Results of Surgical Treatment for Chronic Pulmonary Aspergillosis at the National Lung Hospital 2023-2024

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ABSTRACT

Introduction: Chronic pulmonary Aspergillosis (CPA) is a condition where *Aspergillus* infection invades and develops chronically, gradually destroying lung structures. Surgical intervention is indicated for most patients with localized fungal lesions and severe, persistent, life-threatening hemoptysis. This study aims to evaluate the outcomes of surgical treatment for chronic pulmonary Aspergillosis at the National Lung Hospital from 2023 to 2024.

Methods: This was a retrospective, cross-sectional descriptive study. It included 124 patients diagnosed with chronic pulmonary Aspergillosis who underwent surgical treatment at the National Lung Hospital from January 2023 to June 2024. Data were analyzed using Stata software.

Results: Among 124 patients with chronic pulmonary Aspergillosis, 115 cases received conventional surgery and 9 underwent emergency surgery. There were 72 male patients (58.1%) and 52 female patients (41.9%). The average age was 53±14 years. The primary clinical symptom was hemoptysis (75.8%). The most common co-morbid lung disease was pulmonary tuberculosis, affecting 59 patients (47.6%). Lobectomy was the most frequent indication for moderate to severe hemoptysis, accounting for 85.7% of cases. The median duration of drainage was 5-6 days, and the median hospital stay was 8-12 days. The complication rate was under 10%, and the success rate was 98.28%. Four severe cases requested discharge.

Conclusion: Surgical treatment for chronic pulmonary Aspergillosis is considered to have acceptable complication rates and should be performed in in specialised centres with experienced surgeons to manage and treat chronic pulmonary Aspergillosis, helping patients achieve complete recovery and improved quality of life without symptoms.

Keywords: *Chronic Pulmonary Aspergillosis (CPA), Pulmonary aspergilloma, Pulmonary Aspergillosis (PA).*

SUMMARY

Objectives: To evaluate the outcomes of surgical treatment for chronic pulmonary Aspergillosis at the National Lung Hospital from 2023 to 2024.

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1. INTRODUCTION

Fungal respiratory infections are increasingly reported worldwide. The most common fungus causing lung disease is *Aspergillus* [1]. Chronic pulmonary Aspergillosis (CPA) is a condition where *Aspergillus* infection invades and develops chronically, gradually destroying lung structures. It often develops into saprophytic fungal masses and aspergillomas within lung cavities due to structural abnormalities. With the widespread use of antibiotics, glucocorticoids, and immunosuppressants, the number of immunocompromised patients, such as those with cancer, HIV, or organ transplants, is increasing. Patients with anatomical and structural abnormalities, such as old tuberculosis cavities, asthma, bronchiectasis, and COPD, also see an increased incidence of CPA [4]. Despite these high estimated numbers, reports on pulmonary *Aspergillus* infection in Vietnam regarding diagnosis, treatment, and management are very limited. Pulmonary Aspergillosis remains a neglected disease, meaning many patients do not have access to diagnosis, treatment, and management, leading to infection, exhaustion, or severe complications like massive hemoptysis. Early diagnosis and correct treatment improve treatment effectiveness and reduce the incidence of adverse events and complications. There are three main treatment methods for pulmonary aspergillosis: medical therapy (antifungal treatment), interventional symptomatic treatment (embolization) and surgical intervention. Surgery is indicated for most patients with localized fungal lesions, severe and persistent hemoptysis, or life-threatening bleeding. In Vietnam, surgical treatment for chronic pulmonary Aspergillosis has been performed in some major respiratory hospitals, but it still faces many limitations, novelty, and challenges. Given this reality, we conducted the study: "Results of Surgical Treatment for Chronic Pulmonary Aspergillosis at the National Lung Hospital, 2023-2024".

2. SUBJECTS AND METHODS

2.1. Study Subjects

The study included 124 patients diagnosed with chronic pulmonary Aspergillosis due to *Aspergillus* who underwent surgical treatment at the National Lung Hospital from January 2023 to June 2024, following the 2016 European Respiratory Society and European Society of Clinical Microbiology and Infectious Diseases guidelines (Diagnostic criteria for CPA according to the new ESCMID/ERS/ECMM and IDSA guidelines 2016) [6].

Inclusion criteria:

- Patients aged 18 years or older, regardless of gender.
- Patients who consented to participate in the study.

Exclusion criteria:

- Patients with any of the following host factors for invasive pulmonary mycosis (acute phase factors were controlled before surgery).

