

DESCRIPTIVE ANALYSIS OF 10 YEARS OF INTERVENTIONAL THERAPEUTIC BRONCHOSCOPY

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Abstract:

Objective: To describe our cases in the field of therapeutic Interventional Bronchoscopy after 10 years of experience.

Materials and Methods: We collected history, type of Tracheobronchial Pathology, technique, results and complications.

Results: Were they performed 186 (113 male and 73 female) patients with mean age 51.3 years (range: 8-86). Had 320 procedures or techniques performed on them. Indications for the procedure: benign airway stenosis 45,69% (85/186), malignant stenosis 41,93% (78/186), tracheoesophageal and bronchopleural fistulas 5,91% (11/186), foreign bodies extracted with rigid bronchoscope 4,3% (8/186), and 3 cases of threatening hemoptysis. Among the benign stenosis secondary to intubation followed by the post-tracheotomy were the most common, 35,29% (30) and 34,11% (29) respectively. Between malignant lesions, 63 cases (80,76%) had home lung, of these, carcinoma, bronchogenic, 60 of 78 patients, was the most frequent and 3 carcinoid tumors. The rest 19,23% (15 / 78) were non bronchopulmonary tumors. The most used techniques have been laser in 100 cases, pneumatic dilatation in 65, Endoprosthesis 53 (35 metal and silicone 18), electrosurgery in 50, mechanical resection in 45 patients, 3 fistulas sealments and 3 occlusion balloon by hemoptysis. The most employed combined procedure was resection laser and mechanics more pneumatic dilation. Intraoperative complications in 11 cases (4,8%) and late in 4 (2,15%). All patients (100%) improved their symptoms after the procedure.

Conclusions: The therapeutic interventionist bronchoscopy is a safe and effective procedure in the management of injuries in the airways.

Key words: Interventional pulmonology, rigid bronchoscopy, laser resection, pneumatic dilatation, bronchial electrocautery, stents.

ANÁLISIS DESCRIPTIVO DE 10 AÑOS DE BRONCOSCOPIA TERAPÉUTICA INTERVENCIONISTA

Resumen

Objetivo: Describir nuestros casos en el campo de la broncoscopia terapéutica intervencionista después de 10 años de experiencia

Materiales y métodos: Hemos recogido historia, tipo de patología traqueobronquial, técnicas, resultados y complicaciones

Resultados: Fueron incluidos 186 pacientes (113 hombres y 73 mujeres), con edad media de 51,3 años (rango 8 - 86). Se han realizado 320 procedimientos o técnicas sobre ellos. Indicaciones del procedimiento: estenosis benigna de la vía aérea 45,69% (85/186), estenosis maligna 41,93 % (78/186), fistula traqueoesofágica y broncopleurales 5,91% (11/186), extracción de cuerpo extraño con broncoscopio rígido 4,3% (8/186) y 3 casos de hemoptisis amenazante. La estenosis benigna secundaria a intubación seguida por la post traqueostomía fueron las más comunes, 35,29% (30) y 34,11% (29) respectivamente. Entre las lesiones malignas, 63 casos (80,76%) estaban localizados en el pulmón, de estos, el carcinoma broncogénico, 60 de 78 pacientes, era el más frecuente y 3 tumores carcinoides. El 19,23% restante (15/78) no eran tumores broncopulmonares. La técnica más usada ha sido el laser en 100 casos, dilatación neumática en 65, endoprótesis 53 (35 metálicas y 18 silicona), electrocirugía en 50, resección mecánica en 45 pacientes, 3 sellados de fistulas y 3 oclusiones con balón por hemoptisis. El procedimiento combinado más empleado fue la resección laser más dilatación neumática. Complicaciones intraoperatorias en 11 casos (4,8%) y tardías en 4 (2,15%). Todos los pacientes (100%) mejoraron de sus síntomas después del procedimiento.

Conclusiones: La broncoscopia terapéutica intervencionista es un procedimiento seguro y efectivo en el manejo de las lesiones de la vía aérea.

Palabras clave: Neumología intervencionista, broncoscopia rígida, resección laser, dilatación neumática, electrocauterio bronquial, stents.

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INTRODUCTION

Since endobronchial lasers were first used¹ and pulmonologists' rediscovery of rigid bronchoscopy², a new discipline within this specialty been unveiled, known as Interventional Pulmonology^{3,4}. Our objective is to describe our experience in this field as 2015 marked 10 years since the technique was implemented in our department.

