Diagnostic video bronchoscopy in children

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ABSTRACT

Recent years have been marked by significant progress in pediatric science, including pediatric pulmonology and endoscopy, which has led to significant advances in the diagnosis, treatment and prevention of respiratory diseases in children. The algorithm for choosing the optimal research method, which gives the most complete spectrum of information of interest, has been determined; highlights the modern ideas about the preparation and methods of anesthesia during bronchoscopic manipulations in children.

Keywords: children, bronchoscopy, inflammation, confocal endomicroscopy.

Introduction

Bronchoscopy occupies one of the leading places in the diagnosis of respiratory diseases in children. In many cases, bronchoscopy is of decisive importance both for determining the activity and length of the pathological process, taking material for a biopsy, and for making a diagnosis. In isolated domestic and foreign clinical and experimental works devoted to bronchoscopic studies in children, indications for bronchoscopy are contradictory, ambiguous and are based mainly on clinical and radiological signs of respiratory diseases [1]. This, in turn, complicates the selection of patients for bronchoscopic examination and the choice of the most informative diagnostic method. The studied literature and extensive clinical experience in the use of flexible and rigid bronchoscopy directly in pediatric practice made it possible to systematize and optimize not only the indications, preparation, but also the technique of execution and a differentiated approach to each research method, depending on the age anatomical features and the specifics of the pathology of the child's respiratory tract.

Materials and research methods

For the period from January 2000 to June 2019, 1355 children with suspected foreign bodies of the respiratory tract were inpatient treatment and examination in the department of thoracic surgery of the 2 SamMI clinic. The main group of children consisted of children of the first 7 years of life (88.6%), of which the most numerous was the group of children of early age (56.3%). Of the 1355 children hospitalized with suspected foreign bodies of the respiratory tract, 407 (30.0%) had the diagnosis excluded, and 948 (70.0%) had the diagnosis confirmed. Among the examined patients, 858 boys (63.3%) prevailed, compared with 497 girls (36.7%). Children from rural areas prevailed over urban areas 4.5 times, 1107 (81.7%) versus 248 (18.3%). 1162 (85.8%) children were admitted in a moderately serious condition. A serious condition was noted in 167 (12.3%) patients. An extremely serious condition when seeking help was observed in 24 (1.8%) children. In addition, children who aspirated organic foreign bodies into the respiratory tract 759 (80.1%) significantly prevailed, compared with children who aspirated inorganic foreign bodies 172 (18.1%). 17 (1.8%) have self-withdrawal.

Research results and discussion

Bronchoscopy is indicated for any diseases of the chest or lungs, in which the bronchial tree is directly or indirectly involved. Indications for diagnostic bronchoscopy are: ongoing unexplained cough and wheezing; unexplained shortness of breath or wheezing; suspicion of congenital malformations of the respiratory tract; recurrent infections of the respiratory tract or lungs; persistent changes on the chest x-ray; atelectasis of the lung, lobe or segment; suspicion of a tracheoesophageal or bronchoesophageal fistula; tumor of the mediastinum; chemical or thermal burns of the tracheobronchial tree; tracheobronchial strictures and stenoses; lung abscess; extubation of the trachea after prolonged artificial lung ventilation (ALV); setting, position assessment, sanitation and decannulation of the tracheostomy tube; condition after surgery for lung reconstruction; chest trauma; bronchogenic cysts; cystic fibrosis; bronchial asthma; diagnostic bronchoalveolar lavage; bronchoscopic lung biopsy.
There are no absolute contraindications for bronchoscopy. R. E. Wood noted that "the only absolute contraindication to bronchoscopy is the absence of rational indications." Relative contraindications: acute inflammatory and infectious diseases; pulmonary-cardiac and cardiovascular insufficiency of the III century; paroxysmal tachycardia; atrioventricular block; disorders of the blood coagulation system; intolerance to anesthetics and drugs for general anesthesia; extremely serious condition of the patient, when the specification of the diagnosis cannot influence the treatment tactics.