EORTC/MSF 2008 consensus criteria:

- History of recent neutropenia (absolute neutrophil count < 500 cells/mm³ for at least 10 days).
- Hematological malignancies.
- Hematopoietic stem cell transplantation.
- Solid organ transplantation (heart, liver, kidney, lung).
- Prolonged corticosteroid use (excluding patients with allergic bronchopulmonary

aspergillosis) at a therapeutic dose ≥0.3 mg/kg prednisone for 3 weeks, within the last 60 days.

- Treatment with T-cell immunosuppressants (calcineurin inhibitors, tumor necrosis factor blockers, lymphocyte-specific monoclonal antibodies, immunosuppressive nucleoside analogs) or B-cell immunosuppressants (Bruton tyrosine kinase inhibitors: ibrutinib, acalabrutinib) within the last 90 days.
- Severe inherited or acquired immunodeficiency: chronic granulomatous disease, AIDS, acute graft-versus-host disease grade III or IV.
- Patients diagnosed with co-existing other types of fungal infections in the lung.

Diagnostic criteria for CPA according to the new ESCMID/ERS/ECMM and IDSA guidelines 2016) [6]:

- Risk Factors: Look for risk factors in immunocompromised patients, such as HIV, diabetes, alcoholism, malnutrition, corticosteroid treatment, etc. Also consider patients who have or have had lung diseases causing structural changes like cavities, bullae/cysts: cavitary pulmonary tuberculosis, cavitary NTM lung disease, bronchiectasis, COPD, and so on.
- Clinical Presentation: Symptoms must be present for at least 3 months. These include non-specific symptoms such as hemoptysis, productive cough, chest tightness, and fever.
- Imaging: At least one of the following findings on chest X-ray/CT scan: progressive cavitation, aspergilloma within a cavity, a cavity with adjacent pleural thickening, pericavitary fibrosis, or pericavitary infiltration [14].
- Microbiological and Immunological Tests: These include serum Aspergillus IgG, direct microscopy, fungal culture, galactomannan (GM), PCR, and antifungal susceptibility testing.
- Histopathology: This is considered the gold standard for CPA diagnosis.
- If a chest CT shows an aspergilloma, confirmation of *Aspergillus* infection only requires a positive specific *Aspergillus* IgG test (*Aspergillus fumigatus*) or positive *Aspergillus* antibodies (IgG, IgM, IgE). These are typically positive in over 90% of cases. If these tests are not positive, further evidence of *Aspergillus* infection is needed.

Calculating Treatment Success Rate: Patients were monitored and evaluated for treatment outcomes before discharge based on clinical examination and conventional X-rays. Based on these criteria, treatment outcomes were classified into two groups [3]:

Group 1. Good Outcome (Successful Treatment):

- Clinical: no more hemoptysis, dyspnea, and stable vital signs.
- No mortality within 30 days post-surgery or during initial hospital stay after surgery.
- No intraoperative complications.
- No severe postoperative complications.

Group 2. Poor Outcome (Unsuccessful Treatment):

- Clinical: persistent hemoptysis, dyspnea.
- Treated in ICU, discharged in critical condition.
- Mortality within 30 days post-surgery or during initial hospital stay after surgery.

Assessing Hemoptysis Severity:

- **Mild hemoptysis:** from a few ml to less than 50 ml/24 hours.

• **Moderate hemoptysis:** from 50-200 ml/24 hours.

• **Severe hemoptysis:** over 200 ml/24 hours or an amount sufficient to cause gas exchange disturbances due to obstruction.

Classification of Pulmonary Aspergillosis

▪ Aspergillosis Nodules: These are lesions measuring less than 3 cm, which may or may not form a cavity.

▪ Simple Aspergilloma: This can present in various forms such as a nodule or mass with an air crescent sign, a sponge-like appearance, a spiderweb-like pattern, or internal septa within the cavity. The lesion within the cavity might shift position, known as the "rattling bell" sign, and does not enhance with contrast.

▪ Chronic cavitary pulmonary aspergillosis: This involves one or more cavities, with or without an aspergilloma, and progresses over at least three months.

▪ Chronic fibrosing pulmonary aspergillosis: Characterized by cavitary lesions and widespread fibrosis involving two or more lobes.

▪ Subacute invasive pulmonary aspergillosis**:** Typically progresses over 1-3 months, with increasing cavity size, new cavity formation, perilesional consolidation, and nodular and consolidated lesions that form cavities.

