological changes in soft tissues are detected. Therefore, MRI is primarily prescribed for differential diagnostics with other diseases, mainly when a tumor process is suspected. When interpreting the MRI data, the main signs characteristic of the fungal bodies of PNS are distinguished: - the presence in the investigated sinus of pathological contents in T1-WI in the medial or central parts of zones with a heterogeneous low signal intensity, which is surrounded by a liquid layer; - the presence of pronounced hypointensity in the T2-WI of these zones, sometimes looks like an area that is "devoid of a signal"; - the inflamed thickened mucous membrane in T2-WI is hyperintense. This symptom was observed by the authors in 87.5% of cases [4,8,13].

Thus, the data available in the literature indicate that the possibilities of modern imaging methods in the form of MSCT and MRI in fungal lesions of PNS are quite wide. In this regard, the purpose of this paper is to identify the main radiological patterns of MSCT and MRI for their further implementation into practice in fungal rhinosinusitis.

Methodology

This study was carried out by PROFMEDSERVICE LLC, which is the clinical base of the Department of Otorhinolaryngology of the Tashkent Institute for Advanced Studies of Doctors (rector - professor Akilov Kh.A .; head of the department - professor Arifov S.S.). The work was carried out from 2017 to 2020. During this period, 120 patients with chronic rhinosinusitis of fungal etiology at the age of 18 to 79 years old (mean age was 47.7 ± 1.4 years) were examined and treated.

When establishing the diagnosis, the classification of fungal rhinosinusitis was adhered to, with additions made by the commission of the International Society for Human and Animal Mycology [Chakrabarti A., Denning D.W., Ferguson B.J.].

Used:

- MSCT of the nose and PNS in coronary, axial, and sagittal projections (layer-by-layer scanning with 6 mm slice thickness, tomography step - 8 mm). If indicated, MSCT with contrast was used;

- according to the indications of MRI of the nose and PNS in coronary, axial, and sagittal projections.

Sensitivity was assessed as the ability of the study performed to detect a disease in people who actually have this disease, and was calculated according to the generally accepted method:

The sensitivity of radiation methods (MSCT, MRI) is determined by the formula

$$A/(A+B) \times 100\%$$

where, A – the number of true positives, that is the number of imaging studies performed in patients with fungal rhinosinusitis, where the changes they identified were confirmed during the operation. B - The number of false-negative results, that is, the number of studies in patients with fungal rhinosinusitis, where the changes they identified were not confirmed during surgery.

Characteristic CT and MRI signs of fungal rhinosinusitis

In order to study the sensitivity of imaging methods, the results of MRI and CT findings were analyzed and compared with the results of instrumental endoscopic examination of the affected area and laboratory studies. The analysis revealed the following principals.

Acute invasive fungal rhinosinusitis on CT is characterized by a thickening of the mucous membrane and a decrease in bone density, which is associated with an erosive process. In the early stages, differential diagnosis with nonspecific rhinosinusitis was difficult. The most common target of infection is the nasal cavity, namely the middle turbinate. There is a tendency for unilateral involvement of ethmoid sinuses and sphenoid sinus cells. Bone destruction extends to intracranial structures, cavernous sinus, and orbit. The spread of the pathological process outside the sinuses occurs along the perivascular canals, but their bone walls often remain intact. In this regard, bone erosion and mucosal thickening are not expressed.

A reliable early sign of the spread of fungal infection outside the sinuses is a density reduction of adipose tissue in the perianthral region. CT is also the method of choice for detecting bone erosion. In general, chronic invasive fungal sinusitis on CT is similar to aggressive forms of sinusitis. The walls of the PNS look striated, with areas of clarification, and uneven destruction of bone tissue is observed.

Complications in the form of vascular occlusions with heart attacks, meningitis, leptomeningeal manifestations, intracranial granulomatosis, and pseudoaneurysms are better detected on MRI. On MRI scans, there is usually a moderate decrease in signal intensity in T1 and a significant decrease in T2 mode.

Infiltration of the perianthral zone in the upper jaw in conditions of reactive osteomyelitis is also a likely sign of chronic invasive fungal rhinosinusitis. This form of the disease is characterized by the spread of the pathological process to contiguous structures (orbit, anterior cranial fossa, cavernous sinus), which occurs

as a result of an epidural abscess, parenchymal encephalitis or abscess, meningitis, cavernous sinus thrombosis, osteomyelitis, fungal aneurysm or stroke.

