

Diagnosis and surgical treatment of tracheal cicatricial stenoses: literature review

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ABSTRACT

Aim: To study of the data about the results of tracheal cicatricial stenoses treatment with the goal of further improvement of its results on the basis of diagnosis enhancing, identification of factors of prognosis of the disease and by conducting a differential analysis of tactics of surgical treatment with the use of minimally invasive interventions.

Materials and Methods: We have identified contemporary literature sources on the topic of modern directions of treatment of tracheal cicatricial stenoses and their complications. The studied material has been summarized and represented in the form of literature review in this article.

Conclusions: To increase the quality of treatment of patients with tracheal cicatricial stenoses and their surgical complications an important role is played by objective formation of groups at risk of complications development and prognosis of the disease dynamics. Successful solution of the problem is related mostly to the highly informative diagnostics, reliable determination of severity of disease, as well creation of multidirectional classification of tracheal cicatricial stenoses. These issues may not be considered completely solved, they require further study. All of the above dictates search of new effective methods of treatment of the indicated pathology and proves relevance of the topic. The stated information emphasizes necessity of improvement of surgical tactics of patients with tracheal cicatricial stenoses.

KEY WORDS: surgical treatment, tracheal cicatricial stenoses, endoscopic interventions

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INTRODUCTION

In spite of the progress of surgical techniques the number of patients with tracheal cicatricial stenoses remains high. Tracheal cicatricial stenosis is one of the most serious complications which arise as a result of prolonged orotracheal intubations, tracheostomies, neck injuries with damage to the trachea [1].

Many issues of pathogenesis, diagnostics, surgical treatment and prevention have been largely studied, annual increase of patients with this pathology equals to approximately 5% [2].

It is well known that up to 25-30% of surgical interventions on the trachea are accompanied with various complications, as a result of which 10% of patients die [3].

Patients with tracheal cicatricial stenosis are observed during a long period of time, are repeatedly hospitalized into medical institutions, they undergo complex reconstructive operations which do not always lead to the patient's recovery.

According to the data of a number of authors up to 25% patients remain disabled after the surgical interventions they underwent as a result of chondromalacia, large scars and tissue fibrosis [4].

According to the data of the World Health Organisation (WHO) 93 people per 1000 of population suffer injuries, poisoning and other effects of external causes which make from 7,7 to 8,1% in the general structure of hospital morbidity [5].

The main cause for tracheal cicatricial stenosis is long-term artificial ventilation of lungs (ventilator) as a result of severe combined trauma, major surgical interventions, and severe somatic pathology. Up to 25% of patients in the intensive care unit are on ventilators for more than a week. According to a number of authors frequency of complications of long-term mechanical ventilation through a tracheostomy or intubation tube is up to 80%. Out of all complications tracheal cicatricial stenosis makes up to 25% of cases. The share of post intubation tracheal stenoses in the structure of morbid-

ity makes from 14 to 45%, share of post tracheostomy stenoses makes from 51 to 73% [6].

Neck injuries with damage to the trachea occupy the third place among the causes of tracheal cicatricial stenoses, making from 4,8 to 12% of the number of diseases [6]. Idiopathic tracheal stenosis occurs in 1-2,9% cases [6].

Among the known factors leading to tracheal cicatricial stenosis the main one is the influence of the intubation tube cuff on the tracheal wall. In spite of use of low-pressure cuffs in the modern resuscitation practice, this problem remains acute. The main traumatic factor is considered to be the excess pressure in the cuff of intubation tube in relation to the capillary pressure in the mucous trachea.

A number of factors can be identified related to direct mechanical trauma of trachea leading to formation of cicatricial stenosis. They comprise damage to the cartilage tissue during tracheostomy, trauma to the tracheal wall by the free end of the tracheostomy or intubation tube [7].

Other factors which aggravate damage to the mucous membrane of the trachea and lead to chronic inflammation is reflux of gastric and duodenal contents followed by aspiration, autoimmune process by the type of reaction of the delayed type to cartilage collagen [7].