2.2. Research Methods: Study Design: Retrospective cross-sectional descriptive study. **Data Processing:** Stata statistical software was used.

3. RESEARCH RESULTS

Table 1. Patient Distribution by Age Group and Gender

Gender	Male (n=72)		Female (n=52)		Total (n=124)	
Age	53±12	%	51±17	%	53±14	%
≤35	5	6.94	10	19.23	15	12.1
36 45	12	16.67	6	11.54	18	14.52
46 55	22	30.56	10	19.23	32	25.81
56 65	22	30.56	15	28.85	37	29.84
66+	11	15.28	11	21.15	22	17.74

The average age of onset was 53±14 years, 53±12 for males and 51±17 for females. Males were more affected in the 46-65 age group (30.56%). Females were more affected in the 56-65 age group (28.85%). Males accounted for 72/124 (58.1%) and females for 52/124 (41.9%). The male-to-female ratio was 1.4:1

Table 2. Risk Factors and Co-morbidities

Risk Factors and Co-morbidities	n = 124	%
Pulmonary		
History of pulmonary tuberculosis	59	47.6
Chronic obstructive pulmonary disease	4	3.2
Bronchiectasis	13	10.5
Bronchial asthma	4	3.2
Cysts/Bronchial cysts	2	1.6
Other lung diseases	20	16.1
Extrapulmonary		
Diabetes mellitus	20	16.1
Hypertension	20	16.1
Other factors	9	7.3

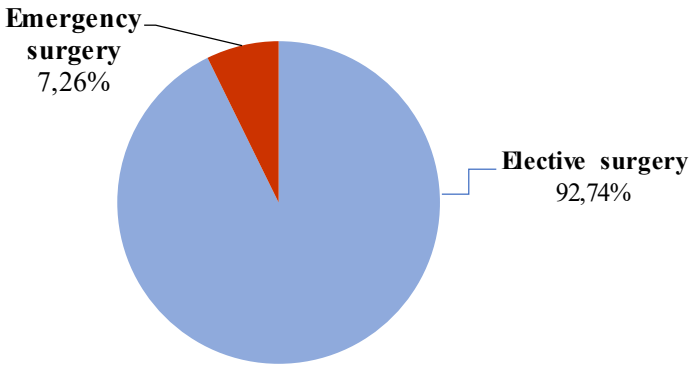
Many patients had two or more historical/risk factors. Among these, a history of pulmonary tuberculosis accounted for the highest proportion at 59/124 (47.6%). This was followed by diabetes and hypertension, both at 20/124 (16.1%). Other co-morbid lung diseases had lower rates: bronchiectasis 13/124 (10.5%), chronic obstructive pulmonary disease and bronchial asthma 4/124 (3.2%).

Table 3. Clinical Symptoms and Signs

Symptoms	Quantity (n=124)	%
Hemoptysis	94	75.8
Cough with sputum	73	58.9
Chest pain/tightness	34	27.4
Weight loss	12	9.7
Fever	17	13.7
Dyspnea	13	10.5
Other symptoms	3	2.4

The most common clinical symptom was hemoptysis (94/124, 75.8%), followed by cough with sputum (73/124, 58.9%), and chest pain/tightness (34/124, 27.4%)

Figure 1. Distribution of Elective and Emergency Surgeries



The majority of patients underwent elective surgery (115/124, 92.74%). A small number of patients underwent emergency surgery (9/124, 7.26%).

Table 4. Surgical Methods and Hemoptysis Status

Surgical Method	No Hemoptysis (n=30)	%	Mild (n=73)	%	Moderate (n=7)	%	Severe (n=14)	%
Segmentectomy	10	33.33	21	28.77	0	0	3	21.43
Lobectomy	10	33.33	32	43.84	6	85.71	9	64.29
Bilobectomy	1	3.33	5	6.85	1	14.29	1	7.14
Wedge Resection	9	30	14	19.18	0	0	1	7.14
Pneumonectomy	0	0	1	1.37	0	0	0	0

The highest percentage of patients with severe hemoptysis underwent lobectomy (64.29%). For moderate hemoptysis, 85.71% of patients underwent lobectomy, with one patient undergoing bilobectomy. Segmentectomy and wedge resection were relatively evenly distributed among patients with mild or no hemoptysis

