Original Article

Safety and feasibility of performing rigid bronchoscopy in the bronchoscopy suite instead of the operating room

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Background: Rigid bronchoscopy is an invasive procedure used for the management of complex airway diseases. Complications related to rigid bronchoscopy are uncommon in the hands of trained physicians. Traditionally, rigid bronchoscopy is performed in the operating room rather than the bronchoscopy suite based on the availability of advanced airway equipment and additional anesthesia support. This study assesses the safety and feasibility of performing rigid bronchoscopy on non-critically ill patients in the bronchoscopy suite. The aim of this study is to determine the safety of performing rigid bronchoscopy in a bronchoscopy suite, outside of an operating room setting.

Methods: This is a retrospective, single-center analysis of 372 rigid bronchoscopy procedures performed for complex airway interventions in the bronchoscopy suite over a 5-year period. The primary endpoint of this study was the safety of performing rigid bronchoscopy in the bronchoscopy suite. In this analysis, safety data was collected regarding intraoperative and post-operative complications of rigid bronchoscopies performed in the bronchoscopy suite.

Results: Over a 5-year period between January 2019 and March 2024, 372 rigid bronchoscopies were performed in the bronchoscopy suite for non-emergent complex airway diseases. The overall incidence of intraprocedural complications in our cohort was 2 out of 372 procedures (0.5%). The two intraprocedural complications were pulmonary hemorrhage in 1 patient and cardiac ischemia in 1 patient. No incidence of airway injury, cardiac arrest, or death were observed. Seven procedures (1.9%) were followed by a change in clinical status requiring increased respiratory support within 24 hours of the rigid bronchoscopy.

Conclusions: Rigid bronchoscopy for the treatment of complex airway diseases, in the appropriate patient population, can be performed safely in the bronchoscopy suite.

Keywords: Rigid bronchoscopy; bronchoscopy suite; airway obstruction

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Introduction

Rigid bronchoscopy is an invasive procedure used for the management of complex airway diseases (1). The rigid bronchoscope provides superior airway control, excellent suction capabilities, safe use of thermal therapies, and direct visualization during stent placement (2,3). The ability to stabilize the airway and allow for lung isolation makes rigid bronchoscopy the procedure of choice for management of airway emergencies such as massive hemoptysis and acute tracheal obstructions (4,5). Rigid bronchoscopy is also performed for non-emergent conditions, such as

non-critical airway obstructions, sub-massive hemoptysis, complications following lung transplantation, and foreign body removal.

Complications related to rigid bronchoscopy are uncommon in the hands of trained physicians (6,7). The most common mechanical complications include trauma to the teeth, oropharynx, vocal cords or other glottic structures, laryngospasm, pneumothorax, hemorrhage, and death (8,9). The incidence of serious complications is less than 2%, with the incidence of death related to the procedure of 0.4% (10,11).

Traditionally, rigid bronchoscopy is performed in the operating room with general anesthesia. Alternative settings and anesthesia support have been implemented during rigid bronchoscopy, such as bedside procedures or in the absence of anesthesia (12,13). Still, the operating room setting has been the norm for the availability of advanced airway equipment and additional anesthesia support. While procedures on critically ill patients may be best served in the operating room, unnecessary use of this location consumes significant resources and can come at an increased cost. Additionally, limited availability of dedicated operating room time for bronchoscopy could prevent adequate access for these procedures. Because the use of general anesthesia is standard practice for rigid and flexible bronchoscopy, the same advanced airway equipment found in the operating room is present in the bronchoscopy suite (14). With appropriate patient selection, experienced proceduralists and anesthesiologists can safely perform rigid bronchoscopy in the bronchoscopy suite rather than the operating room.

This study assesses the safety and feasibility of performing rigid bronchoscopy on non-critically ill patients in the bronchoscopy suite. We believe that performing rigid bronchoscopies for complex airway diseases can be safely performed in the bronchoscopy suite rather than the operating room setting. The analysis will provide physicians with justification for incorporating the practice of rigid bronchoscopy outside of the operating room at their own institutions. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-2024-2163/rc).

