



Surgical Indications for Treatment of Pulmonary Tuberculosis

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Abstract. Surgery for pulmonary tuberculosis (PTB) has passed through various stages throughout history, having been the treatment of choice in the past. It has now been relegated to second place for treatment of this disease. One of the most strongly debated surgical indications has been clinical picture of multidrug resistance with the focus of pulmonary tuberculous activity located in a segment, lobe, or lung. In these cases some authors have described good results with surgical excision. Another important indication is the complications of PTB, among which bronchiectases (provoking pictures of suppuration, superinfections, or hemoptysis) are found, along with known destructive pulmonary sequelae such as destroyed lung, massive hemoptysis, and the presence of a bronchopleural fistula that cannot be resolved with pleural drainage. The presence of a neoplasm in a patient affected by PTB is a surgical indication if the lesion is resectable. The existence of an unidentifiable pulmonary mass or node is a surgical criterion because it might signal bronchogenic carcinoma. A frequent indication for surgery is pulmonary aspergilloma, which in a large percentage of cases is a destructive PTB sequela and generates serious complications, hemoptysis being the most frequent. Mediastinal tuberculous lymphadenitis that produces compressive symptoms and pulmonary complications, especially in children, is another surgical indication for decompressing the bronchial tree. The surgery in these cases consists in excision and curettage of adenopathies. Surgery therefore now constitutes a valid option for the treatment of certain clinical pictures of PTB that do not respond to medical treatment, are serious, and are potentially fatal.

The history of tuberculosis is long and vast. One of its principal points of reference belongs to Laënnec, who in 1819 published his *Traité du Diagnostic des Maladies du Poumon et du Coeur*, describing signs and symptoms of the illness. In 1882 Robert Koch discovered the bacillus responsible for the illness. From a surgical point of view, the first important events were the introduction of therapeutic pneumothorax in 1882 by Forlanini and a description of thoracoscopy for tubercular pleural adhesions in 1911 by Jacobaeus [1].

For many years surgery was the only therapeutic option for fighting pulmonary tuberculosis (PTB), and therapeutic lung collapse had become considerably developed for the intention of impeding the germs' growth, which require an aerobic medium for metabolism. The techniques used were therapeutic pneumothorax, thoracoplasty, plombage, and phrenicectomy [2]. Later, surgical resection was begun on cavitory and other pulmonary tubercular lesions. Despite these efforts, the disease continued to be lethal, and surgical procedures followed by gross complications occurred with great frequency [3].

The beginning of the chemotherapy era in 1940 began an authentic revolution, and the disease became controllable with drug treatment, which now cures almost all patients with PTB. This fact generated the false sensation, especially in countries with endemic tuberculosis, that the disease was at the final stages of being eradicated. The last decade, however, has witnessed serious spread of the disease. This increase is linked to the increase of patients with acquired immunodeficiency syndrome (AIDS) [4] and other immunity-depressed populations [5], although it is also influenced by marginal social circumstances, poor social situations, and poverty. These situations are found not only in underdeveloped countries but also in highly developed ones such as the United States and European countries that now have a large immigrant population [6].

Pulmonary TB usually presents in a primary form, although it can evolve into various clinical scenes. In general, though, it responds well to tuberculostatic treatment. Surgery is reserved for cases that respond poorly to drug treatment or for the complications derived much of the time from sequelae [7]. The role of surgery is controversial because when, how, and in what way it should be carried out in a patient affected with PTB are not universally accepted.

General Principles of Diagnosis and Treatment

The candidate for surgery usually does not respond to drug treatment or has severe complications, which make a correct diagnosis of the presenting lesions especially important. The role of bronchoscopy for evaluating the state of the bronchotracheal tree is fundamental, and not only when there is a suspicion of bronchial involvement [8]. In a significant number of cases intrabronchial involvement may exist that has passed unnoticed and that could cause such problems such as stenosis, atelectasis, and superinfections [9]. It is also important to check for the possible presence of problems that might interfere with a bronchial suture.

Currently, diagnostic mediums using images are of capital importance, the most important of which is computed tomography (CT) of the thorax. Its assistance is indispensable for appraisal of pulmonary and pleural lesions [7]. For the diagnosis of tubercular

bronchiectasis, bronchography continues to be touted by many authors [10], even though its use is limited by the lack of clinical experience with it.