Table 5. Complications by Surgical Indication

Complications	Segmentectomy (n=34)	%	Lobectomy (n=57)	%	Bilobectomy (n=8)	%	Wedge Resection (n=24)	%	Pneumonectomy (n=1)	%
Hemorrhage	0	0	5	8.77	0	0	2	8.33	0	0
Infection	0	0	0	0	1	12.5	0	0	0	0
Pneumonia	0	0	3	5.26	2	25	0	0	1	100
Empyema	0	0	2	3.51	0	0	0	0	1	100
Prolonged Air Leak	2	5.88	9	15.79	0	0	2	8.33	0	0
Severe, discharged at patient's request, Death	0	0	2	3.51	2	25	0	0	0	0

Almost all complication rates were under 10% across all indications. Only 3 cases of pneumonectomy had complications of empyema. Additionally, prolonged air leak was observed in 15.79% of patients who underwent lobectomy. Four patients developed severe postoperative pneumonia requiring transfer to intensive care and intubation, with 3 cases discharged at their request in very critical condition and 1 death, occurring in patients who underwent lobectomy and bilobectomy.

Table 6. Duration of Pleural Drainage and Postoperative Hospital Stay

Duration (days)	Segmentectomy (n=34)	Lobectomy (n=57)	Bilobectomy (n=8)	Wedge Resection (n=24)	Pneumonectomy (n=1)
Drainage (Median, IQR)	5 (2)	6 (3)	5 (5)	6 (3.5)	7
Discharge (Median, IQR)	10 (12)	12 (8)	8.5 (3)	8 (2)	29

Patients who underwent segmentectomy and bilobectomy had a median drainage duration of 5 days post-surgery, while for lobectomy and wedge resection patients, it was 6 days. The median hospital stay post-surgery ranged from 8-12 days for patients undergoing wedge resection, segmentectomy, and lobectomy.

Table 7. Treatment Outcomes by Elective or Emergency Surgery

Treatment Outcome	Emergency (n=8)	%	Elective (n=116)	%	p-value
Unsuccessful	2	25	2	1.72	0.021
Successful	6	75	114	98.28	

The success rate for elective surgery was 98.28% compared to 75% for emergency surgery. This difference was statistically significant with a p-value of 0.021 at a 95% confidence level.

4. DISCUSSION

Table 1 shows that out of 124 patients in the study, 58.1% were male and 41.9% were female, with a male-to-female ratio of 1.4:1. The average age of disease onset was 53±14 years, with males averaging 53±12 and females 51±17. The oldest patient was 78, and the youngest was 24. The 46-65 age group accounted for 29.84%. This is consistent with Hakan Keskin's study (2022) [7], which also found a higher incidence in males and more cases in the 56-65 age group.

Table 2 results show that the most common co-morbidity in the study group was a history of pulmonary tuberculosis, affecting 59/124 (47.6%). This was followed by diabetes and hypertension, both at 20/124 (16.1%). Other co-morbid lung diseases had lower rates: bronchiectasis 13/124 (10.5%), chronic obstructive pulmonary disease, and bronchial asthma 4/124 (3.2%). Old pulmonary tuberculosis is one of the most common underlying conditions in many studies, including those by Smith and Denning (2011) [14] and Koray AYDOĞDU (2015) [10]. According to Gerard Babatasi (2000)

[3], pulmonary tuberculosis and lung abscess were the most common underlying causes of lung disease (65%). The next most common systemic diseases in the CPA group were diabetes and hypertension, which are described as risk factors for developing lung cavities during tuberculosis treatment and can also be predisposing factors for CPA development in post-tuberculosis patients. Bronchiectasis is also a condition that causes structural damage to the airways, creating favorable conditions for chronic pulmonary *Aspergillus* development, accounting for 10.5% of the total patients in this study. COPD has long been considered a risk factor for CPA; however, in this study, COPD was a chronic disease accounting for a small proportion of 3.2%.

The results in Table 3 indicate that hemoptysis was the most common symptom, resulting from the erosion of adjacent blood vessels due to fungal ball movement and toxin production, leading to secondary systemic angiogenesis, especially of the bronchial and intercostal arteries. In our study group, hemoptysis accounted for 75.8%, followed by cough with sputum (58.9%) and chest pain/tightness (27.4%), consistent with Gerard Babatasi's study (2000) [3], where hemoptysis occurred in 66% of cases, cough with sputum in 15%, and 18% of cases were asymptomatic. Another study by Narendran Balasubbiah (2024) [2] reported hemoptysis as the most common symptom associated with aspergilloma at 52%, with 29% of these cases involving life-threatening hemoptysis. Patients experiencing symptoms, especially moderate to severe hemoptysis, should undergo a contrast-enhanced computed tomography (CT) scan to evaluate for bronchial or intercostal artery dilation. Embolization is indicated to reduce the severity of hemoptysis, effectively allowing emergency surgery to be delayed and converted into a routine procedure with a success rate of 73% to 99%. This significantly reduces the risk of intra- and post-operative complications. Proactive pre-surgical embolization of dilated or hypervascular bronchial and intercostal arteries also helps to reduce bleeding during surgery to remove adhered pulmonary aspergillomas.