MATERIALS AND METHODS

We have performed a retrospective study, reviewing the medical histories of patients who have undergone interventional therapeutic bronchoscopy in the Bronchopleural Techniques Unit of the Pulmonology Department at the Hospital Regional Carlos Haya in Malaga over a 10-year period from January 2005 to December 2015. The objective is to describe our experience analyzing the case histories from this period. Endobronchial brachytherapy cases have not been included.

According to 2011 data from the annual hospital report, the reference population for the hospital area is 623,301 inhabitants, and the reference for the province and Melilla reaches 1,249,290 inhabitants. We have also treated patients from other provinces such as Campo de Gibraltar (Cadiz) and El Ejido (Almeria). The Bronchopleural Techniques Unit performs approximately 600 bronchoscopies per year. With the exception of one case, we have not treated pediatric patients.

In our systematic evaluation of each patient, they undergo a blood test which includes hematimetry, basic biochemistry (glucose, urea, creatinine and an ionogram) and hemostasis, as well as an electrocardiogram and arterial blood gas in cases which presented oxygen saturation (SatO₂) of less than 92% or clear respiratory distress. Pulmonary function tests included at least one spirometry study with flow-volume loop. Imaging techniques always included computerized tomography, done in our center or the referring hospital. Said study was analyzed jointly with a radiologist, evaluating the lesion to be treated from different perspectives (axial, coronal, sagittal) and with virtual bronchoscopy, taking the necessary measurements (length of lesion and diameter of a normal and pathological airway) in the case of stenosis lesions that were believed to result in endoprosthesis. At the same time, a flexible bronchoscopy was done in our examination room for all of the programmable (non-urgent)

cases, including those patients who had undergone the procedure in the hospital. The preoperative study was evaluated during the pre-anesthetic assessment, except in those cases which presented a life-threatening emergency.

After informing the patients and signing the corresponding consent form, they were included on a waiting list and scheduled according to considered urgency. In this sense, we had one operating room available in the morning each month. For urgent cases, the anesthesiology team on duty was contacted. The two interventional pulmonologists planned the type of intervention appropriate for each case according to the information collected. The diseases treated were benign and malignant stenosis, tracheoesophageal and bronchopleural fistulas, foreign matter and life-threatening hemoptysis. The interventional therapy procedure was carried out in the operating room, under general intravenous anesthesia, avoiding inhalation anesthetics whenever possible. We did not have jet ventilation available for any case.

The following equipment was used: a rigid bronchoscope Efer-Dumon, comprised of a 13.20mm and 12mm tracheoscope and a 12mm and rigid bronchoscope of different diameters, which used an intermediary piece to pass through the tracheoscope when it was necessary to selectively intubate the left or right bronchi. A Dumon stent loader and introducer. A 5.5 straight-view rigid optics (Efer endoscopy BX 5500). Two flexible bronchoscopes were used interchangeably, one of which was a Pentax EB-1570[®] video bronchoscope 5.1mm in diameter with a 2mm working channel, and the other a Pentax EB-1970[®] bronchoscope with a 2.8mm channel and 6.2mm diameter, according to the need for a larger or smaller working channel. Rigid grasping forceps. Laser equipment (Biolitec[®]) with a cooled non-contact probe for photovaporization and another contact probe for cutting. Electrocautery (ECT) or electrosurgery equipment (Olympus PSD 30[®]) which has a coagulation electrode, electric knife, loop diathermy and hot biopsy forceps. For pneumatic dilation, we used a balloon dilation catheter for controlled radial expansion (CRE Wireguided[™]) from the Boston Scientific[®] trading house with diameters between 6mm and 20mm. The CRE was controlled by a manometer which regulated the pressure acting on the walls of the airway in atmospheres (minimum: 3 atm, maximum: 10 atm.)

The procedure was done according to applicable international recom-

mentations⁵⁻⁷, always being done by the same staff member, from both nursing (a care assistant licensed in nursing) and medical practice (two pulmonologists).

RESULTS

During the period of study, a total of 186 patients were examined, 113 males and 73 females. The average age +/- standard deviation was 51.3 +/- 18.11 (range: 10 - 86). 31.7% of patients did not belong to our health service area. Throughout the course of interventional therapeutic bronchoscopy, 320 techniques or procedures were used on the 186 patients (Table 1).

