Journal of Health and Medical Sciences

The Asian Institute of Research *Journal of Health and Medical Sciences* is a peer-reviewed International Journal. The journal covers scholarly articles in the fields of Medicine and Public Health, including medicine, surgery, ophthalmology, gynecology and obstetrics, psychiatry, anesthesia, pediatrics, orthopedics, microbiology, pathology and laboratory medicine, medical education, research methodology, forensic medicine, medical ethics, community medicine, public health, community health, behavioral health, health policy, health service, health education, health economics, medical ethics, health protection, environmental health, and equity in health. As the journal is Open Access, it ensures high visibility and the increase of citations for all research articles published. The *Journal of Health and Medical Sciences* aims to facilitate scholarly work on recent theoretical and practical aspects of Health and Medical Sciences.

Surgery for Complications and Sequelae of Pulmonary Tuberculosis

Khalil Ghebouli[1], Karim Meskouri[1], Hakim Larkem[2], Mohammed Amine Kecir[2], Mehdi Belbekri[2], Amar Djender[1], Abdelnacer Haddam[1]

[1] Department of Cardiovascular Thoracic Surgery and Organ Transplantation University Hospital Mustapha Algiers, Algeria
[2] Department of thoracic surgery University Hospital of Constantine, Algeria

Abstract
Tuberculosis, colloquially recognized as the "malady of indigence," stands as an ancient affliction that has pervaded human history. Its contagious nature was meticulously chronicled by medical luminaries such as Hippocrates and Galen, with archeological evidence revealing its existence in Egyptian mummies from a bygone era, extending over five millennia. The 1980s marked a resurgence of tuberculosis on a global scale, disproportionately impacting low-income nations. The resurgent relevance of surgery in the therapeutic armamentarium against pleuropulmonary tuberculosis and its sequelae has once again become a pertinent subject. The primary aim of our study is to elucidate the management of sequelar and/or complicated pleuropulmonary tuberculosis. Methods: This constituted a descriptive cross-sectional study conducted from January 2012 to August 31, 2023. The study encompassed the collection of data from 157 patients, all of whom had experienced at least one episode of tuberculosis and undergone surgical intervention. Results: The average age of our patients was 36.83 (±13.18) years, ranging from 19 to 60 years. Males predominated, constituting 36.69% of the cohort. Major symptoms included hemoptysis in 56.05% and bronchorrhea in 33.76% of cases. The primary surgical indications were predominantly bronchiectasis (31.84%), aspergilloma (26.75%), and encapsulated pleuritis (15.29%). Postoperative outcomes were uneventful in 82.80% of cases. The average duration of hospitalization was 13.8 days (±2.2). Conclusion: Despite the technical challenges associated with the surgical management of complications and sequelae arising from pleuropulmonary tuberculosis, the outcomes remain promising.

Keywords: Tuberculosis, Sequelae, Surgery, Complications

1. Introduction

Pleuropulmonary tuberculosis is a condition for which the cornerstone of treatment is anti-tuberculous chemotherapy (Rosenblatt MB, 1973). Since its discovery in the mid-1940s, this therapeutic approach has revolutionized the prognosis of a disease that was predominantly fatal at that time. With the preliminary success of this therapeutic modality, there was a collective belief that tuberculosis would swiftly be eradicated and relegated to the annals of history (Murray, 2004). However, this optimistic outlook failed to account for the enduring factors of poverty, demographic challenges, limited access to healthcare, substance abuse, the

emergence of multi-drug-resistant strains, human immunodeficiency virus, and more recently, extensively drug-resistant tuberculosis (XDR-TB) (Hargreaves, 2008). Tuberculosis, characterized as the "disease of poverty," initially seemed easily "controllable" through anti-tuberculous chemotherapy but continues to be a significant cause of global morbidity and mortality.

Despite adequate medical treatment, tuberculosis often leaves behind numerous sequelae, and surgery plays a pivotal role in the comprehensive management of these sequelae. This study aims to elucidate the specific role and types of surgery within the therapeutic arsenal for the sequelae of pleuropulmonary tuberculosis.