Table 4 shows that most patients underwent elective surgery (92.74%), with emergency surgery accounting for only 7.26%. According to Narendran Balasubbiah (2024), emergency surgery is indicated for massive hemoptysis, sometimes accompanied by respiratory failure, to protect the airway and stop bleeding. However, emergency surgery increases morbidity and mortality risks from 7% to 40% [2], higher than in the elective surgery group. Therefore, many studies recommend early surgery for asymptomatic aspergilloma patients, and we persuade patients to undergo scheduled surgery to prevent life-threatening complications [9].

The results in Table 5 indicate that lobectomy was the most common surgical method in this study. For patients with moderate and severe hemoptysis, lobectomy was indicated in 85.71% and 64.2% of cases, respectively. One patient underwent bilobectomy due to lesions in both lobes. One patient underwent pneumonectomy for mild hemoptysis after bronchial artery embolization, but the hemoptysis continued, affecting the entire left lung. Segmentectomy and wedge resection were relatively evenly distributed among patients with

mild or no hemoptysis. Studies by ChangMing Shen (2022) [13] and Narendran Balasubbiah (2024) [2] also showed lobectomy as the predominant method. Standard surgical techniques involve anatomical lobectomy and segmentectomy. Insufficient resection of the lesion can be a risk factor for recurrence. For post-tuberculosis pulmonary aspergillosis, issues of residual space and prolonged air leaks should be considered. Wedge resection is indicated for simple, small fungal lesions, typically less than 3 cm, or for patients with severely impaired respiratory function where minimal parenchymal removal is preferred. Segmentectomy indications are similar to wedge resection; however, this is a more technically anatomical resection and depends on the thoracic surgeon's expertise. In our study, we observed three cases of recurrence within six months post-surgery. Two cases presented with recurrent hemoptysis and new lesions on chest CT scans, while one case had a productive cough with a positive IgG test. All three of these cases ultimately required lobectomy. The decision for post-operative antifungal treatment (intravenous or oral) depends on whether fungal material was spilled into the pleural cavity during surgery and on the post-operative histopathology. All patients undergoing surgery for complex chronic fungal infections are prescribed oral antifungal medication for 3-6 months, with the duration depending on culture results and imaging findings on CT scans.

Table 6 illustrates that the most common complication in our study was prolonged air leak (> 7 days), occurring in 15.79% of the lobectomy group. Other complications such as pneumonia, hemorrhage, and empyema were all below 10%. Three patients developed empyema after lobectomy and left pneumonectomy, accounting for 2.4%. Four patients developed severe postoperative pneumonia requiring transfer to intensive care and intubation, all of whom requested discharge in very critical condition (3.2%), occurring after lobectomy and bilobectomy. Babatasi's study (2000) reported a postoperative mortality rate of 4%, with prolonged air leak and postoperative hemorrhage rates similar to our study. Our results are lower than those in Hicham Harmouchi's study (2019) [8], which reported postoperative mortality rates ranging from 5-10%, with higher rates in complex pulmonary aspergillosis compared to simple cases. The incidence of empyema after lobectomy was 2%, similar to our study. Currently, the support of minimally invasive video-assisted thoracoscopic surgery (VATS) for pulmonary aspergillosis (PA) helps reduce the complication rate, according to Arvind Kumar (2017) [11]. In our study, 22 patients underwent open surgery (17.74%), while 102 patients underwent VATS (82.26%). VATS has proven advantages over open surgery, such as less pain and faster recovery. However, its indication depends on the classification of pulmonary aspergillosis (PA). We based our decision for VATS or open surgery on the PA classification and the lesions observed on CT scans. For cases with extensive, thick adhesions, and significant fibrotic infiltration, which would make dissection difficult, open surgery was indicated. Notably, none of the cases in our study encountered major vessel bleeding requiring conversion to open surgery [10].