Table 1. Number and type of technique or procedure performed

Procedure	
Endobronchial laser	100
Pneumatic dilation balloon	65
Endoprosthesis	53
Mechanical resection	45
Electrocautery	35
Argon plasma	15
Fistula sealing	3
Bronchial occlusion balloon	3
Microdebridement	1
Total:	320

With regard to personal background, 83 patients had a history of tobacco use (44.6%), 67 had pulmonary disease (36%), there was some cardiovascular risk factor in 63 patients (33.9%), heart disease in 25 (14.5%), and history of other disease for 62 patients (33.3%). Over half, 51.07% (95/186) were patients with multiple diseases, presenting several comorbidities.

The most frequent symptom was benign stenosis, 85 cases (45.69%), followed by neoplastic or malignant stenosis, 78 cases (41.93%), tracheo-

esophageal or bronchopleural fistulas, 11 cases (5.91%), 8 foreign matter extractions with rigid bronchoscopy (4.3%), and 3 cases of life-threatening hemoptysis (1.61%).

The majority of patients came from the Pulmonology Department, followed by the departments of Medical Oncology and Radiotherapy.

The area of treatment or anatomical region was the trachea in 92 cases (49.5%), the bronchi in 85 (45%), of which 46 cases affected the right tree and 39 the left, and the tracheobronchial tree was affected in 9 cases (4.8%).

Access was always obtained via the oral pathway. A rigid bronchoscope was only used as the exclusive instrument in 8 cases (4.3%), only a flexible bronchoscope was used in 40 cases (21.5%) and a combination of flexible bronchoscope through a rigid bronchoscope was used in 138 cases (74.2%).

As far as benign stenosis pathology of the airway (Table 2), of 85 patients, 30 cases were lesions following prolonged intubation (35.29%), there were 29 cases of post-tracheostomy lesions (34.11%), 12 cases of granulomas at the ends of the tracheostomy tube or implanted stent (22.64%), 7 patients (3.76%) with idiopathic tracheal stenosis (Fig.1), 2 patients with recurrent respiratory papillomatosis (2.35%), and other causes in the remaining 5 patients (5.88%), in which we include one case for each of the following diseases: granulomatosis with polyangiitis, amyloidosis, sarcoidosis, tuberculosis and relapsing polychondritis, each of these with severe and extensive endoluminal involvement.

Table 2. Benign stenosis etiology

Type of lesion	number	%
PI	30	35.29
PT	29	34.11
Granulomas	12	22.64
ITS	7	3.76
Recurrent respiratory papillomatosis	2	2.35
Others ⁺	5	5.88
Total patients	85	

PI: tracheal stenosis following prolonged intubation. PT: post-tracheostomy tracheal stenosis. ITS: idiopathic tracheal stenosis. (+) Explanation in the text.



Fig. 1. Circumferential idiopathic subglottic stenosis

In the 78 cases of malignant or tumor pathology (Table 3), the lesion was predominantly intraluminal in 69 patients (88.46%) and extraluminal or from extrinsic compression in 9 cases (11.53%). Of these neoplastic lesions, 63 cases (80.76%) originated in the lungs and, of these, bronchogenic carcinoma was the most frequent tumor constituting 60 out of 78 patients, along with 3 carcinoid tumors. The remaining 19.23% (15/78) were non-bronchopulmonary tumors which affected the lower airway through different mechanisms including proximity infiltration, extrinsic compression and endobronchial metastasis. The origins were: esophagus (6) thyroid (4), mediastinal lymphoma (2), mediastinal germ cell tumor (2) and cervical carcinoma (1). Three cases of post-surgical bronchopleural fistula and eight of neoplastic tracheoesophageal fistula originating from neoplasm were also treated.

We have had 8 cases of foreign matter extraction which required the use of general anesthesia and rigid bronchoscopy due to the impossibility of using flexible bronchoscopy. There were three cases of life-threatening he-

moptysis, the most severe of which occurred in a patient with cystic fibrosis, in which, after failure with artery embolization, bleeding was controlled with rigid bronchoscopy and an occlusion balloon.

Within the techniques or procedures used, a laser was used in 100 patients (53.76%) using both the cooled non-contact probe and the cutting mode. Mechanical dilation with a CRE balloon was the second most frequently used procedure in 65 cases (34.94%). Mechanical resection with a bezel on a rigid tracheoscope or bronchoscope was used in 45 patients (24.19%). Electrocautery (ECT) was used for 35 patients (18.81%) in the different modes of electrocoagulation: electric knife, loop diathermy and hot biopsy forceps. Argon plasma was used in 15 cases (8.1%). Histoacryl® adhesive was used in 3 cases of bronchopleural fistula. Occlusion balloons implanted via rigid bronchoscopy were used in 3 more patients to manage life-threatening hemoptysis pathways. Finally, there was one case of mechanical microdebridement (Medtronic® microdebrider).