If there is the possibility of intervention, it is important to have negative smears and cultures, a point on which all authors agree, including those who decide to operate on patients with multidrug-resistant PTB [11]. Other general matters are the verification of good nutrition and adequate respiratory physiotherapy.

The type of surgical treatment depends substantially on the type of indication present. Primary indications are those seen when portions of the lung affected by tuberculosis cannot be treated with medication and so must be resected. Secondary indications include conditions that require control for associated complications of sequelae [7].

Role of Pulmonary Resection for Treatment of Multidrug-Resistant Tuberculosis

Treatment with various antituberculosis drugs administered simultaneously have reduced the rate of resistance of the disease, which is now 2% to 9% [12]. The distribution of such resistance is heterogeneous, and its presence is usually related to inadequate medical treatment and tuberculous involvement of areas of the lung that the drugs have difficulty reaching, e.g., the pulmonary cavities. The goal of treatment for these patients is to eliminate the focal points of PTB.

Surgical management of patients with multidrug resistance is combined with pre- and postoperative drug treatment. Authors describing this type of treatment cite, as criteria for surgery, failure or relapses during treatment and the small or nonexistent possibility of using other drugs, along with the danger of progression of the course of the disease. Patients requiring this form of treatment are affected by serious destructive lobar or pulmonary lesions, and it is imperative to establish cardiorespiratory stability before carrying out surgical treatment [6, 10, 12–19]. Also described is surgery (pulmonary resection) in patients affected by atypical mycobacterial infections, among which reports the series by Pomerantz et al. stands out, in which *Mycobacterium avium* predominated [14]. It is preferable to carry out surgical treatment after having converted the patient's sputum to a negative status. Tuberculostatic treatment for 3 to 8 months is thus recommended [18]. With cases of multidrug resistance by *M. tuberculosis*, a major left affection has been described, called left bronchial syndrome. This pattern differs from the multidrug resistance by other mycobacteria, which has a similar distribution between the left and right sides [14].

With regard to which surgical technique to utilize, it comes down to the focal elimination of PTB where the lesion has localized. Most of the time a lobectomy is carried out [6, 10, 14, 17–19], although pneumonectomy has been described if the lesions affect the entire lung [6, 7, 14, 16–20]. Segmental resection has also been described [18, 19]. Coverage of the bronchial stump with a myoplasty is considered important, especially in cases in which there is a positive direct smear [6, 10, 14–20], although it has also been advised for cases where the upper lobe is affected [18]. Another important point regarding surgical technique is the avoidance of excessive skeletalization of the bronchial stump so as not to harm the vascularization [14].

Treatment of Complications of Pulmonary Tuberculosis: Bronchiectasis, Destroyed Lung, Hemoptysis, Bronchopleural Fistula

Bronchiectasis

One of the most frequent early complications, which is now less frequent, is bronchiectasis. PTB continues to be one of the primary causes of bronchiectasis, and one should first always rule out the presence of an accompanying or previous tuberculosis process when a patient presents with this pathology. The surgical indications of bronchiectasis of tubercular origin continue to be present, as evidenced by its comprising 16% of all the indications of tuberculosis in a series by Rizzi et al. [18].

The surgical indication is established as a function of the presence of important bronchorrhea, repeated infections, or recurring or massive hemoptysis in cases where the bronchiectasis is sufficiently localized [21]. The diagnosis is confirmed by diagnostic imaging, the most important of which is CT of the thorax [7], especially high resolution CT [21, 22]. Bronchography [5, 7] continues to be advocated by some authors for having a higher sensitivity than CT for bronchiectasis of the middle lobe and lingula [18, 23].

Lobectomy is the first surgical option, although if the lesions are sufficiently serious pneumonectomy may be indicated. The prognosis is always good when the infection is diffuse and there is no relapse subsequent to bronchiectasis.

Destroyed Lung

Frequently in situations of poor medical treatment or multidrug resistance, there is massive pulmonary destruction. It is difficult to define the natural evolution of this clinical situation, but it is usually associated with complications. The most frequent is pulmonary superinfections, although aspergilloma, recurring or massive hemoptysis, and reactivation of the illness are seen.

