Monograph

New Advances on the Surgical Treatment of Bronchial Asthma

Ubaidullo Kurbon1,2, Hamza Dodariyon1, Abdumalik Davlatov3, Sitora Janobilova4 and Massoud Mirshahi1,3,4

1Department of Plastic, Reconstructive Microsurgery and Regenerative Medicine, Avicenna TSMU, Tajikistan
2Khatlon state Medical University, Tajikistan
3Sorbonne Cité Paris University, INSERM U965, France
4Tajikistan Academy of Sciences, Tajikistan

*Corresponding Author: Massoud Mirshahi, Laribosière Hospital, Sorbonne Cité Paris INSERM U965, Paris-7 University, 41 bd de la Chapelle, 75010 Paris, France, Email: massoud.mirshahi@inserm.fr

First Published June 30, 2016
Copyright: © 2016 Massoud Mirshahi et al.

This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source.

Abstract

Management of asthma in chronically affected patients is a serious health problem. Here, briefly we reviewed the surgical methods to treat asthma. Historical aspects such sympathetic-para sympathetic trunk resection and recent advances such as bronchial thermoplasty and resection of the internal branch of the superior laryngeal nerve will be discussed.

Keywords

Asthma; Asphyxias; Laryngeal nerve; Bronchial thermoplasty; Sympathectomy; Para sympathetomy; Surgical resection

Introduction

Asthma is one of the major noncommunicable diseases. It is a chronic disease of the air passages of the lungs which inflames and narrows them. Asthma, most often starts during childhood although chronic bronchial asthma (CBA) develops in adulthood. According to the WHO (World Health Organization) report, the numbers of asthma sufferers are 3-7 times more than cancer patients and 25-100 times the tuberculosis patients in some countries. Epidemiology of severe asthma varies 4-10% of the world population [1]. The economic damage to the disease and attained billions of dollars per year demonstrates the relevance of this issue currently [2,3]. The American Lung Association in 2012 reported that there were about 300 million persons in the world suffering from asthma and
2.5 million people died each year from severe asthmatic crisis [4].

Asthma is an inflammatory disease of the large and small airways strongly accompanied by allergies. Patients with asthma have bouts of breathlessness; chest tightness, coughing and wheezing due to generalized airway obstruction manifested as decreased flow rates over the entire vital capacity and a diminished forced expiratory volume in 1 second (FEV1) that usually reverts completely after the attack. This airway obstruction results predominantly from smooth muscle spasm, although airway mucus and inflammatory infiltrates also contribute [5].

Medical care includes treatment of acute asthmatic episodes and control of chronic symptoms, including nocturnal and exercise-induced asthmatic symptoms. Pharmacologic management includes the use of controlled agents such as inhaled corticosteroids, cromolyn or nedocromil, long-acting bronchodilators, theophylline, leukotriene modifiers, and more recent strategies such as the use of anti-immunoglobulin E (IgE) antibodies (omalizumab) [5]. In practice, often severe drug-resistant forms of asthma are observed in chronically affected patients and their management is a serious health problem in modern medicine. Recent decades have registered a constant increase in CBA and it seems that at present 5% of the global population suffers from it [6,7].

In addition, unfortunately, currently CBA treatments still remain expensive, lengthy, providing only temporary relief and beset with several side effects [8]. Often when an asthmatic crisis occurs, none of these drugs are necessarily at hand or in possession of the patients. This could be the situation in far flung remote areas in different parts of the world.

Along with this, increased number of side effects of drug therapy and the number of individual patients intolerant of medications contribute to a weakening of the therapeutic effect of basic therapy and poor prognosis of the disease, prompting researchers to seek new directions for optimizing treatment of asthma [1,9]. In consequence, the surgical procedure is an alternative approach for the treatment of severe bronchial asthma.

**Historical Aspects of Surgery to Treat Asthma**

Historically, surgical intervention was probably stimulated by the outstanding work of Williams CJB, who in 1840 studied the nerve control of bronchial musculature. As reported by Sedwitz, autonomic nervous system carries both broncho constrictor and bronchodilator fibers, with predominance of the former in the vagus and the latter in the sympathetic nerve system [10]. Various branch of the autonomic nervous system are implicated in bronchial innervation. It is well-known by several surgeons that sympathetic nerve resection can modify vagal tone, eliminate the phenomenon of bronchospasm, change the reaction shocked zone.
The first operation for the removal of superior cervical ganglion of autonomic nervous system in patient with bronchial asthma to relieve in bronchospasm was done by Kummel in 1923 [10]. The positive results obtained by the author, have attracted the attention of many surgeons to sympathectomy in bronchial asthma. However, by no means harmless sympathectomy surgery, it can contribute to the development of complications such as Horner’s syndrome, the appearance of pain in the parotid gland, atrophy of facial muscles, tongue, upper extremities and anhidrosis.