Highlight box

Key findings

- This study reviewed 372 rigid bronchoscopies performed in the in the bronchoscopy outside of the operating room for complex airway interventions. All patients undergoing rigid bronchoscopy in this study were non-emergent cases. The primary endpoint of this study was the safety of performing rigid bronchoscopy in the bronchoscopy suite. The overall incidence of intraprocedural complications in our cohort was 2 out of 372 procedures (0.5%). Seven procedures (1.9%) were followed by a change in clinical status requiring increased respiratory support within 24 hours of the rigid bronchoscopy. This study shows that rigid bronchoscopy for the treatment of complex airway diseases, in the appropriate patient population, can be performed safely in the bronchoscopy suite.

What is known and what is new?

- Currently, there no data describing the safety and feasibility of performing rigid bronchoscopy outside of the operating room.
- This study that rigid bronchoscopy, in the appropriate patient population, can be performed safely in the bronchoscopy suite.

What is the implication, and what should change now?

- The implications of this study are that physicians and hospitals that performing rigid bronchoscopy can consider performing this procedure in the bronchoscopy suite. This transition out of the operating room has significant implications regarding the utilization of procedure space, cost of a procedure space, and improvements in patient care.

Methods

This is a retrospective, single-center analysis of consecutive patients who underwent rigid bronchoscopy for complex airway interventions in the bronchoscopy suite over a 5-year period between January 2019 and March 2024 at Inova Fairfax Medical Center. The cohort comprised outpatients and inpatients. Patients with acute airway emergencies, significant cardiac disease (unstable coronary artery disease or significant pulmonary hypertension), or patients in the intensive care unit (ICU) requiring rigid bronchoscopy were excluded from the study. Rigid bronchoscopies for these patients were performed in the operating room.

The primary endpoint of this study was the safety of performing rigid bronchoscopy in the bronchoscopy suite. In this analysis, safety data was collected regarding intraoperative and post-operative complications of rigid bronchoscopies performed in the bronchoscopy suite. Data included indications for rigid bronchoscopy, American Society of Anesthesiologists (ASA) Physical Status Classification, intraprocedural maneuvers, intraprocedural complications, and post-operative complications occurring within 24 hours following the procedure.

All rigid bronchoscopies were performed on consecutive patients by board certified interventional pulmonologists with fellowship training in rigid bronchoscopy. Experienced

Table 1 Demographic data. Including the number of patients, age, gender, ASA score, and inpatient/outpatient status

Patient characteristics	Data
Number of patients	372
Age at time of rigid (years)	61±13
Gender	
Male	202 (54.3)
Female	170 (45.7)
ASA-PS classification system	
ASA-PS 1	1 (0.3)
ASA-PS 2	7 (1.9)
ASA-PS 3	312 (83.9)
ASA-PS 4	52 (14.0)
ASA-PS 5	0 (0)
Status	
Inpatient	139 (37.4)
Outpatient	233 (62.6)

Data are presented as number, mean ± standard deviation, or n (%). ASA-PS, American Society of Anesthesiologists physical status.

Table 2 The indication for rigid bronchoscopy

Indications for rigid bronchoscopy	Number of procedures
Airway obstruction	266
Airway stenosis	150
Hemoptysis	32
Foreign body	78
Complication following lung transplantation	59
Other	14

anesthesiologists familiar with complex airway diseases and jet ventilation were involved in each case. Either open jet ventilation or closed jet ventilation were used for all procedures.

Data was entered and analyzed using the Research Electronic Data Capture (REDCap), web-based application to prepare for analysis and final datasets. Data is presented as mean, standard deviations, and median. The frequency of events was described as the number of occurrences and percentages.

Statistical analysis

Statistical analysis was used means and median as and was performed using SAS software Version 9.4 (SAS Inc., Cary, NC, USA).

Ethical statement

This study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. As this was a quality improvement study, the local regulatory body at Inova Fairfax Medical Center did not require ethical standard approval. This study protocol was reviewed and the need for approval was waived by the Inova Health System Institutional Review Board. Despite lack of need, all ethical standards were followed in this study. Informed consent was not obtained due to determination of exempt status from the Inova Internal Review Board.