Under compression syndrome in patients with nodular goiter such complications may arise as difficult intubation caused by the presence of difficult airways. «Difficult airways» (DA) are all the clinical situations under which as a result of various combinations of anatomic or/ and functional changes in patients and/ or irrational actions of a professional predicted and unpredicted difficulties with provision of effective ventilation through a face mask, supraglottic airway device, difficulties with trachea intubation, performing of cricothyroidotomy arise or there are various combinations of the indicated situations, which create potential or direct threat to the development of critical violations of gas exchange. To identify difficult airways in patients including those with compression syndrome, scale El-Ganzouri is applied [8].

AIM

The purpose of the research is study of the data about the results of tracheal cicatricial stenoses treatment with the goal of further improvement of its results on the basis of diagnosis enhancing, identification of factors of prognosis of the disease and by conducting a differential analysis of tactics of surgical treatment with the use of minimally invasive interventions.

MATERIALS AND METHODS

We have studied modern, accessible to us, literary sources for the last ten years on the topic of modern directions of treatment of cicatricial stenosis of the trachea and its complications in adults. The studied material is summarized and presented in the form of a literature review in this article.

In the presented review of literary sources, the opinions of various world authors are cumulative. Own research results are the subject of scientific development and will be further presented in specialized scientific journals.

In this article, the analysis of the course and possibility of treatment of this pathology in children was not the purpose of the work.

REVIEW AND DISCUSSION

ETIOLOGY AND PATHOGENESIS OF TRACHEAL STENOSIS. CLASSIFICATION OF TRACHEAL STENOSIS

The basis of tracheal cicatricial stenosis lies on pathological process leading to the replacement of the normal wall of scarred trachea with the tissue which narrows the lumen of the respiratory tract. This is often accompanied by destruction of the cartilaginous trachea leading to the loss of the framework of the tracheal wall, occurrence of tracheomalacia [8].

The trigger of occurrence of cicatricial stenosis is the development of a purulent-inflammatory process, necrosis of the mucous trachea resulting in rough scar after critical ischemia of the tracheal wall [9].

Frequency of occurrence of narrowing of the trachea against the long-term artificial ventilation of the lungs, according to the data of a number of authors makes from 0,2% to 25%. It is impossible to estimate reliably the frequency of this complication occurrence due to great variability of the terms of its occurrence. Tracheal stenosis is often diagnosed only several months after artificial ventilation or performance of tracheostomy [10].

In the first half of the previous century the main cause for cicatricial stenosis of the respiratory tract occurrence were specific infectious diseases, such as diphtheria croup, tuberculous lesion, scleroma, syphilis, actinomycosis. In the middle of XX century the main etiologic factor in the formation of cicatricial stenosis became mechanical damage to the trachea [11].

Since the mid-1970s due to the development and wide use of ventilator and tracheostomy the leading etiological factor of the disease became iatrogenic damage to the trachea. With the aim of ventilator they used orotracheal and tracheostomy tubes with cuffs that exert pressure on the tracheal wall, which further leads to ischemia, necrosis and finally formation of scar tissue [12].

In some patients cicatricial stenosis of the respiratory tract develops in the absence of an obvious cause: in such cases it is classified as idiopathic. As a rule pathological process in such patients is localized in the subclavian part of the larynx and the cervical part of the trachea [13].

Today the main etiological factor of cicatricial stenosis development is mechanical damage of its wall as a result of trauma under various resuscitation measures and manipulations. Most often nowadays trauma to the trachea has iatrogenic nature and occurs during artificial ventilation through an intubation or tracheostomy tube, or as a result of complications during a tracheostomy or tracheal intubation [12].

According to the data of authors the highest percentage of complications (up to 18,5%) was observed in patients who underwent circular resection due to post-intubation tracheal stenosis [14].

This is related to the presence of chronical inflammatory process in tracheobronchial tree, presence of areas of tracheomalacia, impaired blood supply to the tracheal wall after its injury, including those outside the area of scar process, severe somatic status of patients after a long-term treatment in the intensive care unit. During interventions for idiopathic stenosis the percentage of complications is much lower (6,6%) in spite of the fact that during idiopathic stenosis laryngotracheal resections were also performed [15].

