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A 12-year experience in endobronchial intervention using rigid bronchoscopy - account of a tertiary referral centre

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Abstract

We describe our experience of rigid bronchoscopy and endobronchial intervention at a single tertiary centre over a 12-year period. All rigid bronchoscopy procedures between July 2008 and July 2020 (inclusive) were reviewed. All procedures were performed in cardiothoracic theatres by a designated team under general anaesthesia; 2135 rigid bronchoscopies were performed on 1301 patients aged between 18 and 93 years. Complications occurred in 24 (1.12%) procedures. There was one fatality (0.05%). Haemorrhage >100mls occurred in seven (0.33%) all of which were successfully managed endobronchially. Ten procedures (0.5%) were complicated by pneumothorax and an intercostal drain was required for eight. Five patients required intensive care admission post operatively, all of whom were subsequently discharged from hospital. One patient had stent migration. To the best of our knowledge this is amongst the largest single centre collection of data available for endobronchial intervention using rigid bronchoscopy. We show that rigid bronchoscopy is a safe and effective procedure when performed in a high-volume specialist centre with designated lists involving a specialist multidisciplinary team.

Introduction

The first reported interventional rigid bronchoscopy was performed in the late 1800s to remove a foreign body from a main bronchus [1]. During the 20th century flexible bronchoscopy was pioneered and the use of rigid bronchoscopy reduced, however rigid bronchoscopy has advantages over flexible bronchoscopy. Firstly, the patient can be ventilated via the rigid bronchoscope and the procedure performed under general anaesthesia, therefore the patient is unable to cough which is beneficial when assessing the airways and performing interventions. Secondly, the rigid bronchoscope has a wide barrel which allows instruments to be passed through such as bougies and forceps, allowing for interventions to be performed which would not be possible in flexible bronchoscopy. Airway interventions such as stricture dilatation, central tumour biopsies, application of bio glue, stent insertion, foreign body retrieval and laser therapy are possible via rigid bronchoscopy.

In addition, rigid bronchoscopy allows the operator greater ability to deal with major airway haemorrhage and to achieve haemostasis compared with a flexible bronchoscope with its narrow suction port and the risk of obscuration of vision due to blood. Moreover, in such a scenario there is a risk of ventilatory compromise. At rigid bronchoscopy the patient has a secure airway throughout and receives mechanical ventilatory support through the bronchoscope, there is also the option for lung isolation and

thereby airway protection by advancing the tube to the non-affected bronchus protecting it from incursion of blood.

Tracheobronchial stents may also be inserted through a rigid bronchoscope [2,3]. Although studies have reported deployment of tracheal stents *via* a flexible bronchoscope [4,5] rigid bronchoscopy remains the procedure of choice to manage large airway obstruction for the reasons described [6].

Potential complications include injury to the teeth and gums, tracheal or bronchial perforation, bleeding, and pneumothorax [7]. Significant haemorrhage and pneumothorax have been reported in up to 0.5% and 0.12% procedures respectively [8].

We describe the experience of a single centre in London, United Kingdom, and show that endobronchial intervention using rigid bronchoscopy performed in a high-volume specialist centre by an experienced operator with the support of a multidisciplinary team and dedicated cardiothoracic theatre space is a safe procedure with a very low complication rate.

Materials and Methods

Patients were referred to a tertiary centre for assessment, diagnosis and management of diverse large airway pathologies. St George's Hospital, part of St George's University Hospitals NHS Foundation Trust, is a 1300 bed hospital in London. There is a Thoracic Surgical Department, a Cardiothoracic Intensive Care Unit, cardiothoracic theatres and specialist cardiothoracic anaesthetists.

The airway intervention team received referrals from across London and the South of England.

Data collection and analysis

All rigid bronchoscopy procedures between July 2008 and July 2020 (inclusive) were reviewed.

Procedures

All procedures were performed electively, or as an emergency as required, in cardiothoracic theatres by a multidisciplinary team which included a cardiothoracic physician, cardiothoracic anaesthetists, operating department practitioners (ODP), theatre nurses and recovery staff. The cardiothoracic physician is experienced in airway intervention having performed over 12,000 rigid bronchoscopies.