2. Patients and Methods

This study is a descriptive cross-sectional investigation, complemented by a prospective follow-up of patients with a history of successfully treated pulmonary tuberculosis and presenting suspected sequelae based on clinical, biological, and/or radiological signs, subsequently undergoing surgery in our department.

Prior to admission, all patients underwent a comprehensive clinical examination, standard chest X-ray, CT scan, and cardiorespiratory assessments (ECG, echocardiography, pulmonary function tests). Additionally, medical preparation and preoperative physiotherapy were deemed necessary.

For recent sequelae (tuberculous pneumothorax or encapsulated pleuritis), surgery was scheduled after the 5th month of anti-tuberculous treatment to address anatomical lesions sterilized by medical intervention.

The procedure was conducted under general anesthesia. The anesthetist employed a dual-lumen selective intubation tube, allowing modulation of lung ventilation during the operation for enhanced surgical comfort and prevention of septic contamination of the contralateral lung. Thoracotomy was the chosen surgical approach for all patients.

Following surgery, patients spent 24 to 48 hours in the intensive care unit before transitioning to the regular hospitalization unit. During this period, vigilance was maintained for the occurrence of postoperative complications. The assessment of results was based on clinical, radiological, and biological criteria.

3. Results

The study population comprised 157 patients of both genders meeting inclusion criteria and admitted to the Thoracic Surgery Department between January 1, 2012, and August 31, 2023.

The average age of the patients was 36.83 (±13.18) years, ranging from 19 to 60 years. Males constituted the majority at 63.69%. Patients either had a history of treated and declared cured tuberculosis in 139 cases (88.54%), of which 19 patients received second-line anti-bacillary chemotherapy, or presented with histological evidence of tuberculosis during treatment in 18 cases (21.46%).

The major symptom observed was hemoptysis in more than half of the cases (56.05%), with bronchorrhea also being a frequent symptom in 33.76%. Other symptoms included dyspnea (28.66%), thoracic pain (7.64%), and chronic cough (5.10%).

Lesions were predominantly unilateral in 98.73% of cases, with 54.84% affecting the right side. The distribution of patients based on surgical indications revealed a predominance of parenchymal lesions in 64.97% of cases, while pleural involvement was observed in 35.03%.

Among the surgical indications, parenchymal involvement took precedence. This was primarily represented by bronchial dilations (31.85%) and aspergilloma (26.75%). Notably, there were 9 cases of completely destroyed lungs and a singular case of paracicatricial emphysema. Pleural involvement was mainly characterized by encapsulated pleuritis (15.29%), pneumothorax (11.46%), and empyema (6.37%).

Table 1: Detailed Description of Surgical Indications

Surgical indication	Number	Percentage
Parenchymal involvement	102	64.97%
- Parenchymal involvement	50	31.84%
- Aspergilloma	42	26.75%
- Destroyed lung	9	5.37%
- Paracicatricial emphysema	1	0.67%
Pleural Involvment	55	35.03%
- Encysted pleurisy	24	15.29%
- Pnomothorax	18	11.64%
- Empyema	10	6.37%
- Hydropneumothorax	3	1.91%
Total	157	100%

The parenchymal excision procedures included lobectomies (50.32%), pneumonectomies (5.10%), and segmentectomies (3.18%). The extent of parenchymal involvement necessitated a bi-lobectomy in 3.82%. A combined excision with pleurectomy was performed in 3.18% of cases.

Decortication was performed in 23.57% of patients, with 36 patients undergoing simple decortication. This was associated with the closure of a cutaneous fistula in a single patient.

Pleural symphysis through pleurectomy was carried out in 10.19% of cases, specifically in cases of post-tuberculous pneumothorax resistant to drainage. This pleurectomy was combined with emphysematous bulla resection in three patients.

A solitary thoracoplasty was performed, addressing a case of pulmonary aspergilloma where the respiratory function did not permit excision.