All the processes described above are more pronounced with post-tracheostomy stenosis. Having a history of tracheostomy is an unfavorable factor and it increases frequency of postoperative complications.

At present there is no unified classification of tracheal cicatricial stenosis. The variety of classification is related to the specialization of the author and provided data of surgical interventions. Thus for example in the earliest classifications proposed by otolaryngologists the main attention was paid to localization of scar process in relation to the vocal folds, their involvement to the scarring process. The extent of cicatricial changes has not received close attention due to low prevalence of radical resection operations [16].

A number of foreign authors offered classifications based on localization of cicatricial stenosis in relation to the tracheostomy: narrowing of the trachea, cranial tracheostomies, caudal tracheostomies, narrowing of the tracheal segment at the site of tracheostomy [17].

Otolaryngologists offered a classification which differentiates stenosis by the degree of narrowing of the airway lumen: 1 degree – up to 50% of trachea lumen, 2 degree – 51-70% of trachea lumen, 3 degree – 71-99% of trachea lumen, 4 degree – tracheal atresia. The classification described above does not reflect

localization, extent of cicatricial changes; presence of a tracheostomy, areas of tracheomalacia. Nevertheless the provided classification is still most frequently used in the foreign practice [18].

Starting from the mid 60-s treatment of cicatricial stenosis of the trachea became the prerogative of thoracic surgeons, radical intervention came into practice, it allows to reach satisfactory trachea lumen within one operation – circular resection of the trachea. Correspondingly more attention was paid to the extent of cicatricial changes as a main factor which limits performance of resection.

The offered classification based on dividing of stenoses into primary ones caused by a pathological process in the wall of the trachea, and secondary ones caused by compression of trachea from outside. Stenoses were classified into long (more than 2 cm) and limited (up to 2 cm). The author also classified all stenoses by narrowing of trachea lumen into 3 degrees (I degree – narrowing by 1/3; II degree – from 1/3 to 2/3; III degree more than 2/3) [11].

This classification was improved and completed later, with cicatricial stenoses of the trachea classified by: etiology – post-resuscitation, post-intubation, post-tracheostomy, post-traumatic, postoperative, idiopathic; by localization – subfold department (with damage to folds, without damage to folds), cervical trachea, thoracic trachea, combined lesions; by the degree of narrowing – 1 degree (0,9- 0,7 cm), 2 degree (0,7-0,5 cm), 3 degree (less than 0,5 cm); by prevalence – limited (up to 2 cm), long (more than 2 cm); by anatomical form of the lesion – front-side walls, circular narrowing, atresia; by the condition of the walls of trachea: with tracheomalacia, without tracheomalacia; by the presence of a tracheostomy – with a tracheostomy, without a tracheostomy [6].

At present the most complete and convenient in practice are classifications of tracheal cicatricial stenoses with a transition from absolute to relative values, as the length of trachea, its lumen are individual for each patient and depend on anthropometric data, anatomical and physiological features of the body [1].

Stenoses are classified:

- 1) by etiology: post-intubation, post-tracheostomy, post-traumatic, idiopathic;
- 2) by localization: larynx (with damage to the subfold, vocal folds), cervical part of the trachea, upper thoracic, middle thoracic, suprabifurcation parts of the trachea, combined lesions;
- 3) by the narrowing degree: 1 degree (lumen narrowed by 1/3 of diameter of respiratory tract), 2 degree (from 1/3 to 2/3 of diameter), 3 degree (more than 2/3 of diameter);

- 4) by prevalence: 1 degree – less than 15% of all the trachea length of a particular patient; 2 degree – from 15 to 30%; 3 degree – from 30% to 60%; 4 degree – more than 60%.
- 5) by the anatomical form of the lesion: anterolateral wall, circular narrowing, atresia;
- 6) by condition of the walls of trachea: with tracheomalacia, without tracheomalacia;
- 7) by the presence of a tracheostomy - with a tracheostomy, without a tracheostomy [19].