For allergic fungal rhinosinusitis, typical CT findings are the bilateral nature of the process, the involvement of several sinuses, and the presence of areas of increased density in the projection of the affected sinuses. In rare cases, unilateral damage, erosion, and thinning of the bone walls are observed. On MRI, there is a low signal intensity in the T2 mode, which is due to the high concentration of various metallic elements in the fungal organism, high protein levels, and low free water content in mucin. Although the intensity of the T1 signal is variable and low, high, mixed, and intermediate signals can also be observed, a high signal is more often observed.

With foreign bodies of a mycotic nature, which are often localized in the PNS, CT is determined by the darkening of the heterogeneous density of the damaged sinus with inclusions of microcalcifications or ferromagnetic elements of metal density, which corresponds to the deposition of calcium salts and the formation of mycotic calculi. Mucosal thickening is characteristic, signs of osteitis can be determined. The MRI shows an intermediate T1 signal and a low-intensity T2 signal.

Evaluation of the sensitivity of imaging methods

Сравнительный анализ показателя чувствительности КТ и МРТ при различных формах грибковых риносинуситов представлен на рисунке 1.

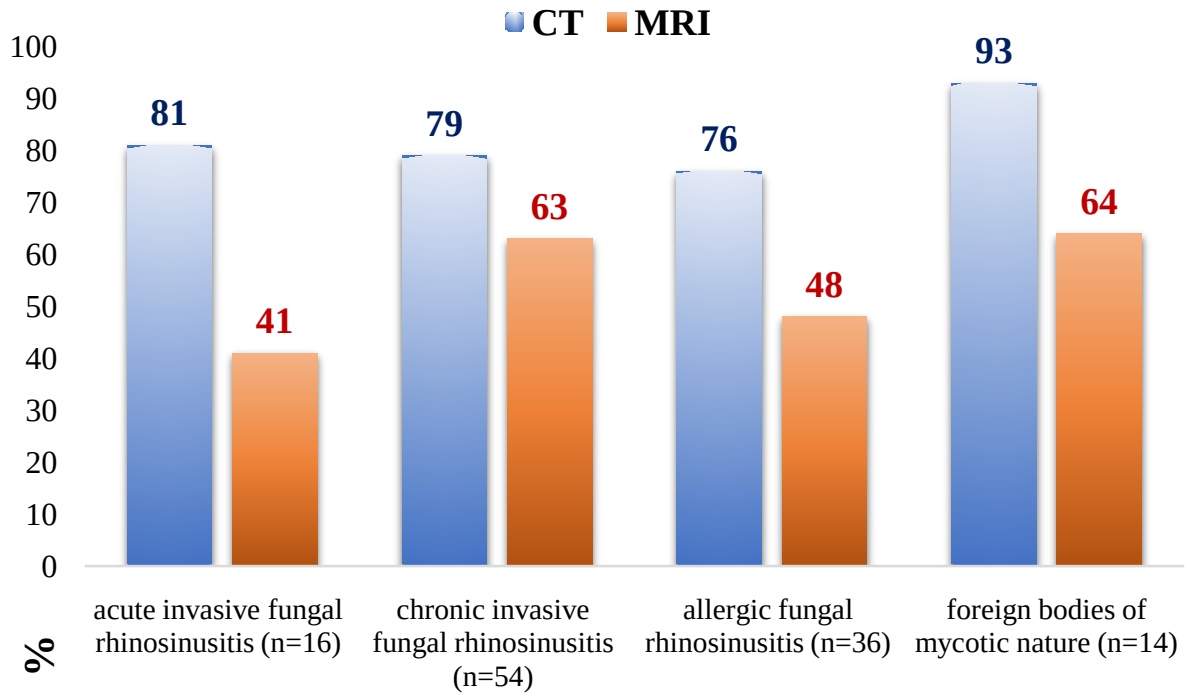

Figure 1. Comparison of CT and MRI sensitivity in various forms of fungal rhinosinusitis

The graph shows that for all forms of fungal rhinosinusitis, the value of the CT sensitivity indicator was higher in comparison with the MRI indicator. At the same time, only with foreign bodies of a mycotic nature, the value of the

sensitivity index exceeds 90%, which makes it possible to recognize this diagnostic method as significant to the full extent. In other cases, despite the relatively high sensitivity, the average is still not high enough to recognize CT as a specific diagnostic method.