Table 2: Description of Surgical Procedures Based On Operative Indication

Surgical Procedure	Bronchectasis	Aspergilloma	Destroyed lung	Emphyema paracicatricial	Pleurésie enkystée	Pneumothorax	Empyema	Hydro-pneumothorax	Total	Pourcentage
Lobectomy	40	39	-	-	-	-	-	-	79	50.32%
Pneumonectomy	1	-	7	-	-	-	-	-	8	5.10%
Segmentectomy	4	1	-	-	-	-	-	-	5	3.18%
Bi-lobectomy	5	1	-	-	-	-	-	-	6	3.82%
Pleuro-lobectomy	-	-	-	1	-	2	-	-	3	1.91%
Pleuro-pneumonectomy	-	-	2	-	-	-	-	-	2	1.27%
Decortication	-	-	-	-	24	-	10	3	37	23.57%
Pleurectomy	-	-	-	-	-	16	-	-	16	10.19%
Thoracoplasty	-	1	-	-	-	-	-	-	1	0.64%
Total	50	42	9	1	24	18	10	3	157	100%

Among the entire study population, postoperative complications occurred in 17.20% of patients.

The most common postoperative complication was pulmonary re-expansion deficit, observed in 7% of patients, followed by hemothorax at 3.82% and infectious complications also at 3.82%, including one case of right post-pneumonectomy bronchial fistula. Residual pleural effusion was noted in 1.91% of patients, and a solitary case of acute respiratory distress syndrome (ARDS) was documented.

Table 3: Description of Surgical Complications

Complication	Number	Percentage %
- Deficient Lung Expansion	11	7.00%
- Haemothorax	6	3.82%
- Infectious complications	6	3.82%
- Residual Pleural Effusion	3	1.91%
- ARDS	1	0.64%
Total	27	17.20%

Among the patients who experienced postoperative complications, accounting for 17.20% of cases, a favorable outcome was observed in 77.78% of patients following medical treatment combined with active physiotherapy or thoracic drainage. However, 22.22% of patients required a surgical intervention, including decortication in two patients, thoracoplasty in two patients, debridement in one patient, and pneumonectomy in another.

Across all operated patients, none experienced postoperative tuberculosis relapse during an average follow-up period of 14 months.

Operative mortality encompasses all deaths occurring within 30 days following surgical intervention. The overall operative mortality rate is 1.27% of cases, involving one case of bronchial fistula following pneumonectomy and one case of acute respiratory distress syndrome (ARDS) after thoracoplasty.

Hospital stay is calculated from the day of surgical intervention until the day the patient leaves the hospital to continue recovery at home. The average postoperative hospital stay is 13.8 ± 1.9 days.

4. Discussion

Our study focuses on a population of 157 patients admitted and operated for complications or sequelae of pleuropulmonary tuberculosis. Pulmonary tuberculosis sequelae predominantly affect adults, likely due to the aging of the patient population.

In our study, the average age is younger at 36.8 years compared to international publications, where the average age is 46 years for (Souilamas, 2001), 40.2 years for (Connery, 2003), and 52 years for (Gueza, 2018). This age difference can be attributed to the relatively younger population composition in our country.

The observed male predominance with a sex ratio of 1.75 aligns with international literature: 2.38 for (Gueza, 2018) and 3.76 for (Robert, 2020). However, the specific cause for this male predominance remains unexplained, apart from the known association between male gender and a higher prevalence of smoking. Smoking induces bronchial inflammation, contributing to the progression of tuberculosis and the development of sequelae.

Symptomatically, sequelae of pulmonary tuberculosis can manifest with various clinical signs. In our series, hemoptysis (56.05%) and bronchorrhea (33.76%) were prominent. The frequency of these symptoms is linked to the etiologies of tuberculous sequelae in our series, dominated by bronchiectasis and aspergilloma.

Despite well-conducted initial treatment, tuberculosis can evolve towards the formation of fibrotic lesions resulting in pleuro-parenchymal and bronchial mutilation, presenting various sequelae. Bronchiectasis is the

primary sequelae in our series, representing 31.84% of observed sequelae. This rate appears higher compared to the literature, such as 5% for (Mouroux ,1996), 12% for (Gursoy, 2010), and 18% in the (Prieto, 2001) series.