Lack of a united generally accepted classification of tracheal cicatricial stenosis does not permit to assess reliably the frequency of complications and mortality after surgical interventions for tracheal cicatricial stenosis depending on etiology, localization, length of process, presence of a tracheostomy and areas of tracheomalacia in the patient.

DIAGNOSIS OF STENOTIC LESIONS OF THE TRACHEA

Tracheal stenosis is diagnosed on the basis of anamnesis, complaints of a patient, characteristic clinical picture, radiological and endoscopic examination data. A pathognomonic symptom which allows to judge on the narrowing of respiratory tract is noisy difficult breathing. However, stridor in cicatricial stenosis of the trachea must be differentiated from an attack of bronchial asthma, inspiratory stridor in paralytic and cicatricial stenosis of the larynx. The severity of the clinical picture depends on the degree of the trachea narrowing. Thus, at the I-II degree of narrowing – difficult breathing may arise only during physical exertion, and at III-IV degree – patients more often have stridorous breathing even at rest [19].

Patients complain on shortness of breath of various degrees of expressiveness, hoarseness, sputum which is difficult to evacuate. Stridor at tracheal cicatricial stenoses is mixed as a rule. In case of localization of pathological process in the cervical part of trachea inspiratory component prevails, in case of stenosis of thoracic trachea or in the presence of tracheomalacia – expiratory one [1].

During objective examination condition of a patient even with compensation of tracheal stenosis is unstable as far as asphyxia can occur when the preserved lumen is blocked by bronchial secretions. Breathing is conducted with the help of auxiliary muscles, position of a patient is forced. Retraction of the flexible muscles of the neck and chest is observed. Cough with a metallic hue and difficulty in expectorating sputum attract attention. Inspiratory shortness of breath, stridorous shallow breathing, cyanosis, and heart failure may occur [20].

The most frequent symptom of tracheomalacia is expiratory stridor, which is accompanied by respiratory attacks and cyanosis, which are aggravated during exertion. The given symptoms most frequently arise during 1-6 weeks after extubation, as far as within this time formation of scar tissue in the wall of the trachea with subsequent narrowing of the tracheal lumen takes place [20].

Today the most informative methods of instrumental diagnostics are X-ray, endoscopic methods of research and research of the function of external breathing. To assess the condition of external breathing function standard methods of research are used: spirometry, pneumotachometry, and body plethysmography. Decrease of vital capacity of the lungs and speed indicators of forced breathing allow to diagnose tracheal narrowing of I degree, and also roughly determine the degree of tracheal stenosis. However, because of considerable change of bronchial resistance reliable relations between these indicators and the degree of tracheal narrowing cannot be identified [21].

Extremely inconvenient seems to be the examination of patients with a functioning tracheostomy. That is why indicators of the function of external breathing are better studied in patients which undergo rehabilitation after restoration of tracheal lumen [22].

Taking into account all the stated above these methods can be considered to be auxiliary in diagnostics of tracheal stenosis. In the algorithm of examination of patients with tracheal cicatricial stenosis an important place belongs to radiological diagnostics. At present leading role among radiological methods of diagnostics belongs to multispiral computed tomography with three-dimensional image reconstruction. The advantage of computed tomography is fact that it provides information not only on the degree and prevalence of airway lumen narrowing, but also on the condition of walls of trachea and peritracheal space [23].

Computer processing of the image with the help of special programs allows receiving a visual three-dimensional reconstruction of the image of trachea and pathological changes located in it [24].

Number of identified stenosis during multispiral computed tomography corresponds to the data of endoscopic examination. According to the data of authors axial and coronal images obtained during multispiral computed tomography tend to overestimation of stenosis degree, and virtual bronchoscopy and sagittal images tend to underestimation. The indisputable advantage of multispiral computed tomography is safety of the examination, therefore, multispiral computed tomography is the method of choice for patients with

subcompensated breathing with critical narrowing of the trachea [24].