Depending on the medical equipment used, rigid (RBS) and fibrobronchoscopy (FBS) are distinguished. The first rigid bronchoscopy was performed by Gustav Hillian in 1897. At the beginning of the 20th century, this method has become widespread in the USA and Great Britain, and then in other countries of the world. The first fiberoptic bronchoscopy was performed by Shigeto Ikeda in 1968 [1, 2]. Recently, the predominant number of examinations is carried out using flexible bronchoscopes. Preparation of a patient for a bronchoscopic examination begins with a thorough examination: clinical and biochemical blood analysis, determination of blood group and Rh factor, coagulogram, tests for HIV infection, viral hepatitis, syphilis. You also need the results of a general urinalysis, electrocardiographic and x-ray studies, or computed tomography (CT) of the chest organs. Any endoscopic examination is performed on an empty stomach to avoid the throwing of food or liquid debris into the airways during vomiting or coughing.

For rigid bronchoscopy, breathing bronchoscopes "Karl Storz" are most often used, provided with a ventilator. RBS can be performed with preserved spontaneous breathing using inhalation anesthetics or against the background of mechanical ventilation. The first type of anesthesia is used quite often, however, insufficient depth of anesthesia and hypoventilation can cause laryngospasm and bronchospasm [1, 3]. For the induction and maintenance of anesthesia during RBS, halogen-containing inhalation anesthetic sevoflurane or intravenous (iv) propofol is most often used [4, 5]. Muscle relaxation is provided by succinylcholine. After intravenous administration of muscle relaxants, the trachea is intubated with a bronchoscopy, followed by bronchoscopy. Mechanical ventilation is carried out through the tube of the bronchoscope. Tubes of rigid bronchoscopes have a wide canal with a small outer diameter, which allows you to freely perform bronchial sanitation even in newborns (including premature babies). The presence of an additional channel for the introduction of instruments provides the possibility of biopsy and surgical endobronchial interventions without the development of alveolar hypoventilation. If video monitoring with the study recording is necessary, it is possible to connect a video camera with direct and side optics [5, 6].

Despite the provision of adequate ventilation during endoscopic examination, RBS has a number of disadvantages: the risk of injury, edema of the vocal cords and subglottic space increases due to the age-related anatomical features of the child's airways. The difficulty of access and examination of the vocal cords, the impossibility of visualizing the upper lobe and segmental bronchi - all this limits the use of RBS in pediatric practice. To minimize complications, it is necessary to adequately select the size of the rigid bronchoscope tube in accordance with the age group [6]. Of course, one of the key points of successful bronchoscopic examination is taking into account the age-related anatomical features of the child's airways. The small size of children's airways, the difference in the anatomical structure of the larynx and different pathologies corresponding to the age group are characteristics that make the endoscopic examination of a child unique and different from that of adult patients.

The first anatomical landmark (when performing bronchoscopy with a flexible endoscope) is the epiglottis, which covers the entrance to the larynx. In children, it is proportionally narrower than in adults, tubular or omega-shaped. With the end of the endoscope, the epiglottis is pressed to the root of the tongue and the larynx is examined. The child's larynx also differs in anatomical structure. Its location in the neck is higher, cricoid cartilage is located near the IV cervical vertebra. With age, the cricoid cartilage gradually descends to the level of the VI-VII cervical vertebra, which corresponds to the localization in adults. The size of the larynx of a newborn is 1/3 of the size of adults [6]. The second anatomical landmark is the true vocal folds located under the false ones. They look like shiny whitish ribbons. At their posterior edge there are elevations formed by arytenoid cartilages. The space bounded by the inner edge of the true vocal folds and the inner surface of the arytenoid cartilage is called the glottis. A normal glottis in a child has a very narrow lumen (about 7 mm from top to bottom and about 4 mm from left to right), so swelling of 1 mm can cause airway obstruction by 35%. Also, due to the fact that cartilage, muscles and submucous tissues are softer and looser, a more significant inflammatory reaction with edema develops, which leads to a significant decrease in the lumen of the glottis [5, 6]. The third anatomical landmark is the keel of the tracheal bifurcation - the carina. In the keel of the tracheal bifurcation, a crest, anterior and posterior triangle are distinguished. Karina can be sharp, flattened, wide, S-curved, saddle-shaped.