Results

Over a 5-year period between January 2019 and March 2024, 667 rigid bronchoscopies were performed at our institution. Three-hundred and seventy-two of these rigid bronchoscopies were performed in the bronchoscopy suite for non-emergent complex airway diseases. Patient demographic data is listed in *Table 1*; 37.4% of the cohort underwent rigid bronchoscopy during an inpatient admission, while 62.6% were outpatients during the procedure. Assessment of patient risk of complications during anesthesia and surgery was described by an ASA score of 1 to 5, with 1 being low risk and 5 being high risk. One patient had an ASA score of 1 (0.3%), 7 had an ASA score of 2 (1.9%), 312 had an ASA score of 3 (83.9%), and 52 had an ASA score of 4 (14%). No patients had an ASA score of 5 (0.0%). The indication for rigid bronchoscopy was malignant endobronchial airway obstruction (266 patients, 71.5%), airway stenosis (150 patients, 40.3%), hemoptysis (32 patients, 8.6%), foreign body (78 patients, 21%), complications following lung transplant including anastomotic stenosis, anastomotic malacia, and dehiscence requirement stent placement (59 patients, 15.9%), and indication listed as "other" (14 patients, 3.8%) (*Table 2*).

The various maneuvers performed during rigid bronchoscopies included thermal therapy (argon plasma coagulation, neodymium-doped yttrium aluminum garnet

Table 3 The various maneuvers performed during rigid bronchoscopies

Intervention performed	Number of procedures
Thermal therapy	104
Cryotherapy/cryodebulking	31
Stent placement	116
Endobronchial biopsy	157
Therapeutic suctioning of secretions	237
EBUS guided transbronchial needle aspiration	96
Balloon dilation	183
Bronchoalveolar lavage	209

EBUS, endobronchial ultrasound.

laser, radiofrequency ablation, electrocautery) in 104 cases (30%), cryotherapy in 31 cases (8.3%), stent placement in 116 cases (31.2%), endobronchial biopsy in 157 cases (42.2%), therapeutic aspiration of secretions in 237 cases (64%), endobronchial ultrasound (EBUS) bronchoscopy guided transbronchial needle aspiration in 96 cases (25.8%), balloon dilation in 183 cases (49.2%), and bronchoalveolar lavage in 209 patients (56.2%) (*Table 3*).

The overall incidence of intraprocedural complications in our cohort was 2 out of 372 procedures (0.5%). The two intraprocedural complications were pulmonary hemorrhage in 1 patient and cardiac ischemia in 1 patient. Cardiac ischemia during the rigid bronchoscopy was diagnosed by the presence of new T-waves on intraoperative electrocardiogram (EKG) which were previously absent. Neither of these complications led to death. No incidence of airway injury, cardiac arrest, or death were observed. Seven procedures (1.9%) were followed by a change in clinical status within 24 hours of the rigid bronchoscopy. Six of these changes were due to new respiratory failure requiring intubation, high-flow nasal canula, or bi-level ventilation (85.7%). In the 24 hours following the rigid bronchoscopy, no patients suffered cardiac arrest.

Discussion

Performing rigid bronchoscopy in the bronchoscopy suite is safe in the appropriate patient population with a team of skilled practitioners. Our study describes a low incidence of intraoperative complications and a low risk for clinical decompensation within 24 hours of the procedure. In addition to the safety profile, important factors such as conservation of hospital resources and financial sustainability are benefits of performing rigid bronchoscopies outside of the operating room.

As mentioned previously, the incidence of serious complications during rigid bronchoscopy is less than 2%, with the incidence of death being 0.4% (11,12). In this study, the incidence of serious complications such as death, hemorrhage, or pneumothorax during rigid bronchoscopy in the bronchoscopy suite was 0.5% with zero deaths. This indicates that in the correct patient populations, physicians can safely that rigid bronchoscopy can be performed outside of the operating room. Most patients were designated as ASA 3 risks, were not critically ill, and were deemed hemodynamically stable prior to their procedure. Fourteen percent of our cohort were ASA 4 risks and did have the potential for serious complications or deaths. We believe that the risk to patient safety when performing rigid bronchoscopy in the bronchoscopy suite can be minimized in appropriately selected patient populations and clinical excellence on the part of the proceduralist and anesthesiologist.

