
بسم الله الرحمن الرحيم

MALIGNANT CENTRAL AIRWAY OBSTRUCTION: EVALUATION & MANAGEMENT

BY

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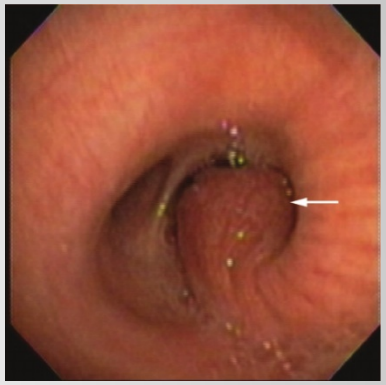
Introduction

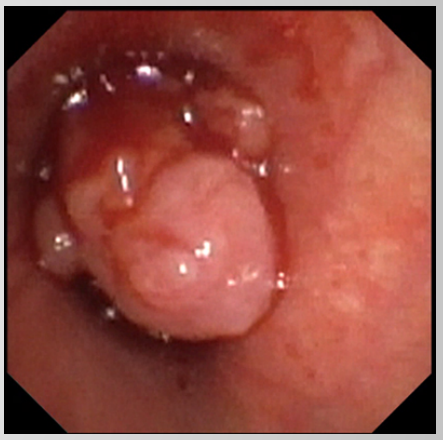
- 20–30% of lung cancer cases are complicated by proximal airway obstruction, which is responsible for 40% of deaths.



- The degree of endoluminal obstruction which will result in symptoms is not entirely clear.
- Many consider an endoluminal diameter <50% of normal to be indicative of “significant airway obstruction”

Clinical presentation of MCAO

- Symptoms are related to local extension, can be mild (cough and exertional dyspnea), but are often severe (rest dyspnea, hemoptysis, post-obstructive infections and asphyxiation).
- MCAO often result in deeply altered QOL and poor prognosis, with patient survival not exceeding 1–2 months.

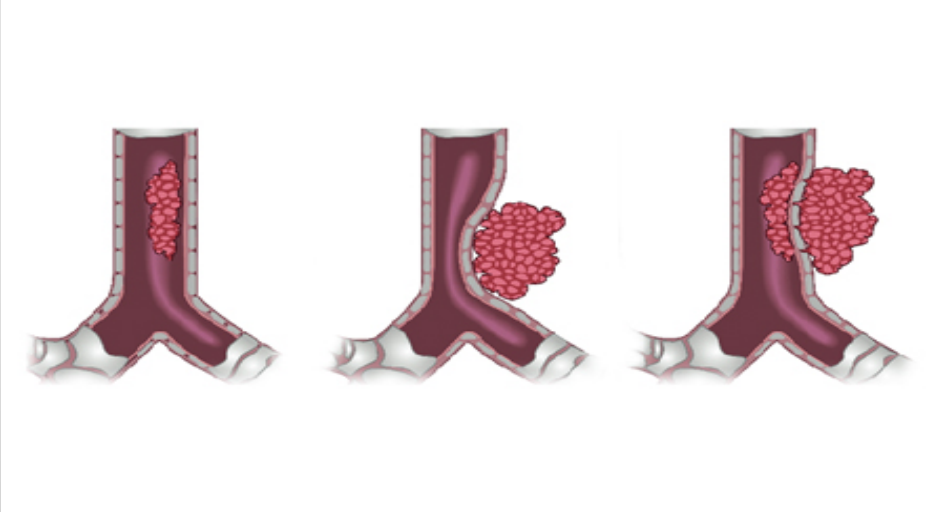


Clinical presentation of MCAO

- In patients with known intrathoracic malignancies the diagnosis of CAO may be relatively apparent,
- However, when a cancer diagnosis has not yet been established, patients will often present after receiving multiple courses of treatment for more common causes of dyspnea and wheezing such as asthma and COPD, especially when tumors are slow growing.

Classification of malignant CAO

- Malignant CAO is classified as extraluminal (extrinsic), endoluminal (intrinsic), or mixed (combined intrinsic and extrinsic).