Destroyed lung secondary to PTB is treated when complications have been detected that are potentially lethal. The surgery for this situation is complex, and complications may arise from excision of a lung with serious inflammatory phenomena that have provoked the PTB and the secondary superinfection [24].

The most frequent resection is pneumonectomy, although if possible lobectomy is tried [19]. Covering the bronchial stump with intercostal muscle, pleura [18, 24], biologic glue, and omentum [16] have been described and can be of assistance in preventing postoperative bronchopleural fistulas, which are the most characteristic complication of this type of surgery [20]. Other adjunctive procedures have been described, such as thoracoplasty tailoring [18], but its use has been rare recently. These are aggressiveness procedures, so care should be taken when selecting candidates.

Hemoptysis

Hemoptysis, a frequent complication of tuberculosis, is usually seen in some of the previously mentioned situations. Massive or chronic evolutionary hemoptysis is mainly responsible for the surgical procedure in a large number of cases. In a recent publication on surgically treated PTB, the indication for surgery

was established to be severe or recurring hemoptysis in 16% of cases [18]. If an *Aspergillus* superinfection does not exist, its origin is usually erosion of a bronchial artery or, more rarely, rupture of a Rasmussen aneurysm in the interior of a tubercular cavity [7].

The presence of PTB with massive hemoptysis necessitates a series of priority measures. The site of bleeding should first be localized through bronchoscopy, avoiding passage of blood into the contralateral lung. This procedure can be performed by bronchial blockage and embolization of the bronchial arteries before scheduling an operation [25, 26]. If the patient fails to respond to conservative measures, emergency surgical treatment is undertaken if the situation may result in severe morbidity or mortality. Surgery consists in excision of the area of pulmonary bleeding, generally a lobectomy. Note that it is of capital importance to have previously localized the zone of bleeding by bronchoscopy [7].

Bronchopleural Fistula

Bronchopleural fistula (BPF) is a severe complication that occurs in patients with PTB and secondary pulmonary damage. The evolution of BPF is variable and depends to a great degree on the level of lung destruction.

The initial treatment for all these cases is pleural drainage, given that the initial clinical expression of BPF is the presence of a spontaneous pneumothorax. Evolution then dictates the need to carry out aggressive measures. Surgical treatment is indicated for unresponsive BPF, which usually coincides with serious lung destruction. In these cases pulmonary resection is carried out whose extensiveness is a function of the viable parenchyma that remains [19].

Nodes and Pulmonary Masses Related to Tuberculosis: Pulmonary Neoplasms

On some occasions patients affected by a node or pulmonary mass undergo surgery without a specific preoperative diagnosis, and PTB is discovered during the procedure. This diagnosis was consistently found in a series of patients with solitary pulmonary nodes [27, 28] and in a study of video-assisted thoracoscopic surgery for excision of solitary pulmonary nodes [29]. A mass was found in 31% of a series of patients treated surgically for PTB [4].

The high frequency of bronchogenic carcinoma in the population treated for PTB is well known, particularly cancer of a scar [7]. On occasion it arouses the suspicion of a neoplasm in a patient who is known to have been affected previously with PTB. This situation was described in 24% of cases studied by Rizzi et al. They reported on patients in whom nodes were seen or those who had a mass in the TB infiltrates, many of them already identified but with poor radiologic resolution.

Staging and treatment of neoplasms are carried out as for all cases of bronchogenic carcinoma. The prognosis depends on the stage of the neoplasm more than on the tuberculosis status. Survival of patients with stage I and or II cancer has been described as comparable to that obtained in a general series of bronchogenic carcinomas operated on in these stages [18].

Pulmonary Aspergilloma

Pulmonary aspergilloma is often produced in residual cavities of tubercular origin. In series published on aspergilloma, the antecedents of pulmonary tuberculosis always stand out, representing as much as 37.5% [30] and including 72.4% in areas of high prevalence of PTB [31]. The most recent publications on surgical treatment of tuberculosis have reported aspergilloma at a frequency of 45% [18]. There is therefore an important tropism of *Aspergillus fumigatus* for tubercular cavity lesions, which are considered the major predisposing factor for aspergilloma [32].

