Cold snare resection for the treatment of benign airway lesions

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Abstract

The objective was to assess the safety and outcome of cold snare technique used by flexible bronchoscopy in the treatment of airway benign neoplasms. The clinical data of 21 patients, who had airway benign neoplasm and were treated through the cold snare method in Sir Run Run Shaw Hospital, affiliated with the Zhejiang University, were retrospectively analyzed. The relief of the symptoms and occurrence of complications were observed and evaluated. All the tumors were benign and removed by cold snare. Postoperatively, we found that the treatment was completely effective in 12 patients, and there was a significant improvement in 7 patients and a moderate improvement in 2 patients, and no recurrence in follow-up visit. In conclusion, the cold snare technique is an economically feasible, safe, and effective method in the treatment of airway neoplasms.

Keywords: Bronchoscope, cold snare, vocal cords, trachea, bronchus; lesion, neoplasm, stenosis

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Introduction

The presence of airway lesions, which are commonly found in clinical work, may cause abnormal narrowing of the air passageways. The clinical presentation of these lesions is variable, and the most common signs and symptoms are hoarseness of voice, cough, sputum, hemoptysis, recurrent pulmonary infections, dyspnea (in varying degrees, depending on the location and extent of the obstruction), and even life threatening. Such lesions are usually detected by X-rays or endoscopic examination. They may occur secondary to tumors, trauma, tuberculosis, long-term endotracheal intubation, and oppression or invasion of the adjacent tumor.¹ In adults, benign lesions (mostly lipomas, leiomyomas, hamartomas, and inflammatory polyps) account for 20% of all tumors of the main airways.² As the number of cases/patients requiring operative interventions grows in critical care medicine, cardiothoracic surgery, and neurosurgery advance, the occurrence of intubation-related laryngotracheal stenosis also increases. It has been estimated that the incidence of postintubation or post-tracheostomy stenosis ranges from 10 to 19%.³ Sometimes, airway stenosis may be misdiagnosed and even lead to life-threatening conditions. Therefore, it is particularly important to find a pertinent approach to treat these cases of benign airway stenosis. Surgical treatments, such as tracheal resection and anastomosis, are relatively effective, but the high rate of complications in elderly patients or patients with

significant underlining co-morbidities should not be ignored. In the past 20 years, the endoscopic techniques for diagnosis and treatment developed rapidly, and endoscopic interventional therapy has played exceedingly important roles in the treatment of airway stenosis due to its short operation time, reduced pain, and the immediate relief of dyspnea and anoxia.⁴ The main endoscopic interventions include high-frequency electric snare, stent placement, balloon dilatation, laser ablation, argon plasma coagulation (APC), and cryotherapy.⁵ By the most common conservative methods for the treatment of airway benign neoplasms, mechanical debulking is achieved hot or cold biopsy forceps and high-frequency electric snare. The technique of removing the tumor by cold snare is similar to that of the use of biopsy forceps, and the major difference from the traditional high-frequency electric snare is that no electricity is utilized in the cold snare method. It is also different from cryotherapy. In this operation, a snare is used to remove the neoplasms mechanically at room temperature without attaching high-frequency electrical or cryotherapy equipment. The procedure is simple and cost-effective, and avoids the thermal damage to the adjacent tissue, which could decrease the complication rate. To further assess the safety, efficacy, and clinical application of cold snare in the treatment of benign airway lesions, we collected and retrospectively analyzed the clinical data of 21 cases treated by cold snare.

Subjects

Retrospective analysis of the clinical data was performed of 21 cases (14 males and 7 females; mean age 51.3 ± 12.8 years, range 28–78 years), in which the patients were diagnosed with airway neoplasms in Sir Run Run Shaw Hospital, affiliated to Zhejiang University, from January 2010 to December 2015. Their clinical findings included hoarseness of voice, cough, blood in the sputum, and dyspnea (range 1–26 months). Three cases of vocal cord neoplasms (with a diameter of 2–7 mm) detected by laryngoscopic examination were included in the investigation. Interventional therapy was required in these three cases, because they were not suitable for resection via suspension laryngoscopy. The tracheoscopy examination revealed the presence of pedunculated tracheobronchial neoplasm lesions with a diameter of 3 mm–18 mm in 15 cases of tracheal granuloma after tracheal intubation and tracheotomy, two cases of tracheal neoplasms, and one case of a left lower lobe neoplasm. Among them, a platelet count of $72 \times 10^9/L$ was established by the preoperative blood routine examination of one case revealed, but neither clotting problems nor history of blood system diseases was indicated. In one case, a patient with a vocal cord neoplasm used warfarin all the time due to rheumatic heart disease. His international normalized ratio was 2.39, PT was 25.4 s, activated partial thromboplastin time was 63.3 s. Warfarin was discontinued, and his therapy switched to low-molecular heparin seven days before the operation. There was no contraindication to tracheoscopy in these patients.

