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Pulmonary mucormycosis: surgical management at a national health institute in Mexico

Mucormicosis pulmonar: manejo quirúrgico en un instituto nacional

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Abstract

Background: *Pulmonary mucormycosis is an opportunistic and potentially fatal fungal infection affecting immunocompromised individuals. Its incidence has risen, ranking as the third most common form after rhino-orbito-cerebral and cutaneous mucormycosis. Its rapid progression complicates early diagnosis and worsens prognosis. Key risk factors include hematologic malignancies, solid organ transplantation, diabetes mellitus, and corticosteroid use during COVID-19.* **Objective:** *To describe the clinical, radiological, and therapeutic features of pulmonary mucormycosis cases at a national referral center and identify factors associated with disease progression and mortality.* **Methods:** *A retrospective study was conducted at the National Institute of Respiratory Diseases of Mexico, analyzing nine confirmed cases between 2022 and 2024. Treatment included antifungal agents such as amphotericin B, isavuconazole in selected cases, and surgical interventions. Results: Computed tomography revealed involvement of multiple pulmonary lobes. The 90-day mortality rate following combined therapy was 44.4%. Diabetes mellitus and biomass exposure were common and identified as aggravating factors.* **Conclusions:** *This study highlights the importance of a multidisciplinary approach and timely diagnosis in improving clinical outcomes in pulmonary mucormycosis. The high prevalence of comorbidities and environmental exposures underscores the complexity of management. This case series provides relevant information to optimize diagnostic and therapeutic strategies, ultimately improving prognosis in this highly lethal infection.*

Keywords: *Invasive fungal infection. Mucormycosis. Surgical resection.*

Resumen

Antecedentes: *La mucormicosis pulmonar es una infección fúngica oportunista y potencialmente mortal que afecta a individuos inmunocomprometidos. Su incidencia ha aumentado recientemente, siendo la tercera forma más común tras la rino-orbito-cerebral y la cutánea. Su rápida progresión dificulta el diagnóstico temprano y empeora el pronóstico. Factores de riesgo clave incluyen neoplasias hematológicas, trasplante de órganos sólidos, diabetes mellitus y el uso de corticosteroides durante la COVID-19.* **Objetivo:** *Describir las características clínicas, radiológicas y terapéuticas de pacientes con mucormicosis pulmonar atendidos en un centro de referencia nacional e identificar factores asociados a su evolución y mortalidad.* **Método:** *Estudio retrospectivo realizado en el Instituto Nacional de Enfermedades Respiratorias de México.*

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Se analizaron nueve casos confirmados entre 2022 y 2024. El tratamiento incluyó antifúngicos como anfotericina B e isavuconazol en casos seleccionados, además de intervenciones quirúrgicas. **Resultados:** *La tomografía computarizada mostró afección de múltiples lóbulos pulmonares. La tasa de mortalidad a 90 días con tratamiento combinado fue del 44.4%. La diabetes mellitus y la exposición a biomasa fueron frecuentes y se identificaron como factores agravantes.* **Conclusiones:** *Este estudio enfatiza la necesidad de un enfoque multidisciplinario y de un diagnóstico oportuno para mejorar los resultados clínicos en la mucormicosis pulmonar. La alta prevalencia de comorbilidades y factores ambientales resalta la complejidad de su manejo. Esta serie de casos aporta información relevante que puede optimizar estrategias diagnósticas y terapéuticas, mejorando el pronóstico de una infección altamente letal.*

Palabras clave: *Infección fúngica invasiva. Mucormicosis. Resección quirúrgica.*

Introduction

Pulmonary mucormycosis is an uncommon invasive fungal infection with a high mortality rate, particularly in immunocompromised patients. The present study aims to describe the demographic, clinical, radiological, and surgical characteristics of a case series of pulmonary mucormycosis treated at a national health institute, with emphasis on the medical-surgical approach and the observed clinical outcomes.

Method

A retrospective study was conducted at the National Institute of Respiratory Diseases Ismael Cosío Villegas, in Mexico City, between May 2022 and February 2024. Patients with confirmed histopathological diagnosis of pulmonary mucormycosis who underwent surgical intervention as part of their treatment were included.