The presence of aspergilloma is explained by the epithelialization of a cavity after evacuation of caseous necrosis. Communication with the respiratory tree allows colonization by aspergillus spores. Local conditions, marked by spore arrival and cavity aeration, foster fungal material proliferation, forming an "aspergillar truffle." In our series, aspergilloma was found in 26.75% of cases, aligning with Kim's study (Kim, 2005) (27.9%) and Souilamas' report (Souilamas, 2001) (45%). However, other publications report no cases of pulmonary aspergilloma.

Destroyed lung is an extensive form of post-infectious tuberculosis sequelae. It occurs after a prolonged course of untreated or inadequately treated pulmonary tuberculosis. Destroyed lung can also complicate stenosis of a sequelar main bronchus from tuberculous bronchitis. In our series, parenchymal destruction was present in 5.37% of cases. Literature analysis shows higher rates, such as 14.1% for (Zaidane, 2018) and 22.6% for (Kone, 2020). This difference may be attributed to our younger population being managed at an earlier stage before lesion extension.

The development of emphysème paracicatriciel post-tuberculeux can result from the distension of a residual tuberculous cavity, typically located within parenchymal consolidation or within a bulging area due to irregular adjacent fibrous bands or airflow obstruction caused by pachypleuritis. It may be situated peripherally in subpleural regions at this stage. Alternatively, it can result from the compression of the bronchus upstream by tuberculous hilar lymphadenopathy. This compression leads to air trapping in the parenchymal territory with progressive distension, eventually forming a large bulla encompassing an entire segment, lobe, or even an entire lung.

In our study, cases of paracicatricial emphysema were rare (0.67%), in contrast to the study by (El Mghari, 2017), where they represented 13.19% of cases.

Regarding pleural sequelae, our study demonstrated the frequency of encapsulated pleuritis. Tuberculous pleuritis is often paucibacillary; repeated aspirations or untimely thoracic drainage can lead to compartmentalization, resulting in the formation of encapsulated pleuritis or pleural pockets. These pockets are characterized by their thickness and significant fibrosis associated with hyper-vascularization.

The deposition of fibrinous material on the pleural surface and colonization by fibroblasts lead to their transformation into collagen, which can calcify in certain circumstances, transforming these encapsulated pleural pockets into true "cuttlefish bone."

Tuberculous pneumothorax constitutes a rare and particularly severe form of tuberculosis. It often complicates cavitary tuberculosis, but certain forms can be observed in miliary tuberculosis or on late fibrous sequelae. It may result from the rupture of a tuberculous cavity, causing a bronchopleural fistula, or the eruption of caseum into the pleural cavity, causing local fibrosis and a parenchymal expansion defect. Another theory involves the development of bronchiolar lesions, where localized trapping promotes the formation of blebs, the rupture of which leads to the release of air into the pleural cavity.

Empyema necessitatis, or perforating empyema, is a rare complication where the inflammatory mass of an empyema spontaneously forms a tract from the pleural cavity to the soft tissues of the thoracic wall, resulting in the formation of a subcutaneous abscess that may sometimes open to the skin. This complication often represents a reactivation of pleural tuberculosis in malnourished or poorly managed patients from the outset.

Hydropneumothorax results from the acute rupture in the pleura of a tuberculous cortical focus in the lung with bronchopleural fistula, which entails the maintenance of pleural infection, hindrance to the re-expansion of the ipsilateral lung, and the risk of inhalation of pus contained in the pleura with seeding of both lungs (Taeib, 1980).

In our series, the rate of pleural sequelae is approximately 35.03%. We documented 15.29% encysted pleuritis, 11.64% tuberculous pneumothorax, 6.37% empyema, and 1.91% pneumothorax. (Simerabet, 2008), in a study involving 145 patients undergoing surgery for pleuropulmonary tuberculosis and its sequelae, of which 112 patients were treated for tuberculosis sequelae, recorded a pleural involvement rate of 69.64%, dominated by encysted pleuritis (26.78%) and empyema (19.64%).