Radiographic Evaluation

Chest radiograph

- Although routinely obtained, basic chest radiographs rarely provide significant information in the evaluation of CAO and are far less sensitive that CT.
- Plain radiographs can occasionally provide clinical value and are sometimes the only imaging modalities available in situations where patients are unable to lie flat for axial imaging due to orthopnea and hypoxia.

Radiographic Evaluation

CT

- CT has long been recognized as the imaging modality of choice for patients with CAO.
- It can provide valuable information for procedural planning through relatively accurate estimations of lesion length, degree of airway narrowing and anatomic relationships to structures surrounding the airways.
- However, CT scanning can over-estimate the degree of obstruction when mucus or blood is present.

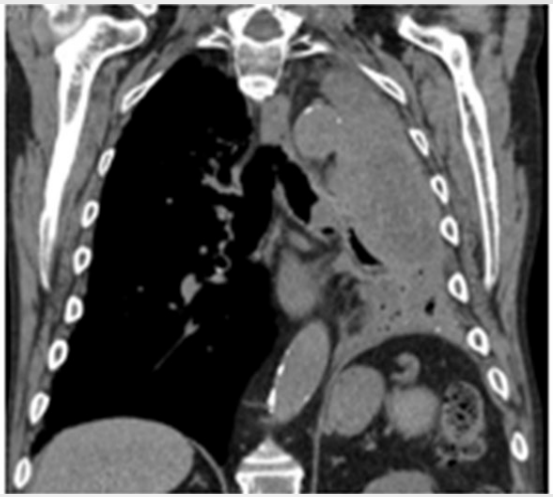
Radiographic Evaluation

CT

- Intraluminal reconstructions allow for a virtual bronchoscopic evaluation.
- The main advantage of the VB is the ability to bypass the obstruction to view the distal airways even with high grade or complete luminal obstruction which precludes the passage of the bronchoscope.