Antifungal treatment was initiated with liposomal amphotericin B as first-line therapy. In some cases, isavuconazole was used as step-up treatment. Surgical decisions included sublobar resections, lobectomies, and pneumonectomies according to the location and extent of parenchymal involvement observed on imaging and the patient's clinical stability. Indications for surgical intervention included hemoptysis, presence of symptomatic cavitations, radiological progression, or lack of clinical response to antifungal treatment alone.

Statistical analysis was performed using non-parametric tests. Continuous variables are presented as medians and interquartile ranges (IQR), and categorical variables as absolute frequencies and percentages.

Results

Nine patients with a confirmed diagnosis of pulmonary mucormycosis were included. The median age was 55 years (IQR: 40-59), with a predominance of females (55.6%). The body mass index had a median of 21.5 kg/m² (IQR: 20.0-22.0). Of the patients, 33.3% were employed in agriculture, 66.7% reported exposure to biomass, and 33.3% had a history of smoking.

All patients had type 2 diabetes mellitus (mean glycated hemoglobin 11.5 mg/dl; IQR: 8.39-13.06). Arterial hypertension was reported in 22.2%, while ischemic heart disease, chronic lymphocytic leukemia, hypothyroidism, and a history of pulmonary tuberculosis were each reported in 11.1%.

The most common symptoms were dyspnea (77.7%), hemoptysis (66.6%), productive cough and fever (44.4% each), and weight loss greater than 10 kg (22.2%). Computed tomography revealed prominent consolidations, cavitations, and the reversed halo sign, with multilobar involvement in 44.4% of cases.

Surgical treatment was indicated based on the extent of parenchymal involvement and clinical condition, and there were no major intraoperative complications (Table 1).

Surgical interventions ranged from necrosectomy to major pulmonary resection procedures, such as pneumonectomies and bilobectomies (Table 2). The most frequently employed surgical approaches were thoracoscopy and thoracotomy (Table 3), each used in 44.4% of cases (n = 4). A robot-assisted approach was used in only one case, representing 11.1% of the total. This distribution demonstrates an equal preference between conventional minimally invasive and open techniques, while the robotic approach, although promising, remains less frequently utilized. The median postoperative hospital length of stay was 8 days (IQR: 4.5-24).

The 30-day mortality rate was 33.3% (n = 3), attributed to massive intraoperative hemorrhage, refractory septic shock, acute respiratory failure, and exsanguinating hemoptysis.

Table 1. Case series of patients with pulmonary mucormycosis

No.	Sex	Age	Approach (Primary)	Surgery performed	Bronchial stump management	Bleeding (mL)	Type of drainage	Catheter removal	Total length of stay	Length of postoperative hospital stay	Death
Case 1	F	57	Thoracoscopy	Necrosectomy	Not applicable	200	Argyle	33	180	150	No
Case 2	M	37	Thoracotomy	Right lower lobectomy	Mechanical	1250	Argyle	5	62	39	No
Case 3	F	65	Thoracotomy	Right upper lobectomy	Manual	900	Argyle	NA	27	21	Yes
Case 4	F	55	Thoracoscopy	Left pneumonectomy	Mechanical	215	Argyle	4	32	16	No
Case 5	M	47	Thoracotomy	Right pneumonectomy	Mechanical	3500	Argyle	7	26	17	Yes
Case 6	F	59	Thoracotomy	Left pneumonectomy	Mechanical	550	Argyle	7	27	13	Yes
Case 7	F	20	Thoracoscopy	Left pneumonectomy	Mechanical	400	Argyle	5	15	10	No
Case 8	M	73	Thoracotomy	Upper and middle bilobectomy	Mechanical	1200	Argyle	5	35	32	Yes
Case 9	F	40	Robot-assisted	Right lower lobectomy	Mechanical	50	Blake	3	24	14	No

Table 2. Procedure performed

Procedure	n (%)
Necrosectomy	1 (11.10%)
Right lower lobectomy	2 (22.20%)
Right upper lobectomy	1 (11.10%)
Left pneumonectomy	3 (33.30%)
Right pneumonectomy	1 (11.10%)
Upper and middle bilobectomy	1 (11.10%)

Table 3. Type of approach

Type of approach	n (%)
Thoracoscopy	4 (44.40%)
Thoracotomy	4 (44.40%)
Robot-assisted	1 (14%)

Discussion

Pulmonary mucormycosis is an aggressive opportunistic infection with a high mortality rate, particularly in immunocompromised individuals, such as patients with poorly controlled diabetes mellitus or those with profound immunosuppression[1]; this mortality has remained consistent since the first reports were described more than three decades ago[2].