From a curative standpoint, most authors (Stevens, 2000), (Rakotoson, 2011) recommend a combination of medical treatment and surgical intervention for therapeutic strategies. The key issue lies in the initiation date of postoperative treatment. This is scheduled and administered to patients from the first, or at the latest, the second postoperative day after conducting a hepatic assessment.

Surgical treatment combined with pre- and postoperative anti-tuberculous chemotherapy appears to yield favorable outcomes, according to (Sung, 1999). However, determining the postoperative therapeutic regimen and its duration remains to be established. Postoperative chemotherapy is recommended to last 22 to 24 months by some authors and 18 months by others (Mert, 2003) to reduce the potential risk of disease reactivation due to postoperative immunosuppression.

In our patients undergoing surgery for sequelae of pleuropulmonary tuberculosis, surgical procedures were performed after five to six months of anti-tuberculous treatment to achieve sterilization of the tuberculous focus (Rosenblatt, 1973), with a correct nutritional status, stable biological parameters, and after correction of any potential comorbidity risk factor. We consider that the sterilization of pleuropulmonary tissues by preoperative anti-tuberculous chemotherapy helps reduce the severity of inflammatory processes typically encountered in this type of surgery, making the operative technique less challenging and less prone to hemorrhage. Postoperatively, patients were promptly and systematically placed on specific therapeutic treatment for a duration of two months, following consensus and in agreement with our pulmonology colleagues due to the risk of disease reactivation.

Concerning the surgical procedures, parenchymal resection was performed in 65.60%, with lobectomies being the most common at 50.32%, occasionally associated with pleurectomy in 1.91%. Ten patients underwent pneumonectomy; however, it is noteworthy that pneumonectomy for benign inflammatory pathologies like tuberculosis is a highly risky procedure, associated with significant hemorrhagic morbidity and elevated mortality, leading many authors to recommend its avoidance (Rahibi, 2009), (Belcher, 1960).

In our series, bronchoplastic lobectomy was not undertaken due to the absence of endobronchial tuberculosis (Kawamura,1999), (Hsu 1997). Apical pleurectomy with or without bullectomy was conducted in 10.19% of cases, primarily for recurrent or chronically resistant pneumothorax requiring definitive surgical intervention. In one patient, lobectomy was performed for a giant paracicatricial bulla sequela of pulmonary tuberculosis.

Pleuropulmonary decortication, indicated in the pachypleuritis stage, accounted for 23.57%, with one case combined with the management of a cutaneous fistula. Typically performed after infection control and in the sequelae stage of tuberculous lesions, some authors suggest intra-pleural administration of antituberculous drugs in addition to oral treatment due to the low intra-pleural concentration of antituberculous drugs in cases of empyema caused by its thick and poorly vascularized capsule (Gupta, 2015).

Thoracoplasty has limited indications in the surgery of sequelae of pleuropulmonary tuberculosis. In our study, only one primary thoracoplasty was performed for a patient with pulmonary aspergilloma, where pulmonary resection was not feasible due to compromised respiratory function. Nevertheless, this technique still has its place in the surgery of tuberculosis sequelae, particularly in the presence of postoperative complications following parenchymal resection or inadequate lung expansion (Kim, 2005), (Gupta, 2015), (Daly, 1986), (Al-Zeerah, 1998).

In the short-term postoperative course, 82.80% of cases showed uncomplicated recovery, while 17.80% experienced postoperative complications, including hemorrhage, pleural empyema, parietal suppuration, air

leaks, and acute respiratory failure, consistent with findings reported in various literature (Kim, 2005), (Csekeo, 1997), (Akbari, 2005).

Two deaths were recorded in our study (1.27%), one due to bronchial fistula post-pneumonectomy in a cachectic patient and another from acute respiratory distress syndrome (ARDS) following thoracoplasty. Mortality is contingent on preoperative factors (functional respiratory and laboratory assessments), anesthesia, and effective postoperative care. However, specific procedure-related factors also contribute. Presently, overall mortality ranges from 0 to 10%, as reported by several authors.