The evolution of aspergillomas is unforeseeable, but it is described frequently with complications, the most common being hemoptysis, exhibited in 90% of the cases in one study [33]. Its origin is due to various causes; among those described is trauma by friction due to its own fungal ball, the production of proteolytic and fibrinolytic enzymes [30, 34], and type III antigen-antibody reactions [30]. The presence of hemoptysis is usually a warning sign, and around 30% evolve into massive hemoptysis [30, 31].

From a radiologic point of view, the presence of a mass in the interior of a cavity is classic and characteristic. It can be surrounded by a crescent of air overhead [35]. On occasion it is not as characteristic and may be confused with a mass of a different origin. From a biologic point of view, detection of precipitin serum or biopsy of a lesion can help with the diagnosis. Sputum cultures are much less specific [30–34].

The surgical treatment of aspergilloma is a much debated matter. On the basis of having described its spontaneous lysis in some 5% to 15% of cases [36], some authors advise an expectant attitude for uncomplicated, asymptomatic cases of aspergilloma; others advise that it is preferable to treat all *Aspergillus* lesions with respect to the future risk of complications [28]. If there is an accompanying clinical picture, and if the patient meets the conditions of operability, it is preferable to undertake surgical resection through the source of the aspergilloma, taking into account the condition of the affected lung. Lobectomy is preferred, although there may also be indications for segmental resection or pneumonectomy depending of the size of the lesion [30, 31, 33, 34]. Another surgical technique used, although only in cases of high operative risk, is simple cavernostomy and extraction of the aspergilloma as well as myoplasty in the treated zona [37]. A surgical alternative in cases that preclude operation is intracavitary instillation of antifungal agents [33, 38]. In cases of massive hemoptysis, as stated earlier, embolization of the bronchial arteries is indicated as a primary recourse before planned surgery. Surgical treatment for aspergilloma demands individual, careful validation because we are dealing with complex pathology.

Mediastinal Gangliobronchial Lymphadenitis Tuberculosis

One of the forms of PTB that has been described as requiring surgical treatment is the primary massive mediastinal adenopathy that causes acute or chronic compression in the bronchotracheal tree with obstructive symptoms [39, 40]. This complication is seen in the context of the bronchial effects of tuberculosis, whose incidence is about 9% in our studies [39]. The complications of this varied clinical picture are pulmonary atelectasis, the formation of bronchial ulcerations, and gangliobronchial perforation with the passage of caseous material into the airways, which can provoke acute episodes [40].

This problem was frequent in the past. Today, although rare, it presents in the tubercular population, especially infants. Surgery can produce satisfactory resolution with regard to the possibility of eliminating compressive, obstructive episodes in the tracheo-bronchial tree. The surgery consists in curettage of the mediastinal adenopathy caused by PTB. Dissection and excision of ganglia should be avoided so as not to provoke vascular accidents. Pulmonary resection is not indicated if irreversible pulmonary damage is not believed to exist [39, 40].

Before the surgical procedure rigid bronchoscopy should be performed to evaluate the lesions and their eventual endoscopic treatment. It is also imperative to have established antituberculous drug treatment for at least 2 months prior to operating.

Complications of Surgery for Pulmonary Tuberculosis

Surgery in patients with PTB is usually indicated in those who are experiencing serious progression of the disease or those with serious complications. The postoperative morbidity may be frequent and grave; worldwide the incidence of complications is reported to be 24% and the mortality 3% [18]. The main complication is postoperative bronchopleural fistula, which is produced with great frequency among those operated on who have positive sputum or a generally deteriorated condition [14].

Conclusions

Current review of the state of the art of surgical treatment of PTB reveals the following. (1) Surgical treatment of PTB continues to have an unflagging role in the management of this disease. (2) Pulmonary resection in patients with multidrug-resistant PTB is defended by some authors, but conclusive data do not exist to make one think that it should be a routine option for this type of patient. (3) Surgical treatment of tubercular pulmonary sequelae, such as destroyed lung, bronchiectases, and cavern tuberculosis, is well established. Its indications mark the presence of serious complications, such as persistent bronchorrhea, repeated pulmonary superinfections, aspergillomas, and massive hemoptysis. (4) The surgical and diagnostic management of a patient with PTB in whom a bronchogenic carcinoma is present does not substantially differ from cases in the general population. The prognosis depends fundamentally on the state of the neoplasia. (5) There are other complications that can be treated surgically with good results, such as large bronchotracheal compressions with childhood mediastinal tuberculosis lymphadenitis.