Table 3. Malignant stenosis etiology

Neoplasm origin	number	%
Pulmonary origin	63	80.76
Bronchogenic carcinoma	60	
Bronchial carcinoid tumor	3	
Extrapulmonary origin	15	19.23
Esophagus	6	
Thyroid	4	
Lymphoma	2	
Germ cell tumor	2	
Cervix	1	
Total patients	78	

Explanation in the text.

A total of 53 silicone-coated stents were used. Of these, 35 were Nitinol self-expanding metallic stents, (31 Boston Scientific® ultraflex, 3 Leufen aerstent TBY® tracheobronchial stents and 1 AERO stent Alveolus, Inc., NC, USA®). The remaining 18 were Dumon stents, 2 of which were tracheobronchial stents (GSSTM Y), 2 hourglass stents (Dumon ST), 1 carina stent (Dumon CB), and the rest were Dumon bronchial or tracheal stents (GSSTM BD and GSSTMTD, respectively) (Fig. 2).

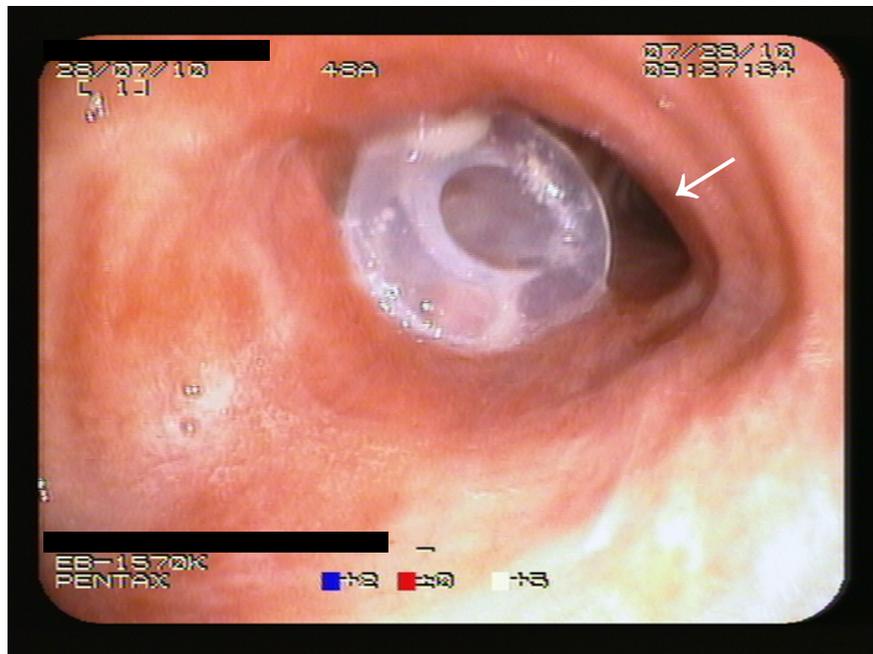


Fig. 2. Dumon CB stent (special for carina). Used for a post-tuberculosis bronchostenosis of the main left bronchus. Opening of the main right bronchus (arrow).

Intraoperative complications were uncommon, with a total of 4.8% consisting of: 7 cases of hemoptysis, controlled by topical measures during the procedure; a bronchial rupture while trying to place the silicone stent; a perforation in the posterior wall of the bronchus intermedius from the laser, requiring an emergency thoracotomy in the case of granulomatosis with polyangiitis; 1 case of airway fire ignited by the laser, which did not cause posterior problems for the patient; and 1

case of exitus during the procedure after massive blood loss when attempting to repermeabilize the main left bronchus after adenocarcinoma of the lung. Postoperative and late complications were: a case of subcutaneous emphysema a few hours after an ECT resection of bronchial infiltration from adenocarcinoma in the main left bronchus which was resolved in 48 hours; 2 cases of silicone stent migration (Fig. 3), both occurring one week after implantation, which required removal in one case and substitution in the other; 2 patients receiving stents (3.7%) who required additional intervention months later due to the appearance of granulomas (Fig. 4) which almost entirely destroyed the distal end of the stent.