All rigid bronchoscopies were performed under general anaesthetic using a total intravenous technique. Patients were pre oxygenated with 100% oxygen prior to induction. Propofol and remifentanil were used for induction and a non-depolarizing neuromuscular blocking agent, for example atracurium, was given. During the procedure ventilation was achieved through the side port in the rigid bronchoscope by means of a hand triggered device such as a Sanders injector using a jet ventilator [9]. Following the insertion of the rigid bronchoscope, a flexible bronchoscope was passed through the rigid bronchoscope to assess the airways. The stents used were Ultraflex® expandable metallic stents (Boston Scientific, Watertown, MA, USA), both partially covered or uncovered.

All patients were taken to recovery post operatively. Post-procedure chest X-rays were performed in selected patients, including all of those who underwent stent placement. Patients who received a stent were kept in hospital overnight for observation of early stent migration. The remaining patients were discharged four hours post procedure, unless there was a complication which required hospitalisation. Patients who had a stent inserted received a five-day course of prophylactic oral antibiotics. Laser therapy was delivered using Nd:YAG laser.

Results

Between July 2008 and July 2020, 2135 rigid bronchoscopies were performed on 1301 patients. Of the 1301 patients, 757 (58%) were men and 544 (42%) were women. The median age was 57 years (range 18 to 93). 860 patients had a single procedure, 283 had two procedures, and 158 patients had three or more procedures. Co-morbidities were present in 60% (781) of patients and included hypertension, COPD, diabetes, ischemic heart disease and pulmonary emboli. Forty percent (520) of patients had no associated comorbidities.

The interventions performed at rigid bronchoscopy are listed in Table 1. During a procedure where the patient underwent more than one intervention the primary intervention is listed and not multiple interventions (for example, if the patient had dilatation of

Table 1. Primary intervention.

Primary intervention	Number of procedures in our patients (%)
Nd:YAG laser	690 (32.4)
Insertion of stent (tracheal and bronchial)	505 (23.7)
Biopsy of proximal tumour	437 (20.5)
Diagnostic inspection of airways	247 (11.5)
Dilatation of proximal stricture	121 (5.6)
Removal of stent	34 (1.5)
Removal of foreign body	29 (1.4)
Application of mitomycin C	30 (1.4)
Percutaneous tracheostomy insertion	22 (1)
Application of bio glue	20 (1)

stricture and a stent insertion then the primary intervention would be recorded as stent insertion).

Partially covered stents were inserted in 404 patients. Of these, 260 were those with endobronchial tumours to prevent the ingrowth of tumour tissue through the stent which could result in further airway compromise. In 127 patients where a lobe or entire lung was compromised because of the tumour mass resulting in collapse of the distal airway, a partially covered stent was inserted to intentionally occlude the tumour at the orifice of the collapsed segment to prevent future encroachment and preserve the patency of the remaining lung; 11 patients had partially covered stents to seal tracheal tears and perforations; and six patients to seal an acquired tracheoesophageal fistula. Uncovered stents were inserted in 101 patients with extrinsic compression or collapse of the airway; 137 of the Nd:YAG procedures were performed in patients post stent insertion. Diagnostic rigid bronchoscopy alone was performed in 247 patients. Of these 188 had previous laser therapy, stent insertion (to check position and integrity of the stent) or following foreign body (FB) retrieval (to assess for the formation of granulation tissue) and post fistula closure (to ensure resolution of the defect). 30 patients were referred for consideration of stent insertion but on performing the procedure there was complete occlusion of the airway with no distal run-off hence the procedure was deemed not technically possible. Twenty-five patients were referred to assess tracheobronchomalacia having had a flexible bronchoscopy. Four patients were referred because the patient did not tolerate flexible bronchoscopy under sedation alone; 29 patients were referred with a foreign body in the airway. For foreign body retrieval we used telescopic rigid forceps if the item was proximal. Flexible bronchoscopy was employed for more distal foreign bodies. Bioglue® was used in 20 patients to seal bronchopleural fistula post pneumonectomy or lobectomy as previously described [10].

Four patients post stent insertion required repeated laser procedures over five years and this accounted for 65 Nd:YAG procedures. For the remaining 501 patients who received a stent there were 72 laser procedures.

Complications

The complications are listed in Table 2. Complications occurred in 24 (1.12%) procedures.

There was one fatality (0.05%), secondary to tumour erosion and massive haemorrhage which occurred prior to intervention at anaesthetic induction. Seven patients had significant haemorrhage (>100mls). Three patients had cardiac arrhythmias post procedure. They were treated with anti-arrhythmic agents and admitted to the intensive care unit for monitoring.