In this regard, it can be argued that, although modern imaging methods in the form of CT and MRI are quite informative, however, they can only be used in conjunction with other research methods.

Analysis of the images and their comparison with the results of other research methods showed that, despite the fact that CT and MRI are limited in terms of determining the fungal etiology of PNS lesions, they are highly effective in detecting the spread of the pathological process to contiguous structures and damage to bone structures, which is of great importance in planning treatment and monitoring the dynamics (tab 1).

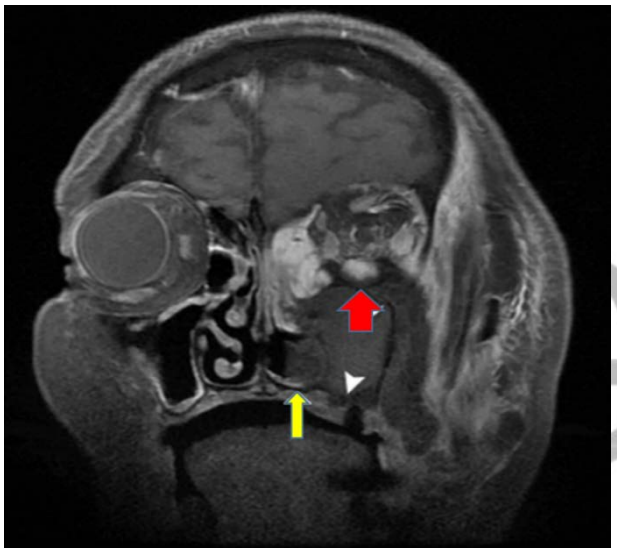

Figure 2. Acute invasive fungal rhinosinusitis. MRI scan (T1 mode with contrast enhancement and suppression of adipose tissue). On the coronal section, there is a darkening of the left maxillary and ethmoid sinuses with a reduced density of the middle and lower turbinates (yellow arrow), loss of contrast enhancement of the maxillary sinus mucosa (white arrow) and lower rectus muscle (red arrow).

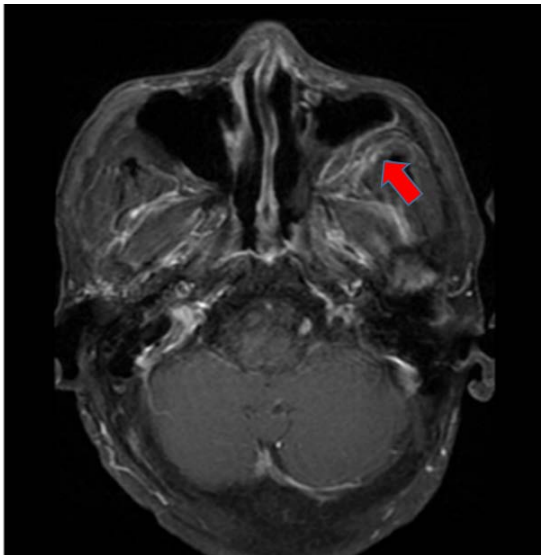

Figure 3. Acute invasive fungal rhinosinusitis.
MRI scan (T1 mode with contrast enhancement and suppression of adipose tissue). An enlargement of the retroantral fatty tissue (red arrow) is noted on the axial section.

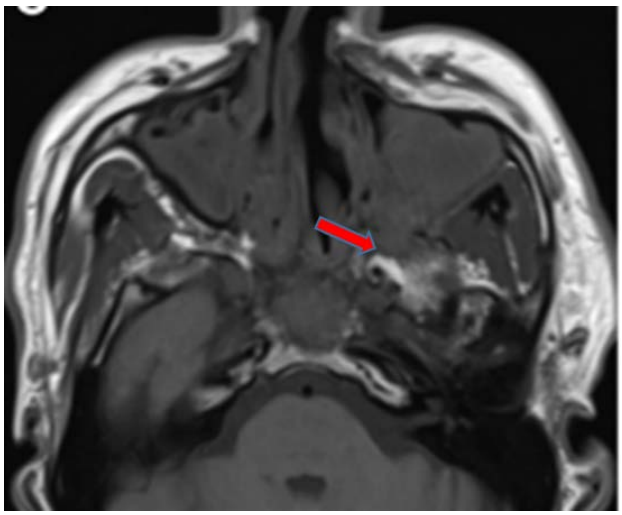

Figure 4. Chronic invasive fungal rhinosinusitis. MRI scan, T1 mode. On the axial section, the pathological process spreads to the pterygopalatine fossa on the left.