As reported by Sedwitz JL in 1963 [10], like sympathetic nervous operations system, some surgical methods were developed on the parasympathetic nervous system to treat asthma. Vagus nerve crossed from cervical access below divergence of the recurrent nerve. Right-vagotomy could be a candidate for treatment of asthma as proposed by Kappis [11]. Some authors tried to produce both methods in a two-stage; vagotomy and sympathectomy [12,13] but the percentage of positive results of surgical treatment of asthma remained the same as in the removal of the superior cervical sympathetic ganglion. Using this surgical method, the number of complications is increased due to the violation of the innervation of the internal organs.

In parallel, Szolcodi-Dimitrov JD in 1953 [14] suggested to remove nodes (2 to 5) of sympathetic trunk and pulmonary branches of the vagus nerve, providing break-resistant pathways of pathological reflexes and stopping reflex processes, leading to a vicious circle, and support asthmatic attacks. Studies have shown the stability of the bronchi against the histamine-like substances, and increased sensitivity to adrenaline. By this method 192 patients were operated. Directly after the operation, allergic and inflammatory processes in the asthmatic lung, bronchus spastic conditions disappeared and in parallel a series regression of secondary asthmatic complication such as emphysema, congestion in the pulmonary circulation were observed. Long-term results of surgical treatment of asthma by this method in a period of 5 to 9 years were studied in 100 patients. Excellent and good results were obtained in 60%, satisfactory - 30% and only 10% of patients with bronchial asthma were kept the same duration and strength. Among the complications of this operation, in one case respiratory arrest and in a few cases pneumothorax were observed.

Szokodi-Dimitrov method has attracted the attention of researchers studying surgical methods for the treatment of patients with asthma. Bronchospasm, hoarseness, Horner’s syndrome, thoracic duct injury, atelectasis, pneumonia, and respiratory arrest described as severe complications of the resection of sympathetic trunk and pulmonary branches of the vagus nerve. On the other hand, it should be noted that the root denervation of the lung by Szokodi-Dimitrov method in 44 patients, recommends to
restrain this operation [22] and the author observed significant impairment of respiratory function. The process of Szokodi-Dimitrov was experimented in animal models (31 dogs) by Alperin et al. They found that bronchial motor reactions were reduced for 2-4 months after surgery and motor function of the bronchi was restored after 6-8-12 months [16].

Not stopping there [17], carried out the autologous transplantation of the lungs. The authors found that; the lung devoid of connection with the central nervous system at the expense of the autonomic nervous system and humoral connections was capable of compensatory reactions and maintenance of gas exchange at the appropriate level. Oxygen saturation remained at the same level. The authors recommended the use of transplantation in cases where long-term therapeutic treatments and various surgical interventions appear ineffectual.

Morphological study showed that after 10-13 months, auto-transplanted lung structure and function of its cellular elements were returned to normal. Lung auto-transplantation was performed in 19 patients with bronchial asthma. In 2 cases, lung auto-transplantation performed on both sides. After surgery, 3 patients died. According to the authors, patients felt much better than before the operation. Long-term results studied in the period from 6 months to 5 years showed the increased airway resistance after autologous transplantation suggesting organic changes of the lung tissue.

Asthmatics generally have a hyperactive carotid body (chemoreceptor) and carotid sinus (baroreceptor). The hyperactivity of both chemoreceptor and baroreceptor reflexes, especially during the attack period, enhances pulmonary vagotonia [18]. The reflex arousal disorder also occurs with the introduction of chemical agents by selectively acting on chemoreceptors. Thus, carotid body serves as a transforming station between the lungs and the respiratory center of the medulla oblongata [19]. Chemoreceptors found in carotid bodies and aortic bodies are responsible for detecting decrease in blood pH by variation of carbon dioxide [20]. Recognizing the important role playback in the area of the carotid sinus allergic reaction, some authors believe that one of the points of action of serum and bacterial antigens in the body is sensitized chemoreceptors of the carotid sinus [21]. The interaction of antigen with carotid sinus chemoreceptors zone changes the metabolism of glomus cells. Emerging afferent impulses travel along the nerve to the nucleus of glossopharyngeal and vagus nerves, raising the tone of the latter. Stimulation of the vagus nerve contributes to the development of bronchospasm and increased secretion of bronchial glands.

Carotid body resection was also proposed for treatment of asthma. A simple surgical procedure including bilateral removal of carotid body (glomectomy) for correction of reflex disturbance in the behavior of the bronchial system was proposed for the first time by Nakayama In
1942 [21,22]. He reported a series of almost 4000 asthmatics treated with 81% improved for five years. Considering this observation, several authors [23-27] showed that unilateral glomectomy gave results similar to those reported by Nakayama. These observations were confirmed from a report of 350 patients by Sedwitz JL in 1963 [10].