Nowadays, magnetic resonance imaging is actively used in the examination of patients with tracheal stenoses. The technique allows conducting research of patients with subcompensated breathing, but unlike X-ray research methods during magnetic resonance imaging patient does not receive radiation exposure. Relative disadvantages of the research are related to the physical principles of the research: performing of MRI is absolutely contraindicated if patients have implanted pacemakers and other foreign bodies in the body that are made of magnetic materials. Moreover the possibilities of digital processing of the obtained image do not allow building three-dimensional reconstructions. Besides performing of MRI is rather long procedure possible only for patients with compensated and sub-compensated stenosis [5].

The standard of diagnostics of stenotic lesions of respiratory tract nowadays is laryngotracheoscopy. Examination of mucosa of the trachea and larynx through an endoscope makes it possible not only to identify the pathology, to determine its degree of narrowing and extent, localization, but also permits to assess the severity of tracheobronchitis, carry out rehabilitation of tracheobronchial tree, to obtain material for bacteriological study. Results of cultures of bronchial secretions and determination of sensitivity of microorganisms to antibacterial drugs allow achieving high efficiency of the conducted antibacterial therapy and decreasing the risk of infectious complications [20].

In presence of critical narrowing of trachea diagnostic procedure can be transformed into a therapeutic manipulation – endoscopic expansion of the airway lumen [25].

SURGICAL TREATMENT OF TRACHEAL CICATRICIAL STENOSES WITH THE USE OF MINIMALLY INVASIVE INTERVENTIONS

Tracheal cicatricial stenosis is life-threatening disease characterized by replacement of normal structures of the tracheal wall with coarse scar tissue which narrows the respiratory tract lumen. For total recovery from this pathological state complex, traumatic surgical interventions are necessary. Many patients are forced to remain disabled, live with a tracheostomy, periodically visiting specialized medical institutions [26].

Nowadays due to achievements of modern medicine, anesthesiology and possibility of long resuscitation, lives of many most seriously ill patients with difficult independent breathing as well as patients in a state of asphyxiation can be saved. To achieve this goal various

methods of artificial ventilation of lungs with the use of intubation or tracheostomy tubes are applied [26].

Tracheostomy is perceived as the method of choice for long-term artificial lung ventilation (ventilator) in critically ill patients. However if the rules of medical care for patients during connection to a ventilator are violated, defects of tracheostomy may cause no less life-threatening conditions later. One of such severe complications is tracheal cicatricial stenosis. Due to wide implementation of artificial ventilation of lungs into clinical practice and increase of general injuries number of patients with this pathology increases steadily [27].

Treatment of tracheal cicatricial stenoses at present remains one of the most complicated and not completely solved problems in surgery. Frequency of development of tracheal cicatricial stenoses after long-term artificial ventilation according to different authors varies from 0,1 to 25% on average equals to 2-3% [27].

Etiological factors and pathogenesis of tracheal stenoses are well studied. Nowadays the majority of all cicatricial stenoses are iatrogenic in nature. The main reason of increase of number of acquired tracheal stenoses is ever wider application in clinical practice of artificial ventilations of lungs through intubation or tracheostomy tubes. Ventilator performed through a naso- or orotracheal tube for more than 3 days, with a higher probability leads to persistent cicatricial stenoses and deformations of the trachea and larynx lumen [23].

The basis of pathogenesis of post-intubation and post-tracheostomy stenosis is trauma with inflatable cuff or the end of the tube of tracheal walls with further accession of infection. The trigger of the disease is tracheal wall damage and development of purulent-necrotic process in it [28].

The periods of time between extubation and the onset of symptoms of cicatricial stenoses vary from several hours to several months, but usually do not exceed 6 weeks. Later manifestation of stenosis symptoms is also possible. In clinical practice shortness of breath and coughing are often associated only with lung diseases and special methods of trachea study are not carried out. This is the reason for stenosis to be often diagnosed late [29].