The results in Table 7 show that the median duration of chest tube drainage was 5-7 days. The earliest drainage removal was 2 days, and the longest was 30 days. Early removal was often seen in patients with simple pulmonary aspergillosis. Complex pulmonary aspergillosis with extensive dissection, adhesions, and poor lung parenchyma quality carries a higher risk of prolonged air leak and increased pleural fluid accumulation post-surgery, leading to longer drainage times. The median postoperative hospital stay ranged from 8-12 days, consistent with Hakan Keskin's study (2022) [7].

In Table 8, we observed that the treatment success rate for patients undergoing elective surgery was 98.28%. There were 4 unsuccessful cases in both emergency and elective surgery groups, occurring in patients who underwent lobectomy and bilobectomy. The difference in treatment success rates between surgical methods was statistically significant. Our study results indicate that surgical prognosis for patients with chronic pulmonary Aspergillosis is favorable, with mortality primarily occurring in patients with poor preoperative prognoses. Therefore, thorough preoperative assessment (respiratory function, nutritional status, and cardiovascular function) is crucial to reduce postoperative complication rates. Strict control of postoperative complications, especially hospital-acquired infections, is essential.

5. CONCLUSION

Surgical treatment for chronic pulmonary Aspergillosis is an effective treatment method with an acceptable complication rate. It should be performed in surgical facilities equipped with experienced surgeons to manage and treat chronic pulmonary Aspergillosis, helping patients achieve complete recovery and improve their quality of life without symptoms.

REFERENCES

1. Aspergilloma: a series of 89 surgical cases. The Annals of Thoracic Surgery. Accessed September 21, 2023. https://www.annalsthoracicsurgery.org/article/S0003-4975(99)01334-X/fulltext.

2. Balasubbiah, N., Saeteng, S., Siwachat, S., et al. Outcomes of pulmonary resection in pulmonary aspergilloma: A retrospective cohort study in a single tertiary-care hospital in Northern Thailand. Asian Journal of Surgery, 2024.02.003. https://doi.org/10.1016/j.asjsur.

3. Babasati, G., Massetti, M., Chapelier, A., et al. Surgical treatment of pulmonary aspergilloma: current outcome. J Thorac Cardiovasc Sur 2000;119:906-12.

4. Bongomin, F., et al. Surgical management of chronic pulmonary aspergillosis in Africa: A systematic review of 891 cases. Mycoses. 2021;00:1–8. DOI: 10.1111/myc.13359.

5. Chen, Q.-K., Jiang, G.-N. Surgical treatment for pulmonary aspergilloma: a 35-year experience in the Chinese population. Interactive CardioVascular and Thoracic Surgery 15 (2012) 77–80.

6. Denning, D. W., et al. ERS and ESCMID guideline for the management of chronic pulmonary aspergillosis released. Eur Respir J 2016; 47: 45–68 | DOI: 10.1183/13993003.00583-2015. http://ow.ly/Tzlsu.

7. Hakan Keskin, Hülya Diro, Nurgül

Bozkurt. Pulmonary aspergilloma management: 5 years of experience from a tertiary hospital. Kardiochirurgia i Torakochirurgia Polska 2022; 19 (4): 194-198.

8. Harmouchi, H., Lakranbi, M., Issoufou, I., et al. Pulmonary aspergilloma: surgical outcome of 79 patients in a Moroccan center. Asian Cardiovascular & Thoracic Annals 2019, Vol. 27(6) 476–480.

9. He, B., et al. Clinical profile and surgical outcome for different types of chronic pulmonary aspergillosis. Am J Transl Res 2019;11(6):3671-3679. www.ajtr.org /ISSN:1943-8141/AJTR0091153.

10. Kumar, A., Asaf, B. B., Puri, H. V., et al. Video-assisted thoracoscopic surgery for pulmonary aspergilloma. Lung India 2017;34:318-23.

11. Koray, A., Funda, İ., Ş., M. F. Surgical management of pulmonary aspergilloma: clinical experience with 77 cases. Turkish Journal of Medical Sciences (2015) 45: 431-437.

12. Mohapatra, B., Sivakumar, P., Bhattacharya, S., et al. Surgical treatment of pulmonary aspergillosis: A single center experience. Lung India 2016;33:9-13.

13. Shen, C. M., et al. Outcomes of surgery for different types of chronic pulmonary aspergillosis: results from a single-center, retrospective cohort study. BMC Pulmonary Medicine (2022) 22:40. https://doi.org/10.1186/s12890-022-01836-z.

Smith, N. L., Denning, D. W. Underlying conditions in chronic pulmonary aspergillosis including simple aspergilloma. Eur Respir J. 2011;37(4):865-872.