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Original Article

Clinical analysis of bronchoscopic electrocoagulation in pediatric patients

Caiyun Ni, Huafeng Yu, Xiaorong Han, Chen Meng, Yanqing Zhang

Department of Respiratory Interventional Radiology, Qilu Children's Hospital of Shandong University, Jinan 250022, P. R. China

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Abstract: This study is to explore the efficacy and safety of bronchoscopic electrocoagulation treatment for pediatric disease of poor ventilation. Seventy pediatric patients of airway stenosis and obstruction as well as pharyngeal and laryngeal cysts received bronchoscopic electrocoagulation treatment, including 15 cases of epiglottic cyst, 13 cases of cicatricial hyperplasia of fibrous tissue after trachea intubation, 5 cases of foreign body in bronchus and 37 cases of endobronchial tuberculosis. Before and after the last electrocoagulation treatment, treatment efficacy was evaluated by examining the patients' clinical presentations and lesions in airway under bronchoscope, examining chest CT and pulmonary function, and estimating pulmonary atelectasis and ventilation function. Seventy cases of pediatric patients were treated by bronchoscopic electrocoagulation, with the total treatment number of 106 times. Among them, 66 cases were treated with marked efficacy and 4 cases were with effective treatment. There was no invalid treatment. The treatment efficacy was 100% without complications. Bronchoscopic electrocoagulation treatment is a fast, effective and safe therapeutic method in treating airway stenosis and obstruction, such as foreign body in bronchus, granulation tissue hyperplasia, and epiglottic cysts. It is worthy of being widely applied in clinic.

Keywords: Airway obstruction, atelectasis, bronchoscope, electrocoagulation, pediatric patients

Introduction

In recent years, the occurrence rate of congenital and acquired airway disease is increasing. The application of bronchoscopy and electrocoagulation treatment makes it possible to diagnose and treat a variety of difficult airway and respiratory diseases [1-3]. For example, bronchoscopic electrocoagulation treatment can unblock airway obstruction in many airway diseases, such as severe airway stenosis due to scar tissue after trachea intubation or thoracic surgery, epiglottic cysts, airway obstruction induced by granuloma, bleeding in trachea or bronchial cavity and benign tracheal or bronchial tumors, especially the ones with pedicles at the base [4-7]. Heat produced by electrocoagulation can lead to coagulation, necrosis, gasification and carbonization, as well as vascular occlusion of tumor tissues [8]. Since the current density through surgical site is much larger than that through electrode plates, the tissues near the cathode will not be burned during treatment [9].

When the diameter of the main airway narrows to less than 50% of the original diameter, patients may have breathing difficulties and poor treatment outcomes [10]. Previously, when the diameter of airway narrows to 2/3 of its original diameter, surgical resection is the only approach [11, 12] to remove narrowed trachea, bronchus and related lung tissues. The surgical resection approach is a difficult procedure, which can cause complications and big trauma, and may remove some of the normal lung tissues [13]. Compared with surgical resection treatment and other medical treatment, bronchoscopic electrocoagulation treatment is with better efficacy, less trauma and quicker recovery. For example, electrocoagulation treatment can rapidly remove stenosis, avoiding open-chest surgery or trauma [14, 15]. In adults, bronchoscopic electrocoagulation treatment has been widely used in the palliative treatment for cancer in lower respiratory tract [16, 17]. However, the use of bronchoscopic electrocoagulation treatment in children is rarely reported. In this study, the efficacy of bronchoscopic

Table 1. Efficacy of bronchoscopic electrocoagulation treatment in 70 pediatric patients

Treatment efficacy	Airway lesion	Cases	Number of treatment	Complications	Adverse reactions
Marked efficacy (66 cases)	Cicatricial hyperplasia airway stenosis	13	14	0	3
	Epiglottic cysts	15	15	0	0
	Foreign body in bronchus	5	5	0	0
	Endobronchial tuberculosis	33	61	0	0
Effective treatment (4 cases)	Endobronchial tuberculosis	4	11	0	0
Total		70	106	0	3

electrocoagulation treatment for treatment of respiratory tract stenosis and obstruction in 70 pediatric patients was analyzed.