Résumé

La place de la chirurgie dans la tuberculose pulmonaire (TP), au temps jadis le traitement de choix, a évolué. Actuellement, sa place est secondaire. Une des indications les plus discutées est la chirurgie dans les formes multirésistantes au traitement médical traditionnel avec foyer pulmonaire en activité, localisée à un segment, un lobe ou tout un poumon. Dans ces cas, certains auteurs ont décrit de bons résultats avec la chirurgie. Une autre indication majeure est le traitement des complications de la tuberculose, parmi lesquelles on trouve les bronchiectasies, avec volontiers des tableaux de suppuration, de surinfection ou des hémoptysies, des destructions parenchymateuses majeures, des hémoptysies massives et la présence de fistule bronchopleurale

non résolue par le simple drainage pleural. La présence de néoplasme dans ce contexte est une indication à la chirurgie à condition que le patient soit opérable et la localisation néoplasique résecable. De même, l'existence d'une masse ou d'une adénopathie pulmonaire nonidentifiable est une indication chirurgicale en raison du risque de laisser passer un cancer bronchopulmonaire. Une autre indication fréquente de la chirurgie est l'aspergillose pulmonaire qui, dans un grand pourcentage de cas, apparaît en cas de destruction parenchymateuse et qui génère de complications sévères, notamment des hémoptysies. La lymphangite tuberculeuse médiastinale est responsable de symptômes de compression et de complications pulmonaires, surtout chez l'enfant, et représente une autre indication chirurgicale pour décompresser l'arbre bronchopulmonaire. La chirurgie dans ces cas consiste en un curage ganglionnaire. La chirurgie reste donc indiquée dans certains cas spécifiques qui ne répondent pas au traitement médical, qui sont graves et potentiellement fatals.

Resumen

La cirugía de la tuberculosis pulmonar (TBP) ha pasado por diferentes etapas a través de la historia, habiendo sido el tratamiento de escogencia en el pasado. Realmente ha sido relegada a un segundo lugar en el tratamiento de la enfermedad. Una de las indicaciones más intensamente debatidas han sido los cuadros clínicos de multiresistencia con el foco de actividad de la tuberculosis pulmonar ubicado en un segmento, un lóbulo o todo un pulmón. En tales casos algunos autores han descrito buenos resultados con la exéresis pulmonar quirúrgica. Otra indicación mayor la constituyen las complicaciones de la TBP, entre las cuales se encuentran las bronquiectasias que se manifiestan por cuadros de supuración, superinfecciones o hemoptisis, junto con cuadros de secuelas destructivas del pulmón, tales como bronquiectasias, destrucción pulmonar, hemoptisis masiva y la presencia de una fístula broncopleurale que no puede ser resuelta mediante drenaje pleural. La presencia de un neoplasma en el contexto de un paciente con TBP constituye una indicación quirúrgica si la enfermedad neoplásica es operable y resecable. Asimismo, la existencia de una masa pulmonar o ganglio representa un criterio quirúrgico por el peligro de que pueda tratarse de un carcinoma broncogénico. Una indicación frecuente de cirugía es el aspergiloma pulmonar, el cual en un alto porcentaje de casos aparece en las secuelas destructivas de la TBP y genera complicaciones, entre las cuales la hemoptisis es la más frecuente. La linfadenitis tuberculosa mediastinal que produce síntomas de compresión y complicaciones pulmonares, especialmente en niños, constituye otra indicación quirúrgica para descompresión del árbol bronquial. En tales casos, la cirugía consiste en la exéresis y el curetaje de las adenopatías. La cirugía, por consiguiente, ahora constituye una opción válida en el tratamiento de ciertos cuadros clínicos de TBP que no responden al tratamiento médico, los cuales son graves y potencialmente letales.

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