The fact that first endoscopic intervention which is carried out in specialized institutions in many patients (more than 40%) is performed as an emergency, quite often in the first hours, proves the importance of timely diagnosis of the disease at the pre-hospital stage [29].

Instrumental methods of diagnostics comprise radiological, endoscopic and studies of the function of external breathing. The main tasks of these methods are determination of stenosis localization, its extent,

condition of the larynx above and below stenosis, general condition of a patient [3].

Role and place of each method is identified individually depending on the severity of a patient's condition, the level of equipment of a medical institution and training of medical personnel.

In emergency situations when a patient has stridor at rest or with a slight physical exertion the method of choice is diagnostic laryngotracheoscopy. If necessary, diagnostic examination can be transformed into endoscopic operation. In the shortest period of time and with a minimum trauma with the help of special techniques it is possible to restore the lumen of respiratory tract in majority of patients. Such tactics allows refusing from emergency surgical operations accompanied with high mortality or unjustified tracheostomies, which later complicate treatment and worsen the prognosis. The decisive method of diagnostics of tracheal cicatricial stenoses is endoscopic one [30].

Laryngotracheoscopy allows not only to detect stenosis but also evaluate the mucous membrane of larynx and tracheobronchial tree, degree of expressiveness of its inflammatory changes, with the help of endoscopic ruler measure in millimetres the diameter of the narrowed area and determine the degree of stenosis, determine its length with accuracy up to 1 cm, distance to the main anatomical landmarks (bifurcation of the trachea, vocal folds, tracheostomy) [16].

Besides in the postoperative period it is possible to evaluate the healing process of the tracheal anastomosis with the help of tracheobronchoscope and determine the effectiveness of operation treatment [14].

The main method of tracheal cicatricial stenoses treatment is surgical one. The only radical operation which allows restoring airway patency and removes scar tissue is circular resection of trachea with intertracheal anastomosis. Other operations including endoscopic ones are considered to be palliative, and indications for them must be reasonable and restricted. Nevertheless resection of trachea is rather complicated and traumatic intervention, for this reason it requires a great experience from a surgeon. Number of possible complications according to the authors, Murgu S. et al., may reach 15%, and postoperative mortality may vary between 1,5 and 12,4% [24].

For part of patients such operations are impossible or not indicated due to prevalence of scar changes, severity of the condition, high level of operation risk or anatomic peculiarities. One of conditions for their performing is absence of tracheostomy at the time of operation [16].

Wide application of endoscopic method of treatment has given a chance to refuse from emergency operations, and this in turn decreases the frequency of post

operation complications and total mortality. Providing quick and adequate restoration of the airway patency, the method allows liquidating chronic hypoxia, which creates favorable conditions for the scheduled examination and choice of optimum tactics of treatment.

One of the first interventions performed on the patient with decompensated tracheal cicatricial stenosis is emergency restoration of airway patency. To carry out this task various endoscopic methods can be applied. They can be classified into two big groups:

- Methods aimed at removing part of scar tissue from the trachea lumen (mechanical, physical).
- Methods aimed at expansion of the narrowed part of trachea.

Physical methods of influence are based on the use of properties of different types of radiation or high-frequency currents to destroy biological tissues. These methods can be applied in two modifications – to destroy scar-granulation tissues in a circle or their dissection along [3].

The main advantage of electrosurgical method lies in the fact that thermal tissue damage is minimal and general availability and low cost of equipment makes it the most attractive method. Serious disadvantages comprise the presence of contact of the electrode with tissues, as a result of which carbon deposits and welding of the electrode occur, which can lead to bleeding. At the application of all the physical methods of destruction of scar-granulation tissues there is high probability of damage to adjacent unchanged areas of trachea. Later it will inevitably lead to development of inflammatory process, which in turn leads to involvement of ever more tissues to the scarring process and can have negative impact on the results of treatment [4].