Methods and materials

Patients

Seventy pediatric patients were recruited in Qilu Children's Hospital of Shandong University, from September 2010 to October 2013, with disease course of one month to two years. They had airway stenosis and obstruction caused by various reasons. Among them, there were 15 cases of epiglottic cyst, 13 cases of cicatricial hyperplasia caused by trachea cannula, 5 cases of granulation tissue hyperplasia caused by foreign body in bronchus and 37 cases of endobronchial tuberculosis. Diagnosis of tuberculosis was in accordance with Children TB diagnostic criteria of Zhu Futang Practical Pediatrics [18]. All patients received bronchoscopy examination (**Table 1**).

Prior written and informed consent were obtained from the guardians of the patients and the study was approved by the ethics review board of Shandong University.

Instruments

EVIS LUCERA BF-260 electronic bronchoscope, with thermal probe of CD-6C-1 column electrocoagulation head, was purchased from Olympus (Tokyo, Japan). ERBE VI0200D APC2 respiratory endoscopy electrosurgical workstation system was obtained from ERBE Elektromedizin GmbH (Tubingen, Germany). BeneView T8 monitor was purchased from Mindray (Shenzhen, China).

Bronchoscopy electrocoagulation treatment

No anticoagulant or antiplatelet drugs were taken before surgery. Chest CT was performed to evaluate the site of airway stenosis and patient's condition. Airway stenosis due to external tube compression was excluded. Bronchoscopy examination was conducted to preliminarily assess the granuloma size, airway stenosis degree of cicatricial hyperplasia, as well as texture, location, size and epiglottis pressure degree of epiglottis cyst.

Patients were fasting for 4-6 hours before surgery. Bronchoscope was put into the airway through laryngeal mask. Electrocoagulation treatment monitor was adjusted to automatic mode, with output power of 20-40 W. Electrocoagulation lasted 2 to 4 seconds each time and multipoint electrocoagulation was performed from the central part of the lesion to other parts of the lesion. Trachea cannula was maintained for 3 to 5 days after electrocoagulation treatment, and was removed when local edema decreased and tissue necrotic disappeared. Patients were re-examined at 4 to 7 days after bronchoscopic electrocoagulation treatment. Biopsy forceps were used to remove necrotic tissues after electrocoagulation.

Efficacy of treatment

The efficacy of treatment was assessed based on improvement of clinical symptoms and physical signs, removal of granuloma, improvement of airway stenosis and pulmonary function and scope of atelectasis. Marked efficacy was defined based on the following features. After treatment, there was no breathing difficulty. Tidal volume or vital capacity increased more than 100%. Under bronchoscope, the diameter of narrowed airway widened more than 2/4 and the size of epiglottic cysts reduced more than 2/3. The scope of atelectasis narrowed more than 2/3 as revealed by chest imaging. Effective treatment was defined on the following characteristics. After treatment, breathing difficulty improved. Tidal volume increased 50-100%