When examining the trachea, first of all, attention is paid to its shape. So, in newborns, it is funnel-shaped, its lumen is narrow, the back wall has a wider fibrous part, the walls are more pliable, the cartilage is
soft, easily compressed, but well visualized during endoscopic examination. The mucous membrane of the trachea is pale pink in color, rich in blood vessels, with underdeveloped mucous glands and elastic tissue. The secretion of the glands provides a 5 micron layer of mucus on the trachea surface. The growth of the trachea occurs in parallel with the growth of the trunk, most intensively - in the first year of life and in puberty. Features of the structure of the trachea in children lead to the easy occurrence of stenotic phenomena in inflammatory processes, especially against the background of prolonged mechanical ventilation; often define tracheitis, laryngotracheitis or tracheobronchitis. [4] In diffuse bronchitis of II and III degrees of intensity of inflammation, dystonia of the trachea and main bronchi may occur, expressed in protrusion of the membranous part into the lumen of the trachea and bronchi during exhalation [7]. Examination of the bronchial tree begins from the side with the least pronounced changes, determined in advance by radiographs or CT scans. If the changes are expressed equally on both sides, then the examination begins from any half of the bronchial tree.

By the time the baby is born, the bronchi are well-formed. The growth of the bronchi is intense in the first year of life and in puberty. Their mucous membrane is richly vascularized, covered with a layer of mucus. The right bronchus is, as it were, a continuation of the trachea, it is shorter and wider than the left. This explains the frequent ingress of a foreign body into the right main bronchus. The bronchi of children of the first year of life are narrow, their cartilage is soft, muscle and elastic fibers are not yet sufficiently developed. The tenderness of the mucous membrane of the bronchi, the narrowness of their lumen, the tendency of the mucous membrane to generalized edema and swelling explain the frequent occurrence of bronchitis in young children with the syndrome of complete or partial obstruction [4, 6].

Normally, the lumen of the bronchi is free, oval or round in shape, the mucous membrane is pale pink in color with a delicate vascular pattern, the mouths of the mucous glands are punctate, cartilaginous rings are emphasized, the bronchial liquid transparent secret evenly covers the mucous membrane throughout, in the lumen those of the bronchi are not visualized [7].

In order to correctly assess the prevalence of the inflammatory process along the tracheobronchial tree and the degree of changes in the mucous membrane, endoscopists use the classification proposed by J. Lemoine in 1965: diffuse bronchitis, spreading to all visible bronchi; partial diffuse bronchitis - the upper lobe bronchi and their segmental branches are intact; severely limited bronchitis - one branch is affected. The listed forms can be one or two-sided, accompanied by tracheitis. For a more accurate diagnosis, the concept of the degree of intensity of inflammation of the mucous membrane has been introduced. The apparent intensity of inflammation can be of 3 degrees [8].

With bronchitis I st. the mucous membrane is pale pink in color, with moderate edema, "blurred" vascular pattern; the relief of the cartilaginous rings is somewhat worn out, the mouths of the mucous glands are not determined, the lumens of the bronchi of the 3-4th order are somewhat narrowed, but the bronchi can be traced up to the 5th order inclusive; in the lumen of the bronchi - a moderate or large amount of mucous secretion.

Bronchitis II Art. characterized by pronounced edema and bright red hyperemia of the bronchial mucosa, the vascular pattern is not visualized. The inter-annular spaces are smoothed, the orifices of the segmental and subsegmental bronchi are narrowed due to mucosal edema. Moderate contact bleeding of the mucous membrane is noted. In the lumen of the bronchi there is an abundant amount of mucopurulent, viscous or liquid secretion.

Endoscopic picture of III degree bronchitis. The intensity of inflammation is manifested by hyperemia of the mucous membrane of a purple-cyanotic color, its edema, due to which the mouths of the segmental bronchi appear to be point, their spurs are expanded, inactive, there is a longitudinal folding of the mucous membrane. There is a pronounced contact bleeding of the mucous membrane in contact with a bronchoscope. The inter-annular spaces are completely smoothed into the level with the cartilaginous rings due to mucosal edema. The secret is purulent, viscous or liquid, in a very large amount, requiring constant aspiration.