Apparatus and method

Equipment and preoperative preparation

(1) Equipment used: electronic bronchoscope (endoscopic system: OLYMPUS LUCERA CV–260, bronchoscope: BF1T260), cold snare (JIUHONG Medical Co., Ltd). (2) Preoperative preparation: The clinical histories of all patients were collected to find out whether there was a heart pacemaker implantation, severe high blood pressure, arrhythmia, severe liver and kidney impairment, allergy to narcotic and anticoagulant drugs, etc. Each patient underwent a standard preoperative assessment, including physical examination, routine laboratory tests, and computed tomography of the chest (18 patients with tracheal and bronchial lesions). Each patient was subjected to an initial diagnostic flexible endoscopy to identify the location and severity of the lesion. The degree of stenosis was estimated visually. Informed consent was obtained prior to each bronchoscopy procedure. The patients fasted for 8 h before the bronchoscope examination.

Anesthesia

Flexible bronchoscopy was performed under either general or local anesthesia. When the patients were treated by three-way laryngeal mask airway ventilation under general anesthesia, the bronchoscope was inserted through the mask, and the dosage of anesthetic was adjusted according to the patient's weight and condition. While the patients were under local anesthesia, 2% lidocaine was administered

via nebulizer inhalation for 20 min before the operation combined with intratracheal instillation of 2 mL–10 mL. During the operation, the patients breathed spontaneously with supplemental O₂ delivered through the nasal cannula. Patients' vital signs, such as ECG, blood pressure, and saturation of pulse oxygen (SPO₂), were closely monitored during the surgery.

Treatment process

When the neoplasm was seen under the bronchoscope, the operator deployed the snare through the working channel and adjusted the bronchoscope to a better position, ensuring the neoplasm was easy to trap. Cold snare was used to encircle and entrap the neoplasm and bring it down to the base of the stalk. When placing the snare, the operator had to ensure a circumferential view of the stalk and snare had been provided. Then, the snare was tightened and the neoplasm severed by pulling the snare as soon as it was in the proper position. The whole procedure was performed without delivering electric current to the snare. Then, the endoscope was withdrawn with the neoplasm attached to the snare or the neoplasm was clamped out by biopsy forceps. The neoplasm could also be sucked by endoscopy and removed along with the endoscope. We measured the size of the resected specimens and submitted them for histopathologic evaluation. If a remnant of the neoplasm was detected, we removed it again by the identical procedure to ensure that the entire suspicious lesion was completely excised. Hemostasis was achieved using adrenaline-soaked neuropatties (1 in 1000), icy normal saline, or by suction to minimize the bleeding into the lower respiratory tract. If the lesion could not be removed completely by cold snare and a greater remnant was present, or brisk bleeding (defined as spurting or diffuse and massive bleeding that continued for more than 5 min) was encountered, biopsy forceps electrocoagulation was performed on the wound to clean the wound and achieve hemostasis. The whole surgical process was carried out in the bronchoscopy suite by an experienced team. Otolaryngologists were needed to assist during the operation of three cases of vocal cord neoplasms.

Postoperative treatment

After the operation, the patients were sent to the Post Anesthesia Care Unit after general anesthesia and continuously fasted for four hours after waking. Patients who had received local anesthesia also fasted for 4 h postoperatively. All the patients were closely observed for appearance of hemoptysis, dyspnea, cough, and other clinical symptoms. At the same time, blood pressure, and SPO₂ were monitored and recorded. To review bronchoscope when necessary to observe the surgical wounds, and so on, the patients in the three cases of vocal cord neoplasms were requested not to speak for a week after the operation.

Evaluation of the effects

According to the symptoms of the patients before and after the interventional therapy, the chest computed tomography (CT) or lesion size was examined by bronchoscopy, and the

rate of the unobstructed airway, i.e. the curative effect, was judged and defined as follows: (1) completely effective: complete disappearance of hoarseness, cough, and dyspnea and completely cleared airway lesions. (2) Partially effective: the symptoms existing before the intervention, including hoarseness, cough and dyspnea, were alleviated. More than 50% of the lesion was cleared, and the airway opened again. (3) Slightly effective: the symptoms of hoarseness, cough, and dyspnea were slightly relieved. Less than 50% of the lesion was cleared, and the airway opened again. (4) Ineffective: all the symptoms were not mitigated; there was no objective evidence to support the improvement of the airway. Follow-up bronchoscopy was available two months later in all patients. The mean follow-up period was 217 ± 23 days, and no recurrence was noted.