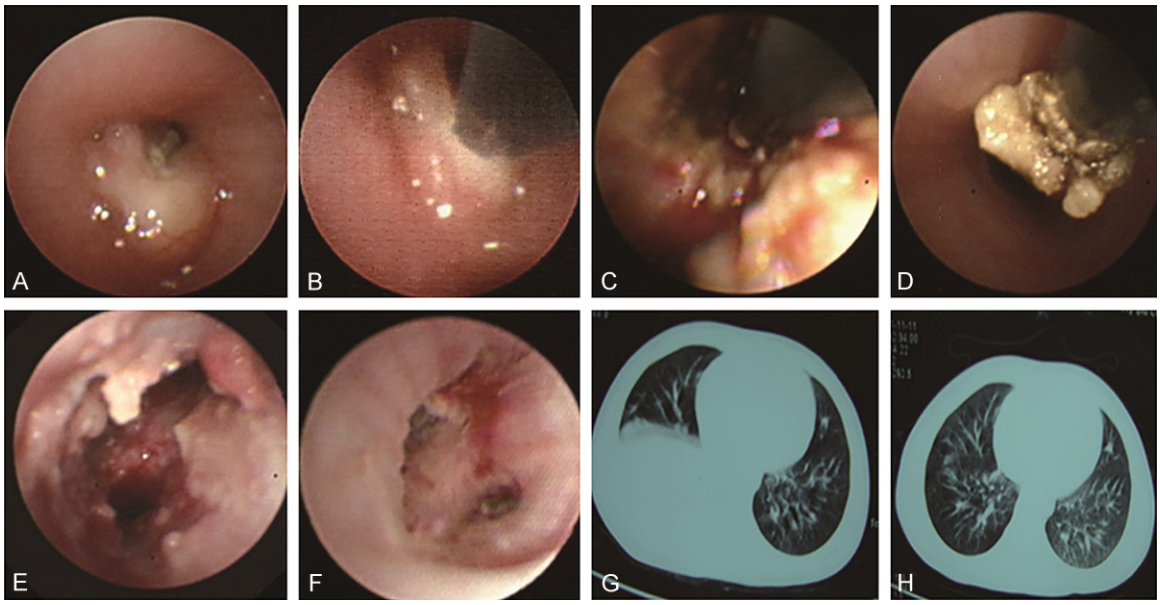

Figure 1. Bronchoscopic electrocoagulation treatment in one pediatric case with endobronchial tuberculosis. The images of bronchus under bronchoscope and images of chest by CT scanning were shown. The male pediatric patient was aged 2 years and 4 months. He was admitted because of tuberculosis caused atelectasis for more than 2 months. When admission, he was conscious, with shortness of breath, rough lung breath sounds, and diminished breath sounds in right lower lung. His heart rate was 118 beats/min, with regular rhythm. After bronchoscopy electrocoagulation treatment, granuloma was removed. After treatments with freezing, balloon dilatation and lavage, distal airway was gradually unblocked, and atelectasis disappeared in chest CT. At 1, 3, 4, 6 months after discharge, bronchoscopy was performed. Trachea and bronchus was patent, without restenosis or proliferation of granuloma. Chest CT showed no recurrence of atelectasis. A. Bronchus opening in the inferior lobe of right lung under bronchoscope before treatment. B. Bronchus opening in the inferior lobe of right lung under bronchoscope during electrocoagulation treatment. C. Bronchus opening in the inferior lobe of right lung under bronchoscope during electrocoagulation treatment. D. Bronchus opening in the inferior lobe of right lung under bronchoscope during electrocoagulation treatment. Incrustation caused by electrocoagulation was observed. E. Bronchus opening in the inferior lobe of right lung under bronchoscope at 4 days after electrocoagulation treatment. F. Bronchus opening in the inferior lobe of right lung under bronchoscope at 2 weeks after electrocoagulation treatment. G. Chest CT before electrocoagulation treatment. Atelectasis was observed in inferior lobe of right lung. H. Chest CT at 2 months after electrocoagulation treatment. Atelectasis of inferior lobe of right lung disappeared.

and the diameter of narrowed airway widened 1/4 to 2/4 under bronchoscope. The size of cysts decreased 1/3 to 2/3 and atelectasis scope narrowed 1/3 to 2/3 in chest imaging. Invalid treatment was defined based on one of the following clinical manifestations. There was no improvement in the clinical presentations. The diameter of narrowed airway did not widen or widened less than 1/4. The size of cysts decreased less than 1/3. The scope of atelectasis was not improved or narrowed less than 1/3 in chest imaging.

Results

Short-term efficacy evaluation

The changes in clinical presentations, bronchial lesion, chest image and pulmonary function before electrocoagulation and after the last electrocoagulation treatment were evaluated for treatment efficacy (**Table 1**). A total of 106 times of electrocoagulation treatment under bronchoscope were performed in 70 pediatric patients. The treatment efficacy was 100%, with 66 cases of marked efficacy and 4 cases of effective treatment. Thirteen cases of cicatricial stenosis, including 12 cases of subglottic stenosis, and 1 case of right main bronchus stenosis, were treated with marked efficacy. And, 15 cases of epiglottic cysts were also treated with marked efficacy. There were 5 cases with bronchial foreign bodies in airway, which induced granuloma hyperplasia and caused airway obstruction and atelectasis. They all had marked efficacy after electrocoagulation. In addition, 33 cases with endobronchial tuberculosis were treated with marked

efficacy. Endobronchial tuberculosis induced granuloma tissue and caseous tissue and caused atelectasis in these patients. Effective cases included 4 cases with endobronchial tuberculosis. In these 4 effective patients, granuloma tissue and necrosis tissue was removed without re-generation. Patent airway was observed. There was no patient with invalid treatment.

The treatment in 70 pediatric patients went smoothly, without airway perforation, bleeding or other complications. Three cases had the adverse reaction of hypoxemia. They were all babies less than 6-month old and had relatively severe airway obstruction. When there was hypoxemia, the electrocoagulation treatment was paused. Patients were given oxygen for about 1 min until hypoxemia disappeared. Then the electrocoagulation treatment was continued. There were no other complications in these 3 cases after treatment. **Figure 1** showed the images of bronchus opening in the inferior lobe of right lung under bronchoscope and the chest CT scanning images of one case with endobronchial tuberculosis before and after electrocoagulation.