The endoscopic picture of hypertrophic bronchitis has the following characteristic features: the mucous membrane is gray, the vascular pattern is not traced. The cartilage contours are erased. Vitreous edema and longitudinal folding of the mucous membrane are observed. The mouths of the lobar and segmental bronchi are sharply narrowed and deformed due to mucosal edema. Interlobar and intersegmental spurs are thickened, limited in mobility. Moderate contact bleeding of the mucous membrane with instrumental palpation is noted. In the lumen of the bronchi - a liquid mucous or mucopurulent see in atrophic bronchitis, a gray mucous membrane with an enhanced or thickened vascular pattern is visualized, cartilaginous rings are emphasized, deepening of the inter-annular spaces, and expansion of the mouths of the mucous glands are noted. The mouths of all visible glands are gaping, carina and intersegmental spurs are
razor sharp. In the lumen of the bronchi, a moderate amount of mucous or mucopurulent secretion is found.

According to IK Esipova (1995), deforming bronchitis can be both the final stage of development of any bronchitis and be systemic in nature, developing from the initial lesion of separate lobar and segmental bronchi after pneumonia. Distinctive features of the endoscopic picture are uneven narrowing of the lobar, segmental and subsegmental bronchi, deformation of the spurs, tortuosity of the mouths of the bronchi, restriction of mobility. The mucous membrane in the area of the spurs and orifices - with linear whitish scars, deforming and narrowing the mouth of the bronchi. The pattern of cartilaginous rings is smoothed, deformed, in the lumen of the bronchi - mucopurulent contents [7].

An integral part of diagnostic bronchoscopy in pediatrics is direct biopsy and diagnostic bronchoalveolar lavage (BAL). To obtain cells, extracellular proteins, lipids located on the epithelial surface of the alveoli and in the terminal parts of the respiratory tract, the BALF diagnostic method is used, which makes it possible to increase the sensitivity and specificity of diagnostic bronchoscopy. BAL is a safe and fast procedure with a low complication rate, even in newborns. In terms of diagnostic value, it is comparable to an open lung biopsy [9]. Analysis of fluid after BAL not only allows the study of proteins and inflammatory mediators, but also facilitates the differential diagnosis between infectious and non-infectious causes of pulmonary infiltration. Most often BAL is used to diagnose alveolar proteinosis, hemosiderosis, lipoid and interstitial pneumonia, sarcoidosis, allergic alveolitis, idiopathic fibrosis, and many other diseases [6].

To perform BAL, the bronchoscope is brought to the orifice of the subsegmental bronchus. A sterile isotonic sodium chloride solution heated to a temperature of 36-37 °C is used as a lavage liquid. The liquid is injected through a short catheter inserted through the biopsy channel of the bronchoscope, and immediately aspirated into the sterile container. The solution is injected three times at the rate of 1 ml per 1 kg of body weight for each involved segment or lobe identified on CT. The first injection is sent for bacterial inoculation, the others - for cytological examination and analysis of the BAL fluid solution [6, 7]. Further, to obtain tissue for cytological and histological examination, direct biopsy is performed using biopsy forceps or a scarifier brush (brush biopsy).

After examining the pathological formation, biopsy forceps are introduced through the endoscope channel and, under visual control, they are brought closer to the biopsy site, positioning perpendicular to the formation from which the material is taken. The forceps are opened, rest against the formation, from which the biopsy is taken, then the branches are closed, and the forceps are removed together with the cut-off fragment. The obtained biopsy fragments have a size of 0.1-0.2 cm. They make smears-prints for cytological examination, and the biopsy fragment is immersed in a vial with a 10% formalin solution.

**Conclusion**

To obtain material from the focus of inflammation, a brush biopsy is also performed using a special scarifier brush in a protective case, which protects the material from contact with the flora of the upper respiratory tract. Under visual control, a sterile scarifying brush in a case is introduced into the subsegmental and then into the smaller bronchus, which communicates with the focus of inflammation. The brush is pushed out of the case and several scrubbing movements are made, then the brush is re-inserted into the case, and the latter is removed with it. Several smears are made on dry glass slides. To diagnose ciliary dyskinesia, the material obtained by brush biopsy is placed on a glass slide with saline, after which it can be examined using electron microscopy for the presence and movement of cilia for 30 minutes [6, 7].

**References**