Results

Therapeutic effect

Three cases of vocal cord neoplasms (Figure 1) and 18 cases of tracheal and bronchial lesions (Figure 2) were treated by

cold snare 25 times in total, with an average of 1.4 procedures per patient (range 1–3 procedures). Among them, five patients (23.8%) were treated with two procedures, and one patient (4.8%) was subjected to three procedures. In one case (4.8%), combined biopsy forceps was used to assist in removing the residual lesions tissue, and electrocoagulation was utilized in one case (4.8%) to achieve hemostasis after the resection. The clinical symptoms of patients before and after the treatment were comparatively analyzed, and reviews of the chest CT scans or bronchoscopy results were required to determine the changes in the size of the neoplasm and the rate of the unobstructed airway; then the curative effect was judged and assessed in accordance with the previously defined criteria—the effect was completely effective in 12 cases (57.1%), partially effective in 7 cases (33.3%), slightly effective in 2 cases (9.5%), and ineffective in 0 cases (0.0%).

Postoperative histopathology

The results of the histopathologic evaluation revealed that there were three histopathologic types of vocal cord

Figure 1 Vocal cord neoplasm in a 43-year-male patient. A picture/image of the neoplasm was taken before (a) and after (b) the cold snare resection. (A color version of this figure is available in the online journal.)

Figure 2 Post-tracheostomy benign tracheal stenosis in a 47-year-female patient who had a duration of cannulation for 90 days following cerebral hemorrhage operation. The formation of granulation tissue obstructed the tracheal before (a) and after (b) cold snare resection. (A color version of this figure is available in the online journal.)

neoplasms: squamous cell papillary hyperplasia, polyps of the vocal cords along with formation of submucosal abnormalities or inflammatory granulation polyp. Tracheal or bronchial pathology, respectively, was characterized by one case of fibro-fatty tissue, six cases of chronic active inflammatory reaction of the mucous membrane, 11 cases of chronic mucosal inflammation with the proliferation of granulation tissue and inflammatory exudation.

Complications and their management

Irritating cough and blood in sputum were the main symptoms during the operation. Intratracheal instillation of 2% lidocaine relieved these symptoms. There were no intra- and perioperative deaths. Procedure complications were relatively minor and manageable. During the operation, bleeding was present in six cases, in five of which it was stopped by repeated flushing of the wounds with diluted norepinephrine and iced saline. In one case, this procedure was combined with probe electric coagulation to cease the bleeding. Neither massive hemoptysis nor hemorrhagic shock was observed after the operation. No perforation, infection, and other complications occurred during or after the resection. No patient had obvious hemorrhage, including the patients with preoperative examination of thrombocytopenia and the one with rheumatic heart disease.

Discussion

The technique of surgical resection and end-to-end anastomosis is still considered to be the optimal treatment option for young patients with symptomatic benign tracheal stenosis.^{6,7} However, there is a recognized morbidity and even potential mortality associated with its application.⁸ Thus, endoscopic treatment should be considered in elderly subjects or in patients with significant underlying co-morbidities.⁹ Until now, the therapeutic approaches used in cases with airway stenosis have included stent placement, laser therapy, APC, mechanical dilation, and cryotherapy.¹⁰ Generally, stent placement is not appropriate for the treatment of benign airway stricture caused, and incidence of stent migration of 45% has been reported.¹¹ AND-YAG laser is commonly used to treat benign stenosis, because it provides excellent immediate and short-term results.¹² Nevertheless, its use is limited due to the total dependence of the rate of transition between vaporization and coagulation on the distance between the tissue and the tip. Moreover, it is difficult to maintain this distance constant to control the vaporization depth and predict the thermal effect.¹⁰ APC was introduced into flexible endoscopy in the 1990s¹³ and has become widely used in the treatment of benign or malignant lesions in the airway.^{14,15} Although the penetration depth of approximately 2 mm in APC is constant and predictable, and unnecessary damage to the adjacent tissue could be avoided, its efficiency is exceedingly low. Alternatively, mechanical dilation, cryotherapy, and stent placement are the options usually used for the treatment of benign web-like tracheobronchial stenosis. So far, the high-frequency electric snare has been considered to be particularly effective in removing pedunculated lesions