Long-term efficacy

Follow up of 1 to 36 months was performed in 70 pediatric patients. The clinical symptoms, chest CT, bronchoscopy and pulmonary function were examined and evaluated. During follow-up, trachea and bronchus was patent. No further proliferation of granuloma, obstructive pneumonia or atelectasis was observed. Epiglottis was patent and showed normal size and morphology. Trachea and bronchus were both patent without restenosis or granuloma generation.

Discussion

The life quality of most patients with significant airway stenosis is seriously impaired by severe dyspnea, which produces a sense of suffocation or even respiratory failure. The etiology of airway stenosis involves many factors, such as endotracheal intubation, tracheal cicatricial hyperplasia, tracheal trauma, obstruction by benign tumor, epiglottis cysts, tuberculosis and foreign body, etc [19-22]. The common treatment methods for tracheal stenosis include surgery, bronchoscopy and electrocoagulation. Compared with surgery, electrocoagulation, which has been widely used in adults, has better treatment efficacy, less trauma and better recovery [16, 17]. However, trachea of children is relatively narrow with thin walls. It is difficult and risky to remove airway stenosis with surgery in children. In this study, we analyzed the efficacy of bronchoscopic electrocoagulation treatment for treatment of respiratory tract stenosis and obstruction in 70 pediatric patients.

Among the enrolled 70 pediatric patients, 15 cases had epiglottic cyst obstruction (21.4%), 13 cases had cicatricial hyperplasia airway stenosis (18.6%), 5 cases had foreign body in bronchus (7.1%) and 37 cases (52.3%) had endobronchial tuberculosis. These were all benign pediatric tracheal diseases. The total treatment number of electrocoagulation was 106 times. After treatment, no complications were observed. Only 3 cases had the adverse reaction of hypoxemia, which was relieved by oxygen inhalation during treatment.

Traditionally, epiglottic cysts are treated surgically via endoscopic excision [23]. Recurrence occurs if excision incomplete and multiple procedures may be necessary. On the other hand, too much excision would cause big trauma in patients, especially in children. In this study, the 15 cases with epiglottic cysts were treated with marked efficacy after electrocoagulation. CT of epiglottis was performed before electrocoagulation to exclude diseases such as meningocele. At 4-5 days after treatment, patients were reexamined by bronchoscopy and necrotic tissues were removed. Patients' symptoms were relieved, such as immediate improvement in dyspnea, disappear of stridor sounds and choking relief. No postoperative recurrence was observed. The 13 cases had cicatricial hyperplasia airway stenosis because of long history of tracheal intubation. It is difficult and risky to perform surgery in these cases. Bronchoscopic electrocoagulation treatment could induce necrosis of cicatricial tissues, thus relieving airway stenosis and dyspnea. However, our results were inconsistent with a previous study by Zhang et al [24]. This inconsistence might be caused by different subjects used and different sample size. Foreign body in bronchus could induce the formation of granulation tissues [25], which further cause airway obstruction. To effectively remove foreign body and the granulation tissues, electrocoagulation

was carried out. Coagulation therapy has automatic hemostatic function. Therefore, after granuloma tissues were removed, foreign body was fully exposed with a clear vision and was removed smoothly. In China, tuberculosis is very common in children [26]. The effects of conventional anti-tuberculosis treatment on hypertrophic granulation tissues, caseous necrotic materials, cicatricial hyperplasia stenosis induced by bronchial tuberculosis is poor. In this study, the hypertrophic granulation tissues and caseous necrotic materials induced by bronchial tuberculosis were removed by electrocoagulation treatment. The electrocoagulation treatment was performed many times to completely remove those tissues. And, 33 cases were with marked efficacy and 4 cases were with effective treatment.

In summary, bronchoscopic coagulation has wide therapeutic indications, and its treatment efficacy is significant, safe and reliable. And, to avoid therapeutic risks, professionally trained operators are required.

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Disclosure of conflict of interest

None.

Address correspondence to: Caiyun Ni, Department of Respiratory Interventional Radiology, Qilu Children's Hospital of Shandong University, No. 23976, Jingshi Road, Huaiyin District, Jinan 250022, P. R. China. Tel: 13964166718; Fax: 0531-811-81597; E-mail: s81880205@163.com

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