The safest ways in this regard are methods aimed at expansion of the stenosis - bougie and balloon dilatation. These interventions in patients with critical tracheal stenosis are usually performed first. The most available method of one-time expansion of lumen in patients with cicatricial stenosis is bulging with tubes of a rigid bronchoscope. As a result of such influence local rupture of scar occurs. Consistently using tubes of increasing diameter, one can most quickly (within 0.5-1 minute) and quite effectively restore the lumen of the respiratory tract with the evacuation of the secretion accumulated in the substenotic department. This operation can be performed with plastic bougie and a set of intubation tubes put on the fiberscope. In the presence of tracheostomy bougie or tubes are sometimes passed through the tracheostomy hole under local anesthesia [2].

Currently, expansion of the narrowed area before the introduction of endoprosthesis is successfully used [30].

According to some authors balloon dilatation allows restoring the trachea lumen with minimum trauma to the mucous membrane. Apart from temporary expansion of the narrowed part of trachea this method can be applied as an independent method of treating scar stenosis after lung transplantation, circular resection of trachea, radiation therapy [31].

An important advantage of operations of one-time endoscopic expansion of tracheal cicatricial stenoses is the fact that they allow quickly and effectively expand the lumen, eliminate ventilation disorders, and stabilize the patient's condition, at the same time trauma to the intact parts of the trachea is minimal [25].

A significant drawback of the method is unstable effect of the treatment with development of restenosis in a considerable part of patients. So as an independent method of treatment it is applied only in a restricted number of patients according to strict indications. «Bright» period lasts from several hours to several months, most often 7-14 days. Then regardless of the method of endoscopic influence on the scar tissues in a considerable part of patients the lumen of the trachea narrows again. The best results were obtained only when conducting repeated expansion of membrane-like stenosis [3].

At present universal method of restoring airway patency, it forces specialists to resort to combined methods. For example, photodestruction, electrocoagulation or mechanical removal of tissues supplemented with bougie or balloon dilatation. Opinions of specialists regarding application of the endoscopic methods mentioned above in emergency situations differ. Thus some authors believe that the only way to help with decompensated stenoses in seriously ill patients is emergency tracheoscopy with recanalization of the trachea using a laser, they emphasize that endoscopic laser interventions are simple, effective and safe way of restoring tracheal patency [30].

Other researches note that in emergency situations, in the absence of a tracheostomy, when hypoxemia increases after anesthesia, only the tube of a rigid bronchoscope can be used to quickly expand the lumen and restore adequate breathing [15, 22].

Thus different authors apply different methods of endotracheal impact on scar tissue. Each one chooses one or several most convenient ways of restoring airway patency. The choice of the method is affected by the personal experience of a doctor, as well technical capabilities of a clinic as for a specific clinical situation.

The most important and not fully solved problem for today in the surgery of cicatricial tracheal stenoses is maintaining the lumen of the respiratory tract at a level sufficient for adequate breathing. For provision

of this task cylindrical structures (stents) are installed in the lumen of the trachea for a long time, preventing its narrowing [20].

The choice of method and way of installation depend on localization of stenosis, presence or absence of tracheostomy, general condition of a patient and personal experience of a doctor. If the situation regarding the severity of a patient's condition allows determining further tactics during the day, then in order to provide reliable patency of the respiratory tract an orotracheal intubation tube is used [2].

In the presence of tracheostomy and low localization of stenosis a split section of thermoplastic intubation tube, extended tracheostomy cannula or T-tubes are used. With "immature" cicatricial stenoses, some authors leave the tube in the trachea for 3-4 months, during which the scar tissue matures in the form of cicatricial compaction of the walls of the trachea itself, which keeps its lumen from collapsing [17].

In the absence of tracheostomy it is advisable to use endoprosthesis. In case of emergency when the stenosis is localized in the cervical and upper thoracic parts of the trachea, the most accessible method was previously considered to be the placement of a tracheostomy below the narrowing and the introduction of a tracheostomy tube. If the narrowing was localized in the middle or lower third of the thoracic part of the trachea, when the length of conventional tracheostomy tubes was insufficient, extended tracheostomy tubes were used. In the absence of tracheostomy tube of the required length sometimes individually split section of thermoplastic tube was sometimes used. Advantage of such constructions lied in the fact that being individually fitted they as a rule did not damage the trachea walls, they were easy to pull out and insert again. However, despite the obvious advantages, all the methods had a significant drawback - the need for the imposition and long-term support of a tracheostomy, which significantly worsens the patient's quality of life and the conditions for performing a subsequent surgical operation [9].