Several recent studies have emphasized that optimal management should be multimodal, integrating early antifungal therapy, control of underlying diseases, and resective surgery when indicated. In particular, the surgery has proven useful in cases with hemoptysis, extensive cavitation, or pulmonary necrosis, contributing to improved clinical outcomes[3]; the authors analyzed a cohort of patients who underwent surgical resection and concluded that, in combination with antifungal treatment, it was associated with a higher survival rate.

Fernández et al.[4] also advocated for this combined approach, emphasizing that surgical intervention should be considered early, as rapid disease progression may limit therapeutic options. This view has been supported by Choi et al.[5], who identified that pulmonary resection is associated with better clinical outcomes, especially when complete resection is achieved, and the patient's functional status allows for adequate recovery.

In our cohort, all patients underwent surgical intervention, and although deaths occurred, these were related to extensive disease at admission or a deteriorated clinical status, which is consistent with findings reported by Peng et al.[6], who compared clinical manifestations and outcomes in immunocompromised versus immunocompetent patients and demonstrated that profound immunosuppression correlates with worse prognosis.

Regarding the surgical approach, thoracotomy has been the most commonly used technique over time; however, recent advances have enabled the use of minimally invasive techniques, such as thoracoscopy and even robotic surgery in highly selected scenarios. Our experience aligns with this trend, as thoracoscopic surgery was performed in equal proportions to open surgery, suggesting that, in experienced centers, fungal infections are not an absolute contraindication for minimally invasive techniques.

Finally, Danion et al.[7] emphasize that modern diagnostic tools -such as high-resolution computed tomography and rapid microbiological diagnosis- have improved the early detection of pulmonary mucormycosis, enabling timely intervention before irreversible lesions develop.

In summary, the current literature supports an individualized and aggressive approach to pulmonary mucormycosis, and early surgical resection, in conjunction with targeted antifungal therapy, can significantly improve survival. The decision should be based on the extent of disease, the patient's clinical status, and the experience of the treating team, while prioritizing early intervention as a key therapeutic cornerstone.

Conclusions

Pulmonary mucormycosis remains a highly relevant clinical challenge due to its nonspecific presentation, rapid progression, and high lethality, particularly in immunocompromised patients. In this case series from a national referral center, a consistent association was demonstrated between pulmonary mucormycosis and risk factors such as poorly controlled diabetes mellitus, biomass exposure, and immunosuppressive states, which should be considered in the evaluation of patients with atypical respiratory symptoms.

The combined treatment, which included first-line antifungal agents and surgical resections tailored to the location and extent of pulmonary involvement, allowed for a comprehensive approach with an acceptable complication rate. The 30-day mortality (33.3%) and 90-day mortality (44.4%) reflect the intrinsic severity of the disease but also underscore the potential impact of timely intervention. Notably, the choice of surgical

approach -whether thoracotomy, thoracoscopy, or robot-assisted surgery- was individualized, demonstrating that even in severe fungal infections, minimally invasive techniques can be applied with favorable outcomes in experienced centers.

This study supports current recommendations from the international literature, which promote a multimodal and individualized approach. Surgical resection should not be considered a last resort, but rather an active tool within initial management, particularly in patients with extensive cavitation, hemoptysis, or clinical progression despite adequate antifungal treatment.

Finally, improvements in diagnostic tools, together with the experience of the clinical and surgical team, are determinants for achieving timely diagnosis and offering effective treatment. This series contributes local evidence on the clinical behavior of pulmonary mucormycosis and strengthens the need for aggressive and multidisciplinary therapeutic strategies in high-complexity settings.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of human and animal subjects. The authors declare that no experiments were performed on human subjects or animals for this research.

Confidentiality, informed consent, and ethical approval. The authors have obtained approval from the Ethics Committee for the analysis of anonymized clinical data obtained routinely; therefore, informed consent was not required. All relevant recommendations have been followed.

Declaration on the use of artificial intelligence. The authors declare that they did not use any type of generative artificial intelligence for the writing of this manuscript.

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