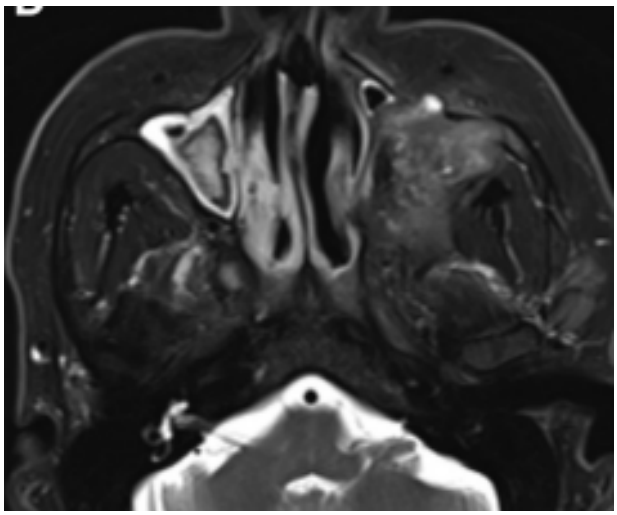

Figure 5. Chronic invasive fungal rhinosinusitis. MRI scan, T2 mode with suppression of adipose tissue. An axial section shows a lesion with a low signal on the left.

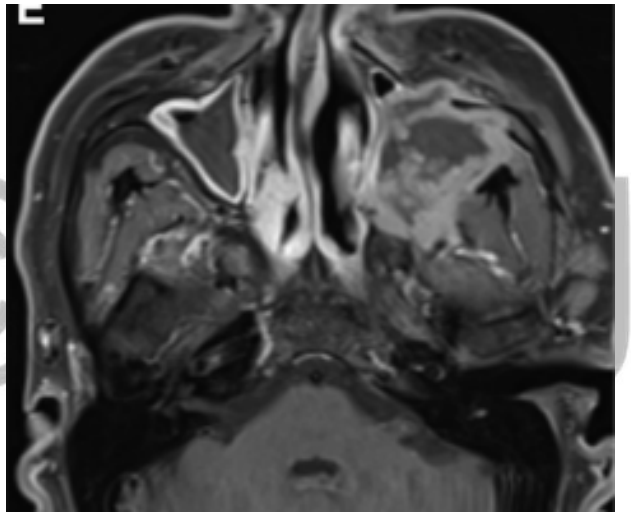

Figure 6. Chronic invasive fungal rhinosinusitis. MRI scan, T1 mode with contrast enhancement and suppression of adipose tissue. On the axial section, there is an increase in the peripheral areas of the formation with a less pronounced central area.

Table 1.

The effectiveness of CT and MRI in assessing the pathological process in fungal rhinosinusitis

Indicator	MRI	CT
Determination of the primary localization of the pocket of infection	-	+
Assessment of destruction of bone walls	-	+++
Assessment of spread to brain structures	+++	+
Assessment of the alleged etiology of the pathological process	++	+

Conclusion.

Thus, for all forms of fungal rhinosinusitis, the value of the CT sensitivity indicator is higher in comparison with the MRI indicator. In this regard, it can be argued that although modern imaging methods in the form of CT and MRI are quite informative, they can only be used in conjunction with other research methods.

Analysis of the images and their comparison with the results of other research methods showed that, despite the fact that CT and MRI are limited in terms of determining the fungal etiology of PNS lesions, they are highly effective in detecting the spread of the pathological process to contiguous structures and damage to bone structures, which is of great importance in planning treatment and monitoring dynamics.

Based on the data presented in them (on the average sensitivity of imaging methods (CT (82%) and MRI (54%)) and their information content in various aspects of the disease), it is possible to select the most rational way to assess the severity of the pathological process in fungal rhinosinusitis, depending on its appropriate clinical form. The choice of the most optimal imaging method will improve both the process of diagnosing the pathological process and the tactics of treatment.

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