Two patients could not be immediately extubated in theatre post procedure secondary to respiratory distress or failure and they were transferred to intensive care. They were subsequently successfully extubated and discharged home the following day. One patient had stent migration. This was discovered on the post procedure chest radiograph. The patient had a repeat procedure and the stent was repositioned.

Discussion

We present data of a large number of rigid bronchoscopies from a single centre. The complication rate in our series was favourable (1.12%) when compared to other published reports citing complication rates of between 3.9% and 13.3% [8,11-13]. A series of 1115 procedures (both rigid and flexible bronchoscopy) for malignant airway obstruction quoted an overall complication rate of 3.9% and a mortality rate of 0.5% [11]. A recent multi-centre study of 1546 rigid bronchoscopies reported a complication rate of 6.7%, a peri procedural mortality rate of 1.2% and severe haemorrhage (defined as >200mls blood loss or requiring major intervention) was reported in 1.2% of procedures [13]. We report a fatality rate of 0.05% and significant haemorrhage rate (>100mls) of 0.32%. We appreciate that ours was a heterogenous group, making it difficult to compare the groups in some scenarios (for example, foreign body retrieval with a prolonged stenting/laser procedure). Furthermore, 11.5% (247) of our procedures were diagnostic where no airway intervention was performed and this may account for the low overall complication rate of 1.12%. However even if we were to only consider the interventional procedures - 1888 procedures - the complication rate remains favourable at 1.27%.

Central airway tumour was a common reason for referral to our service. Approximately 13% of lung cancer patients will develop central airway obstruction over the course of their disease [14]. In patients with unresectable tumours or those whose functional status prohibits radical surgery, or those who have progressive disease despite chemoradiotherapy treatment and who present with impending airway obstruction, rigid bronchoscopy can play a vital role by offering tumour debulking and stent insertion thereby not only preserving but improving respiratory function and quality of life [15,16]. The implication of this is significant as patients may be subsequently enrolled in trials and may even be eligible for treatment which they previously may not have tolerated [17].

In almost a quarter of our cases we inserted a tracheal or bronchial stent. Stents can be deployed for various pathologies [1]. The most common indication is airway occlusion secondary to tumour [18]. Patients who develop tracheal stenosis after tracheostomy have been successfully weaned from mechanical venti-

Table 2. Complications.

Complication	Number of patients (%)	Management
Haemorrhage (>100mls)	7 (0.32)	Haemostasis achieved endobronchially
Pneumothorax	10 (0.47)	Intercostal chest drain (8 patients)High flow oxygen (2 patients)
Cardiac arrhythmia	3 (0.14)	Anti-arrhythmic agents
Respiratory failure	2 (0.09)	Ventilated and monitored on ICU
Stent migration	1 (0.05)	Repeat procedure and reinsertion of stent
Death	1 (0.05)	

ICU, intensive care unit.

latory support after tracheal stent insertion [19]. There are favourable reports of stent insertion in selected patients with benign tracheobronchial stenosis who have multiple co-morbidities and are considered unsuitable for surgical intervention [20,21]. The role of stent deployment in patients with airway malacia is evolving and may be used as a temporary measure to wean patients from mechanical ventilatory support [22]. It also has a role in sealing tracheoesophageal fistulas [10,23]. Metal fatigue and stent fracture over time is a known association of intraluminal stents [24] and we encountered this in 34 patients. From our early encouraging experience [25] we proceeded with endoscopic stent removal if this occurred. The median time from stent insertion to removal was 50 months.

Training opportunities in rigid bronchoscopy in the UK are largely only available to thoracic surgeons, and there is a lack of opportunities for trainee pulmonologists. In our opinion rigid bronchoscopy should form part of training for respiratory physicians who wish to provide interventional airway procedures. Many trainees in South London gain exposure to rigid bronchoscopy though our service. This has been shown to increase confidence and knowledge about the indications and complications [26]. We believe this is important to the development of pulmonologists who will later be faced with patients who may benefit from airway intervention.

Conclusions

To the best of our knowledge this is amongst the largest single centre collection of data available for endobronchial intervention using rigid bronchoscopy. We show that rigid bronchoscopy is a safe and effective procedure when performed in a high-volume specialist centre with designated lists involving a specialist multidisciplinary team. We would encourage increased exposure to the procedure for trainee pulmonologists.

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