The benefits of the interventional procedure in relation to survival have been very good. In general, survival of more than one year counted from the day of the interventional procedure was 80.6%, with the remaining 19.4% surviving less than one year. However, in the malignant tumor group of patients, survival rates were visibly lower. Of the 78 patients with neoplastic lesions, 48 (58.97%) survived longer than one year. However, even in these cases, with the exception of the intraoperative exitus, 100% showed an immediate improvement in dyspnea

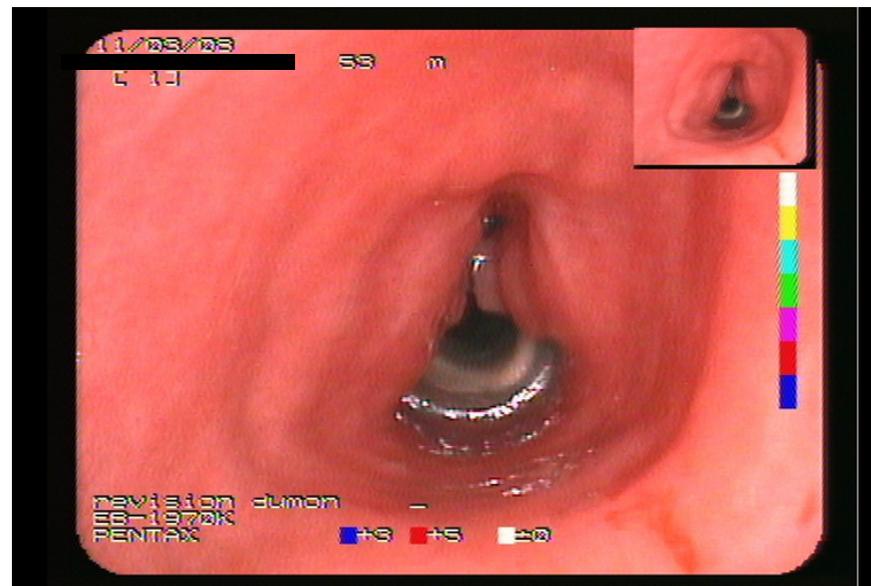


Fig. 3. Tracheal stenosis following prolonged intubation with malacia in the trachea wall. Distally migrated Dumon stent which needed to be re-positioned.

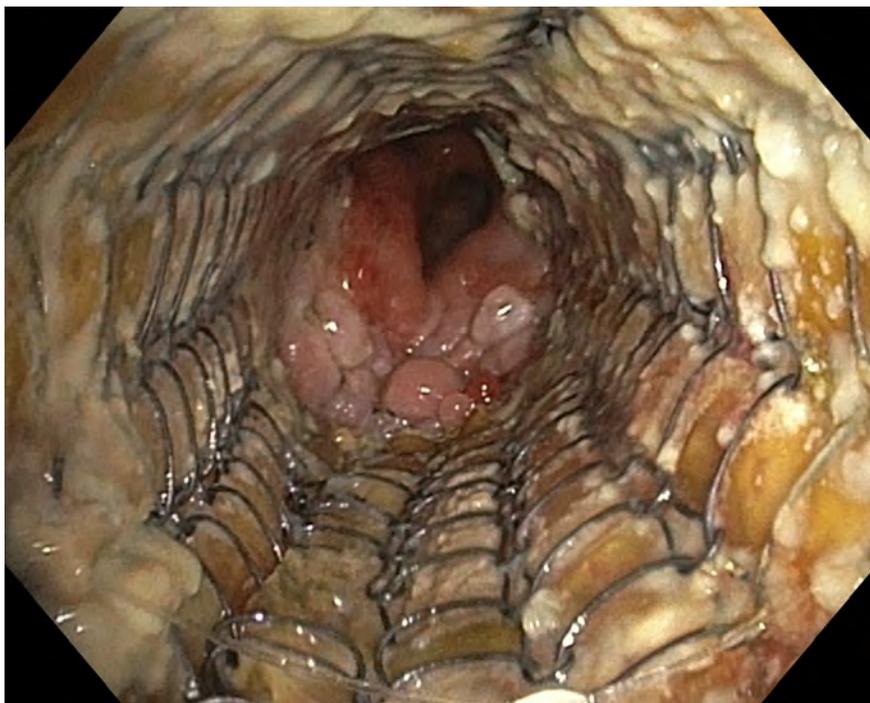


Figure 4. Tracheal metallic stent with formation of granulomas at its distal end.