The introduction into clinical practice of prostheses completely located in the trachea, as well as the development and improvement of methods of their installation using endoscopic techniques allowed in many cases to completely refuse from emergency open operations. Nowadays majority of researches believe that in the absence of tracheostomy it is more appropriate to use endoprosthesis [11].

Prosthetic trachea as an organ has been developed for many years all over the world. Those applied at the first stages with the goal of replacing the cartilage framework, grafts, as well as monolithic, fine-porous, mesh

and combined alloprostheses caused granulation and cicatricial stenosis. All the prostheses were inserted into trachea during open surgical operations [19].

Requirements for all the endoprosthesis are as follows: non-toxicity, biological inertness, stability in body tissues, sufficient rigidity, strength, elasticity and flexibility, sufficient drainage function, which allows to remove mucus from the respiratory tract, impermeability to liquid, air and bacteria, easy availability and possibility of sterilization [15].

After inserting endoprosthesis in all the patients at the beginning (from several days to weeks) problems may arise related to the presence of foreign body in the trachea lumen – reflex cough and increased tracheobronchial secretion. Inner surface of the prosthesis contributes to the deposition of sputum, due to this obturation of the lumen may occur. This process can be prevented when using aerosols with regular mechanical removal of overlays during tracheoscopy. Tracheoscopies with sanitation must be performed regularly, and during the first once every three months. Due to the contact of foreign body with the trachea wall granulomas can be formed. In case of their detection granulomas must be removed mechanically or with the help of laser and electrocoagulation. With recurrent granulomas brachytherapy can be used [30].

It is known that dilatation of tracheal cicatricial stenoses with the help of stents allows not only temporarily restore adequate patency of the airways and prepare a patient for the planned operation but also contributes to the formation of reliable fibrous framework around the protector [4].

Nowadays in literature (Bourinet V et al.) there is no consensus as for how long a stent should be kept in the area of stenosis for the lumen to be formed. Authors believe it to be appropriate for endoprosthesis to stay in the trachea for approximately 4 months [15].

There is a report where the duration of endoprosthesis in the tracheal lumen varied from 5 to 24 months. Remote results are traced back to 1 to 5 years. After

removal of the stent stable positive (good and satisfactory) results were obtained in 13 patients, unsatisfactory ones in 9 patients. In all the patients with localization of stenosis in the cervical region, as a result of the treatment, a lumen sufficient for breathing was formed. When the stenosis was localized in the chest such a result was obtained in only 1 patient out of 10. Out of this the author makes a conclusion that temporary insertion of a stent of different construction for cicatricial stenosis in the cervical part of trachea allows to achieve stable effect in all the operated patients but for stenosis localized in the thoracic area this variant of treatment is of low efficiency. Thus results of long-term dilatation of cicatricial stenosis on the stents are controversial. The range of positive results is very wide and includes from 20 to 94,6% [30].

This condition must be related to the lack of uniform criteria in the selection of patients and insufficiently large number of patients in whom the technique of treatment by dilatation on the endoprosthesis was used. Besides it should be noted that in the literature researches completely divide the results of treatment with tubular structures which are fully inserted into the tracheal lumen, and therapeutic tracheostomy tubes that require a functioning tracheostomy, which is fundamental.

CONCLUSIONS

Summing the information obtained by the data of the literature review, we can state the lack of generally accepted concept of application of mini-invasive interventions for tracheal stenosis. In the available literature there are no clearly formulated indications and contraindications for their application.

In the publications in this filed there are no researches devoted to the comparative analysis of endoscopic and traditional surgical interventions for of tracheal stenosis. All of it dictates the necessity of conducting further researches in this important section of clinical surgery.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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