5. Conclusion

In a nutshell, tuberculosis persists as a pervasive dilemma within regions constrained by limited resources. Notwithstanding diligent medical interventions, its enduring legacy of substantial sequelae necessitates surgical intervention. Despite the intricate challenges posed by inflammatory processes, surgery emerges as an imperative and irreplaceable modality in addressing these lingering repercussions, characterized by rates of morbidity and mortality deemed within acceptable rates.

Ethical statement: All procedures performed in this case study involving human participants, were in accordance with the ethical standards of the Faculty of Medicine of Algiers and with the 1964 Helsinki declaration and its later amendments. Written and informed consent for publication was obtained from the patient.

Conflict of interest: The authors have no conflict of interests to declare.

Authors' contributions: Conception, data collection, and writing of the original draft (KG); literature review (KG and MK, AH); methodology (KG, AH, AD, MK, MB); resources (KG, LH).

References

Akbari JG, Varma PK, Neema PK (2005). Clinical profile and surgical outcome for pulmonary aspergilloma: a single center experience. *Ann Thorac Surgery, 2005*;80(3):1067-72. https://doi: 10.21037/shc-22-5

Al-Zeerah M, Jeyasingham K (1998). Limited thoracoplasty in the management of complicated pulmonary aspergillomas. *Thorax 1989*;44:1027–30. https://doi: 10.1136/thx.44.12.1027

Belcher JE, & Plummer NS (1960). Surgery in broncho-pulmonary aspergillosis. *Brit J Dis Chest 1960*;54(4). https://doi.org/10.1016/S0022-5223(19)39828-9

Connery CP, Knoetgen J, Anagnostopoulos CE, Svitak MV (2003). Median sternotomy for pneumonectomy in patients with pulmonary complications of tuberculosis. *Ann Thorac Surg. 2003*;75:1613-7. https://doi: 10.1016/s0003-4975(02)04901-9

Csekeo A, Agócs L, Egerváry M (1997). Surgery for pulmonary aspergillosis. *Eur J Cardiothorac Surg. 1997*;12(6):876-9. https://doi: 10.1016/s1010-7940(*97*)00272-8

Daly RC, Pairolero PC, Piehler JM (1986). Pulmonary aspergilloma. Results of surgical treatment. *J Thorac Cardiovasc Surg 1986*;92:981–8. https://doi.org/10.1016/S0022-5223(19)35813-1

Elmghari M, Zaghba N, Benjelloun H, Yassine N (2020). Profil clinique et radiologique des séquelles de tuberculose. *Rev Mal Respir. January 2017*;34:A231-A232. https://doi : 10.1016/j.rmra.2020.11.504

Gueza N, Bouhedda M, Lellou S (2017) Vivre avec des séquelles de tuberculose. *Rev Mal Respir. Janvier 2018*;35 supp:A181. https://doi : 10.1016/j.rmr.2017.10.414

Gupta PR, Jain S, & Kewlani JP (2015). A comparative study of itraconazole in various dose schedules in the treatment of pulmonary aspergilloma in treated patients of pulmonary tuberculosis. *Lung India 2015*;32(4):342–6. https://doi: 10.4103/0970-2113.159563

Gursoy S, Ozturk Aa, Ucvet (2010). Surgical management of bronchiectasis:the indications and outcomes. *Surg Today 2010*;40(1):26-30. https://doi: 10.1007/s00595-009-4013-x

Hargreaves S (2008): WHO report alarming rise of resistant tuberculosis. *Lancet infectious diseases 2008*; 8:220. https://doi.org/10.1016/S1473-3099(08)70057-4

Hsu HS, Hsu WH, Huang BS, Huang MH (1997). Surgical treatment of endobronchial tuberculosis. *Scand Cardiovasc J . 1997*;31(2):79-82. https://doi: 10.3109/14017439709058073

Kawamura M, Watanabe M, Kobayashi K (1999). Surgical treatment for tuberculous tracheobronchial stenosis. Kekkaku. *1999 Dec*;74(12):891-6. https://pubmed.ncbi.nlm.nih.gov/10655696/