DISCUSSION

Interventional therapeutic bronchoscopy has proven, in general, to be very effective in improving symptomatology in patients affected by airway stenosis⁸. This is especially true in the case of benign stenosis, for which it can be a decisive and definitive method, avoiding open surgery which is a much more invasive procedure and is not without the possibility for significant complications⁹. However, cases must be studied and evaluated together with pulmonologists, thoracic surgeons and otolaryngologists in order to select the most appropriate initial treatment for each patient. However, in the case of malignant airway stenoses, endoscopic treatment is always done as palliative care¹⁰⁻¹¹, thus obtaining poorer results regarding medium to long-term survival¹², although there are immediate benefits for patients' quality of life.

Among the benign stenoses in our study, for which therapeutic endosco-

py has been the most frequent advice (58.06%), we can note, in accordance with the bibliography¹³, stenosis following prolonged intubation and post-tracheostomy stenosis which were the most habitual symptoms. Of the latter, we have seen two types: those associated with lesions on the tracheal tube once closed and more distal lesions of the trachea subjected to pressure from the endotracheal tube cuff, analogous with those caused by decubitus which provoke the ballooning of the endotracheal tube with regard to the tracheal mucosa. These stenoses result in an ischemic lesion on the mucosa and cartilage in the airway, which provokes malacia and loss of tracheal wall structure¹⁴. These lesions are almost always subsidiaries of endoprosthesis rather than ablative heat treatment (laser or ECT). The third most common type of benign stenosis was caused by stenosing granulomas in patients using a permanent tracheostomy tube in 10 cases and 2 cases at the distal ends of metallic endoprostheses.

With regard to idiopathic tracheal stenosis, we only had 7 patients and it is noteworthy that all of them were women with an average age of 58 and that the anatomic area affected was the subglottis-trachea in all cases. While uncommon, this type of stenosis is difficult to manage endoscopically. All patients were subjected to laser and mechanical resectioning with the bezel of a tracheoscope, avoiding placing the stent in the area immediately below the vocal cords. The first stage of the endoscopic surgery was done with a laryngeal mask and fiber laser using a flexible bronchoscope, intubating with a rigid instrument for resection in the second stage. Mitomycin C was applied at the end of the procedure in each case. Of the 7 patients with idiopathic subglottic tracheal stenosis, 4 were treated with bronchoscopy just once, without recurrence, in follow-up since 2010 for the oldest bronchoscopy treatment and since July 2015 for the most recent. In contrast, in the 3 remaining cases, recurrence has been the standard, with the average time until the first restenosis being 20 months (8-32). All patients underwent open surgery after an average of 3.3 (2-4) laser procedures. One of the patients who underwent thoracic surgery passed away 4 days after surgery from a Montgomery stent obstruction, which was implanted to aid the trachea. The other two patients to undergo thoracic surgery (one at our center and one at the Hospital Clínico de Valencia) have been free of disease during follow-up since 2011 and 2012, respectively. There is still no clear explanation as to why idiopathic stenosis recurs after the use of laser. Based on our experience, after the second restenosis we believed we should consider stopping ablative heat endoscopy (laser or ECT) and consider

open surgery when possible, as recurrence is highly likely, especially in cases of early restenosis.

Within benign stenoses, a numerous group of systemic inflammatory diseases of unknown etiology are worth mentioning which, occasionally, extensively and severely affect the tracheobronchial tree. Our experience is limited in this field as we have treated 5 patients in total. The patient with granulomatosis with polyangiitis presented multiple stenoses in the bilateral peripheral bronchi, pseudomembranes, mucosal ulcerations and the characteristic lesions described as submucosal tunnels (pinhole like)¹⁵⁻¹⁷. She underwent repermeabilization with broncholaser and balloon dilation on 8 occasions (from 2009 to 2011), occasionally with rigid bronchoscope under general anesthesia and other times with flexible bronchoscope and conscious sedation, with satisfactory but transient results. On one occasion, laser perforation of the stenosed bronchus intermedius required an emergency thoracotomy. We can note that, in spite of the serological management of the disease with the normalization of renal function and negativization of anti-neutrophil cytoplasmic antibodies (C-ANCA) with immunosuppressive treatment (steroids and cyclophosphamide), airway lesions continued to progress until endobronchial involvement spontaneously stabilized from October 2011 to the present. Since then, we have done non-invasive monitoring with occasional spirometry and clinical examinations.