The advantage and vulnerability of carotid bodies resection in bronchial asthma and their possible complications were reported by several authors [10,28-32]. Surgical removal of the carotid body resulted several damages such as death in sleep, pneumothorax in patients with a short neck, bleeding from the carotid artery, cardiac arrest, aneurysm and rupture of the enervated sinus separation superior thyroid artery from the external carotid artery, bleeding from the internal jugular vein and common vein face, mono and hemiparesis, hemiplegia, paresis of the recurrent glossopharyngeal nerve, laryngospasm, motor aphasia and increased blood pressure with symptoms of collapse.

The nerve of the pterygoid canal (Vidian nerve) also contained sympathetic and para sympathetic nerves. The vidian neurectomy procedure has been well described previously [33]. This method as a less invasive endoscopic posterior nasal neurectomy is considered the treatment of choice for patients with allergic rhinitis who require surgical intervention. According Agarwal PN, Bilateral Vidian neurectomy relieved completely all the rhinorrhea cases, all the nasal polyposis cases, 79-3% of headache and faceache cases and 55-5% of bronchial asthma cases [34,35].

So, to this day, dozens of surgical techniques used [36] were divided into three groups: 1) methods of tissue therapy; 2) a variety of interventions (blockade and surgery) on the autonomic nervous system; 3) methods of resection of pathologically changed areas of the lung [36]. Many of these methods because of life threatening complications and implementation difficulty have not been found widespread use not only in connection with the traumatic but low efficiency also. The risks associated with general anesthesia during these operations exceeded the positive results many times, and the possibility of bleeding due to the implementation of wide access troubling limited the range of surgeons able to perform these operations.

Nevertheless, interest in surgical methods for the treatment of asthma is not quenched, but rather at a new stage of development of medicine began to rise.

**Recent Advances in Surgery to Treat Asthma**

To introduce and develop a good clinical practice, a new surgical method accompanied with the minimum duration of the operation, and at least economic cost, less traumatic, routine preoperative preparation will be ideal for the treatment of asthma. Recent advances in surgery
to treat asthma were approved in two new methods; Bronchial Thermoplasty and Resection of the Internal Branch of the Superior Laryngeal Nerve as we recently reported [37].

**Bronchial Thermoplasty**

Bronchial thermoplasty (BT) is a novel procedure being developed as a potential treatment for asthma [38-44]. It delivers thermal energy to the large airways during a bronchoscopy to decrease the amount of bronchial smooth muscle (Figure 1).

Experience with animal studies has enabled us to develop appropriate reliable equipment, define therapeutic parameters and describe tissue effects of treatment [45]. Recent evidence showed that high temperature of bronchial thermoplasty disrupts the actin-myosin interaction through denaturation of the motor proteins disturbing the airway smooth muscle (ASM) spasm cascade [46].

The effect of bronchial thermoplasty could be also attributed to the theory that “pacemakers” within the proximal airways might control ASM contractility and that bronchial thermoplasty ablate these controlling centers, leading to the distal effect [47]. Another concept is that a phenotype of individuals with asthma has a prominent component of large airway inflammation and the modification in the adjacent structure in the airway leads to a decrease in the mucus gland hyperplasia, mucus production, and change in the airway autonomic tone, which could be a contributing factor to the response in bronchial thermoplasty [47].

![Figure 1: Bronchial thermoplasty. (A) Airway smooth muscle hypertrophy (an increase in individual muscle cell size) or hyperplasia (an increase in cell number) is one of the factors that may contribute to the exaggerated airway narrowing in asthma especially during an asthma attack. (B) Bronchial thermoplasty delivers thermal energy to the large airways during a bronchoscopy to decrease the amount of bronchial smooth muscle.](image)
out airway perforation or stenosis. BT was well tolerated in patients with asthma and resulted in reduced airway hyper-responsiveness that persisted for at least 2 years [45,48].

The European Respiratory Society/American Thoracic Society (ERS/ATS) task force in 2014 strongly recommended consideration of bronchial thermoplasty in adults with severe asthma in a context of institutional review board (IRB)-approved systematic registry or as part of a clinical study [49]. Benefits and harm of the procedure may be large and the long-term side effects are unknown. Studies are still needed to assess exacerbation rates and long-term effects on lung function. Studies evaluating which phenotypes would respond, effects on obstructed patients with an FEV1<60%, and the patients who received systemic steroids needed to be examined [50].

Resection of the Internal Branch of the Superior Laryngeal Nerve

The larynx is innervated by the internal and external branch of the superior laryngeal nerve, the recurrent laryngeal nerve and sympathetic nerve. Conventionally, the internal laryngeal nerve is described as sensory, the external laryngeal nerve as motor, and recurrent laryngeal nerve as mixed. The internal laryngeal nerve is sensory down to the vocal cord, the recurrent laryngeal nerve is sensory below the vocal cords and there is overlap between the territories innervated by the two nerves at the vocal cord themselves.