Kim Yt, Kang Mc, Sung Sw, Kim Jh (2005). Good long-term outcomes after surgical treatment of simple and complex pulmonary aspergilloma. *Ann Thorac Surg. 2005 Jan*;79(1):294-8. https://doi: 10.1016/j.athoracsur.2004.05.050

Kone S, Thiam K, Diatt S, Kone S, Toure N (2020). Prise en charge des séquelles de la tuberculose. *Rev Mal Respir actualités. Janvier 2020*;12(1):171. https://doi : 10.1016/j.rmra.2019.11.383

Mert A, Bilir M, Akman C, Ozaras R, Tabak F, Ozturk H, AktugluY (2001). Spontaneous pneumothorax: a rare complication of military tuberculosis. *Ann. Thorac. Cardiovasc. Surg. 2001* ; 7 (1) : 45-8. https://pubmed.ncbi.nlm.nih.gov/11343566/

Mouroux J, Maalouf J, Padovani B, Rotomondo C, Richelme H (1996). Surgical management of pleuropulmonary tuberculosis. *J Thorac Cardiovasc Surg. 1996 Mar*;111(3):662-70. https://doi: 10.1016/s0022-5223(96)70320-3

Murray JF (2004). A Century of Tuberculosis. *American Journal of Respiratory and Critical Care Medicine 2004*; 169: 1181-1186. https://doi: 10.1164/rccm.200402-140OE

Prieto D, Bernardo J, Matos Jm, Eugenio L, Antunes L. Surgey for bronchiectasis (2001). *Eur J Cardiothorac Surg 2001 Jul*;20(1):19-23. https://doi: 10.1016/s1010-7940(01)00746-1

Rahibi I, Yassine N (2009). Les aspergillomes pulmonaires : A propos de 50 cas. *Rev Mal Respir 2009*:1532-15. https://doi : 10.1016/j.rmr.2017.10.560

Robert C, Bernard P, Lefebvre M, Herve C, Eschapasse E, Deschanvres C, Raffi F, Coutherut J, Biron C, Blanc F (2020). Quelles pratiques de diagnostic et de prise en charge des séquelles de tuberculose pulmonaire chez les migrants primo-arrivants dans un CLAT ? *Médecine et Maladies Infectieuses, Sept 2020*;vol50 issue6 supp:S148-S149. https://doi.org/10.1016/j.medmal.2020.06.315

Rosenblatt MB (1973). Pulmonary tuberculosis: evolution of modern therapy. *Bull N Y Acad Med 1973*; 49: 163—96. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1806933/

Rakotoson JL, Razafindramaro N, Rakotomizao JR (2011). Les aspergilomes pulmonaires : à propos de 37 cas à Madagascar. *Pan Afr Med J 2011*;10:4. https://doi : 10.4314/pamj.v10i0.72209

Simerabet A (2008). Traitement chirurgical de la tuberculose pleuro-pulmonaire. Thèse de médecine. Algérie 2008. https://hsl.lib.unc.edu/wp-content/uploads/2021/12/MolinaAlgiers1950.pdf

Souilamas R (2001). Surgical treatment of active and sequelar tuberculosis forms of pulmonary tuberculosis : *Ann Thorac Surg. 2001* ; 71:443-47. https://doi: 10.1016/s0003-4975(00)02377-8

Stevens DA, Kan VL (2000). Practice guidelines for diseases caused by Aspergillus. *Clin Infect Dis 2000*;30(4):696–709. DOI: 10.1086/313756

Sung SW (1999). Surgery increase the chance of cure in multidrug-resistant pulmonary tuberculosis : *Eur J Cardiovasc Surg. 1999 Aug.* ;16(2):187-93. https://doi: 10.1016/s1010-7940(99)00158-x

Taeib Jacques Meyer (1980). Pyopneumothorax tuberculeux. Thèse de doctorat en médecine , Paris 1980 ; n° : 59. https://www.memoireonline.com/09/10/3913/m

Zaidane S, Benjelloun H, Zaghba N, Yassine N (2018). Hémoptysies sur séquelles de tuberculose : approche étiologique *Rev Mal Respir. January 2018*;35:A181. https://doi : 10.1016/j.rmra.2021.11.282