Stenosing tumors have been the second most frequent symptom of therapeutic bronchoscopy in our study (nearly 42%). We can highlight bronchopulmonary origin and bronchogenic carcinoma as the most frequent, present in more than 80% of cases, and a miscellany of non-bronchopulmonary tumors that affect the airway, predominantly from the esophagus and thyroid. Indications in these cases of malignant disease are generally palliative. Exceptions to cases of tumors in which treatment can be curative, such as photodynamic therapy, are still under debate and are the cause of controversy in the literature¹⁸. Carcinoid tumors are among these exceptions¹⁹⁻²⁰ with exclusively endobronchial involvement. In our experience, we have treated 3 typical cases of carcinoid tumors without detected metastasis in scans with octreotide (octreoscans) in which 2 cases were completely resected with loop diathermy and had no recurrence after follow-up of more than 5 years in the first case and more than 2 in the second. However, in the third case a complete resection of the tumor was not possible and, after repermeabilizing the main right bronchus which was completely stenosed provoking atelectasis, the patient

underwent a pneumonectomy. Carcinoma in situ is another exception, an uncommon occurrence in clinical practice, but which allows for local endoscopy treatment. In our study, we have only recently treated 1 case, using ECT without tumor recurrence after 3 months.

Massive or life-threatening hemoptysis constitutes one of the emergencies most feared by pulmonologists²¹⁻²². The use of rigid bronchoscopy allows us to simultaneously secure the airway and ventilation and, along with the possibility of breathing with large diameter tubes, achieve immediate hemostasis of bleeding areas and insert Fogarty endovascular catheters or bronchial balloon catheters, which are specifically made for this purpose (Olympus B5-2C 5F and B7-2C 7F). The 5F Fogarty catheter used on our patients provides an inflated diameter of 11mm, which is more than sufficient to occlude segmental and lobular bronchi, even the bronchus intermedius in its distal third. It can be inserted through a working channel, which does not allow us to extract the bronchoscope later, or parallel with the bronchoscope, helping it with biopsy forceps inserted in the channel which grip the distal end of the catheter, allowing us to direct it to the desired bronchial area.

The management of fistulas in the airway is very complex²³. Bronchopleural fistulas can be treated with different methods. We have used an n-butyl 2 cyanoacrylate adhesive substance in the three cases, resolving the escape of air in two cases. An additional surgical procedure was required due to seal failure in the third case. Other proposed methods include Watanabe Spigots²⁵⁻²⁶ and finally shut-off valves²⁷. For their part, tracheoesophageal fistulas²⁸ suppose an even more complex problem. The 8 cases in the study originated from neoplasms and a silicone or metallic stent was placed in the trachea in each case. The fistula output only managed to be completely reversed in one case. Treatment must be accompanied by sealing the fistula through the digestive tract with a self-expanding metallic stent, which was not possible for the Digestive Department in half of the cases. To this complexity we can add a patient with a very advanced-stage neoplastic process with poor general metabolic conditions due to nutritional problems given that, until the fistula was fixed, they had to be fed through parenteral or enteral nutrition (percutaneous endoscopic gastrostomy (PEG) tube)²⁹.

With regard to the different types of interventional procedures, during bronchoscopy it is common to not perform a single procedure, but rather several. In this sense, the combination of techniques that was most commonly used in our study was laser and mechanical resection, followed by pneumatic

dilation in 37 cases and laser and mechanical resection accompanied by pneumatic dilation and endoprosthesis placement in 13 of the cases with malignant infiltrative stenosing lesions. Finally, for the first time in Spain, we had the opportunity to use mechanical microdebrider bronchoscopy for the resection of granulomas in a metallic stent³⁰⁻³¹.

CONCLUSIONS

We can end this 10-year descriptive analysis of airway intervention at our center by concluding that the procedure is safe in general, with a low complication rate, and it is in line with information published in similar studies. The benefits of the technique can be curative in some cases of benign lesions. In the case of malignancies, if the patients are appropriately selected, they can also benefit from an alleviation of symptoms with improved quality of life for a large majority³². As for the benefits interventional procedures have had for other types of diseases we have treated (systemic diseases which affect the airway, fistulas, etc.), we cannot draw any definitive conclusions as the results have not always been satisfactory and there have been a small number of cases.

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