The superior laryngeal nerve arises from the middle of the inferior vagal ganglion, and in its course receives one or more communication from the superior cervical sympathetic ganglion: most frequently, the connection is with the external laryngeal nerve. The superior laryngeal nerve is divided into two branches, a smaller, external and a larger, internal branch- approximately 1.5 cm below the ganglion: rarely both branches may arise from the ganglion.

Resection of the internal branch of the superior laryngeal nerve (ib-SLN) for first time was proposed by Ulmer WT [51], Schlenkhoff D [52] and Melnikov VM [53] as a surgical treatment of CBA. This was a novel approach and a turning point in the clinical handling of CBA. However, this innovative approach was progressively abandoned in the face of certain post-operative problems due to the invasive surgery involved 35 years later, another approach through a minimum-invasive surgery was proposed by Kurbon and their colleagues [37] in which they showed that ib-SLN resection was an easy and practically safe method to obtain a permanent relief for a large number of patients from chronic bronchial asthma and asphyxia resulting from severe crisis (Figure 2 and Figure 3). The ib-SLN nerve was identified by using the optical zoom for magnification and unilateral resection was performed on the ib-SLN following well-rehearsed precision technique and use of micro toolkit. The patients were placed in supinator position. The method was applicable with a mini-
mum possible financial burden, both for pre-operative preparation of the patients or for post-operative care [37].

Figure 2: Anatomic localization of internal branch of the superior laryngeal nerve: The larynx is innervated by the internal and external branches of the superior laryngeal nerve, the recurrent laryngeal nerve and sympathetic nerve. Internal branch of the superior laryngeal nerve as a sensory and parasympathetic nerve derived from superior laryngeal nerve.

This method can be used as an adjunctive therapy in the complex treatment of patients with bronchial asthma of infectious-allergic, mixed and atopic diseases. The indication for resection of the internal branch of the superior laryngeal nerve is for the reversibility of the bronchial obstructive, which is defined in the preoperative period of pharmacological tests. In 83% of cases, it proved to be reversible bronchial obstruction and 68.2% of cases gave positive results, out of which 23.8% of patients in the future asthma attacks were absent [37].

Figure 3
3(A): To accurately determine access to on trigonum caroticum (bounded superiorly posterior m.digastricus, lateraly-m.sternocleidomastoid and medialy-m. superio omohyoideus), the access line within this triangle focusing on the upper edge of the thyroid cartilage was marked; (B): Red line and black line shows lower border of hyoid bone and upper border of thyroid cartilage respectively; (C): Local infiltration anesthesia performed with a solution of 1% lidocaine with epinephrine (1: 100,000) from outside to inside layers, as well as on the sides of the treated area to block all cutaneous sensory nerve branches suitable to the wound; (D): The Incision of the layers - skin and subcutaneous tissue with Fascia superficialis and m. platysma dissected in the same plane. Then, stepping back from the edge of the skin wound of 0.5 cm is cut deeper-situated; (E, F): At this stage, the gap between the lower edge of the hyoid bone and the upper edge of the thyroid cartilage should find (the search area of 2 to 2.5 cm in diameter); (G,H): After ascertaining the correct anatomical choice resected 0.5-1 cm (arrow) from the trunk of the internal branch of the superior laryngeal nerve.

Although the mechanism of action of ib-SLN resection is not currently completely understood, it should be considered as a valid and potentially valuable option for patients who have severe persistent asthma and who remain symptomatic despite inhaled corticosteroids and long-acting beta-2 agonists. Because of cholinergic control of inflammation, partial resection of vagal nerve [54,55] may be implicated in the modification of of neuroimmune axis in chronic bronchial asthma.

**Concluding Remark**

Opening airway in asthmatic patients is the first objective. All proposed methods; medication or surgical for treatment of asthma still remains an actual problem of medicine.

Surgical techniques for the treatment of asthma have experienced many periods of ups and downs. Some ways because of the inefficiency, traumatic and life-threatening postoperative complications remained in history while others - still used for improvement and have a right to exist in the complex treatment of asthma along with conservative therapy.

In the future, biomaterial implantation for recanalization of bronchial airway, targeting of bronchial smooth muscle by gene therapy using small interfering RNA as well as using autologous stem cells therapy for reconstruction of bronchial wall may be the new ways for minimal invasive treatment of asthma.

**References**


asthma-statistics/


12. Levit VS. Sympathectomy or vagotomy in bronchial asthma. Physician work. 1926; 7: 592-599


evaluation and treatment of severe asthma, European Respiratory journal. 2014.