from the airway.¹⁶ In the present study, we used the cold snare resection technique and achieved good results. In this operation, we just need a snare removing the neoplasms mechanically at room temperature without attaching high-frequency electrical or cryotherapy equipment. Compared with the traditional neoplasm resection, cold snare is a safe and effective method that can also be employed for neoplasms of different sizes in the vocal cords and the tracheal or bronchial tube. Furthermore, the cold snare procedure has the following advantages over the high-frequency electric snare technique: (1) Cold snare could be used without electricity in the process of operation, contributing to the higher simplicity of the intervention; (2) Hot snare needs electricity in the process of operation and any mishandling of the operating time can result in the injury of the submucosal tissue caused by heat propagation. Complications such as hemorrhage of tracheal mucosa, perforation could occur in severe cases. When used for the therapy of vocal cord neoplasms, heat snare is more likely to burn the surrounding normal tissue, whereas the cold snare technique could effectively decrease the incidence of these complications; (3) it can be difficult to assess the histologically definitive diagnosis of neoplasms due to cautery artifacts in the treatment of small neoplasms via high-frequency snare. In contrast, the neoplasms resected by cold snare can be fully evaluated; (4) when working with a heat energy source like high-frequency snare and electrocautery, the fraction of inspired oxygen (FiO₂) should be limited to 0.4% or less to prevent the risk of airway fire,^{17,18} whereas cold snare resection could be performed under high oxygen concentration; (5) the cold snare resection in the area of the vocal cords conducted through a bronchoscope could be more convenient and cost-effective compared with the resection through a laryngoscope; (6) The cold snare procedure does not generate heat in the process of operation, which reduces the thermal stimulation of the normal tissue, especially in patients with scar physique. Zhang *et al.* reported that in dogs the thermal lesions induced a greater growth of the granulation tissue and cartilage damage compared with the mechanical lesions.¹⁰ In our examination, cold snare resections were performed in the 21 patients, including three cases of neoplasms in the vocal cords and eighteen cases of tracheal or bronchial lumen neoplasms. The biggest neoplasm was 18 mm in diameter. We removed all the specimens from the tracheal tube by cold snare, biopsy forceps, or bronchoscopic suction and sent them for biopsy. In the current case series, we have shown that cold snare performed by bronchoscopy can result in successful treatment outcomes in patients with benign pedunculated neoplasms with a relatively low rate of complications. However, it is worth noting that there are some suitability requirements to comply with concerning the sizes and forms of the neoplasm that is subjected to cold snare resection. This treatment option is the optimal choice for the therapy/surgical treatment of narrow-based, pedunculated lesions. The application of cold snare is also acceptable for the excision of broad-based neoplasms.

In this study, the diameter of the biggest narrow-based pedunculated neoplasm was 18 mm. Neoplasms with

different sizes and shapes were present in the rest of the cases, including broad-based, flat, and pedunculated. However, an assessment of the level of difficulty of cold snare implementation and the risk of bleeding has to be conducted before the operation of neoplasms bigger than 10 mm in diameter. Furthermore, such an assessment is exceedingly important before the cold snare treatment of wide-based or thick, pedunculated lesions. Otherwise, diffuse and massive bleeding can occur in the area of the surgical surface. More attention should be paid to the risk of choking, especially during the operation of larger endotracheal neoplasms. Before undertaking a neoplasm excision, it is imperative to evaluate whether the lesion could be removed completely. When it cannot be entirely eliminated by cold snare, or there is a risk of considerable subsequent hemorrhage, an electric knife or electrocoagulation could be used additionally. Cold snare resection is also a good choice for surgical removal of vocal cord neoplasms, when patients are not suitable for operation by laryngoscopy.

Conclusion

The option for the management of benign trachea stenosis varies with the type and extent of the disease. Cold snare is a safe and effective method for the therapy of patients with benign neoplasms in the vocal cords and the tracheal and bronchial lumen, especially for those who have physical scars. This approach offers many advantages, such as simplicity, low price, and less complications. Therefore, the use of cold snare resection by bronchoscopy is promising but should be further explored.

Authors' contribution: En-guo Chen, Feng-jie Wu contributed equally to this paper and they are the co-first authors. En-guo Chen and Hui-hui Hu have made substantial contributions to conception and design of the study; Feng-jie Wu collected the data from the reported case; Ji-song Zhang searched literature; Han-liang Jiang and Liang-liang Dong analyzed the data; En-guo Chen wrote the manuscript; Hui-hui Hu revised the manuscript; All authors approved the final version of the manuscript.

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