The bronchoscopic maneuvers and tools used during rigid bronchoscopy in the bronchoscopy suite were the same as those used in the operating room, without change in procedural practice. The current cohort underwent rigid bronchoscopy for the treatment of airway obstructions, hemoptysis, airway complications following lung transplant (both early and late post-transplant period), bronchial and tracheal stenosis, and foreign body removal. Treatment of these conditions required thermal therapies, balloon dilation, cryotherapy and debulking, and stent placement. Traditionally, thermal therapy or stent placement for airway obstruction are performed in the operating room due to potential risk of airway complications. This study demonstrates the ability to emulate the patient care in the bronchoscopy suite is dictated by the equipment, treatment tools, and the personnel involved. Typically, the limiting factor of performing various maneuvers is the availability of the capital equipment to perform these procedures in the bronchoscopy suite.

Modern bronchoscopy suites and operating rooms have similar capabilities. Rigid bronchoscopy, by standard practice, requires specialized equipment and general anesthesia. Most advanced bronchoscopy suites are outfitted with this equipment, including bronchoscopy towers, video assisted thoracoscopic surgical cameras and telescopes, video laryngoscopes, anesthesia machines, jet ventilators,

and difficult airway carts. While cardiopulmonary bypass support is not normally available in bronchoscopy suites, this equipment is unnecessary for hemodynamically stable patients. In circumstances when appropriate rigid bronchoscopy equipment is not available in the bronchoscopy suite, it can be purchased or shared from the operating room. Additionally, interventional pulmonologists trained in advanced airway procedures offer excellent support for anesthesiologists in situations where a difficult airway may be encountered.

In addition to the safety, performing rigid bronchoscopy outside of the operating room may carry substantial financial benefits for a hospital system. The disparity between the cost-per-minute of using the operating room versus the bronchoscopy suite can be significant (15). While our medical center invested approximately $160,000 in capital costs to purchase video-assisted thoracoscopic surgery (VATS) cameras, telescopes, bronchoscopy towers, rigid bronchoscopes, and a jet ventilator to be used in the bronchoscopy suite. Furthermore, direct costs are the costs attributed directly to any procedure such as disposable tools and use of procedural space. The direct cost attributed to the operating room is primarily related to physical space utilization and specialized nursing. The contribution margin is a key performance indicator for procedural sustainability and profitability. Contribution margin is calculated by subtracting variable direct cost for a procedure from the adjusted gross revenue collected. Rigid bronchoscopies performed in the bronchoscopy suite significantly reduces direct cost by utilizing a less costly space and no specialized intraoperative nursing. As a result, the contribution margin of a rigid bronchoscopy performed in the bronchoscopy suite is significantly higher than cases performed in the operating room. Performing rigid bronchoscopies in the bronchoscopy suite resulted in a direct cost reduction of approximately $2,000 per case. As a result, performing 80 rigid bronchoscopies in the bronchoscopy suite resulted in a direct cost reduction equivalent to the cost of the capital investment for new equipment.

Limitation of our study is the retrospective, single-center nature of the analysis. Physicians performing these procedures were fellowship trained in interventional pulmonology. Additionally, patients who were critically ill, deemed hemodynamically unstable, or had concern for potential difficult airways were excluded from our analysis. Procedures for these patients were performed in the operating room. As a result, compared to all rigid bronchoscopy procedures performed at Inova Fairfax Medical Center, the risk for complications in this cohort may have been significantly lower, resulting in fewer poor intraoperative and post-operative outcomes.

Conclusions

Rigid bronchoscopy for the treatment of complex airway diseases, in a select patient population, can be performed safely in the bronchoscopy suite of some hospitals. With appropriate equipment, proceduralists, and anesthesiologists, rigid bronchoscopy can be performed with minimal intraprocedural or post-procedural risk. Successful implementation of a rigid bronchoscopy program in the bronchoscopy suite requires appropriate equipment and specialized personnel. If developed correctly, use of the bronchoscopy suite can result in direct cost reduction and a relative improvement in contribution margin. With the excellent safety profile of this study, hospitals across the country should feel comfortable performing rigid bronchoscopy in the bronchoscopy suite rather than being restricted to the operating room setting.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-2024-2163/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-2024-2163/dss

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are

appropriately investigated and resolved. This study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. As this was a quality improvement study, the local regulatory body at Inova Fairfax Medical Center did not require ethical standard approval. This study protocol was reviewed and the need for approval was waived by the Inova Health System Institutional Review Board. Despite lack of need, all ethical standards were followed in this study. Informed consent was not obtained due to determination of exempt status from the Inova Internal Review Board.

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