endoluminal left mainstem obstruction secondary to squamous cell carcinoma

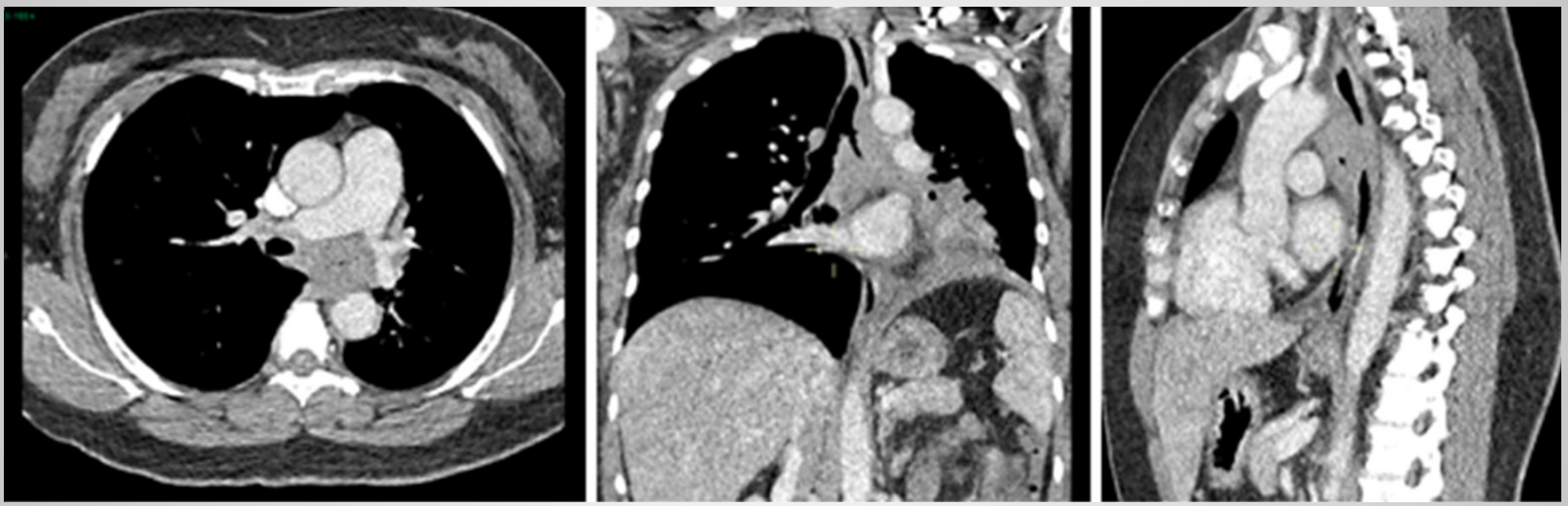
Axial



Coronal

Sagittal

Mixed left mainstem obstruction secondary to adenoid cystic carcinoma



Axial Coronal Sagittal

Evaluation

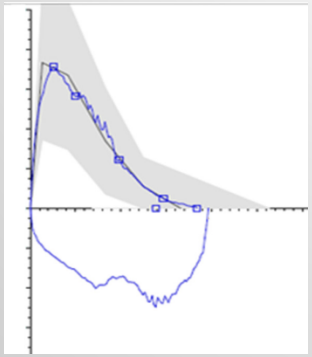
Pulmonary function testing

- Spirometry can be a useful tool to assess for airflow limitation from CAO and document post treatment effect.
- Unlike in peripheral airway disease, CAO does not typically result in significant reductions in FEV1 or VC until obstruction is relatively severe.
- However, the PIF and PEF flow rates are often significantly reduced.

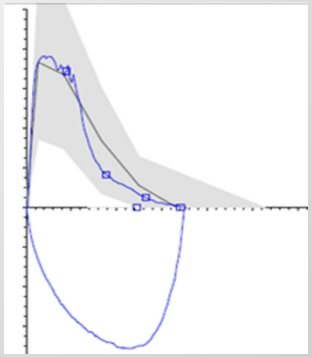
Evaluation

Pulmonary function testing

- In tracheal obstruction, there will be truncation of the inspiratory and expiratory limbs of the flow volume loop.
- While in unilateral mainstem obstruction a biphasic curve may be seen resulting from delayed airflow in the affected lung



FVL before and



1 month after intervention (show improvement in the truncation of the inspiratory loop)

Evaluation

Diagnostic flexible bronchoscopy

- FB as a diagnostic tool can provide a real-time assessment of CAO with the ability to distinguish tumor from associated blood, secretions or necrotic tissue.
- It is considered the gold standard in assessing morphology and degree of CAO.

Evaluation

Diagnostic flexible bronchoscopy

- A major advantage of FB when compared to CT is the ability to biopsy lesions as histological subtyping is an important factor when considering therapeutic intervention.
- Tumors which are highly sensitive to radiation or chemotherapy, such as SCLC, may not require bronchoscopic intervention if the patient is minimally symptomatic and the obstruction is not critical.

Evaluation

Diagnostic flexible bronchoscopy

- Flexible bronchoscopy in the setting of CAO can have significant risks, especially when performed without immediate access to the equipment and skill sets necessary to manage possible complications.

- Even gentle tumor manipulation can induce bleeding and edema which may convert a previously stable partial airway obstruction into an airway emergency.

Evaluation

Diagnostic flexible bronchoscopy

- One must also be cautious about the use of sedative agents, particularly neuromuscular blocking agents, due to the potential to induce complete airway obstruction secondary to loss of respiratory drive muscle tone.

Management

Therapeutic bronchoscopy

- While systemic chemotherapy, radiotherapy and occasionally surgery may be options in the definitive long-term management of malignant CAO,
- Bronchoscopic modalities are the cornerstone of treatment in the acute phase and often result in dramatic and near immediate symptomatic improvement.

Therapeutic bronchoscopy

- Therapeutic interventions in the central airways are efficient tools in palliative relieving dyspnea or controlling hemorrhage as a bridge to more definitive therapy such as radiation or surgical resection.

- Even in critically ill patients with CAO, previous work has shown that bronchoscopic interventions can often facilitate rapid extubation, de-escalation of care and long term survival.

Technical success

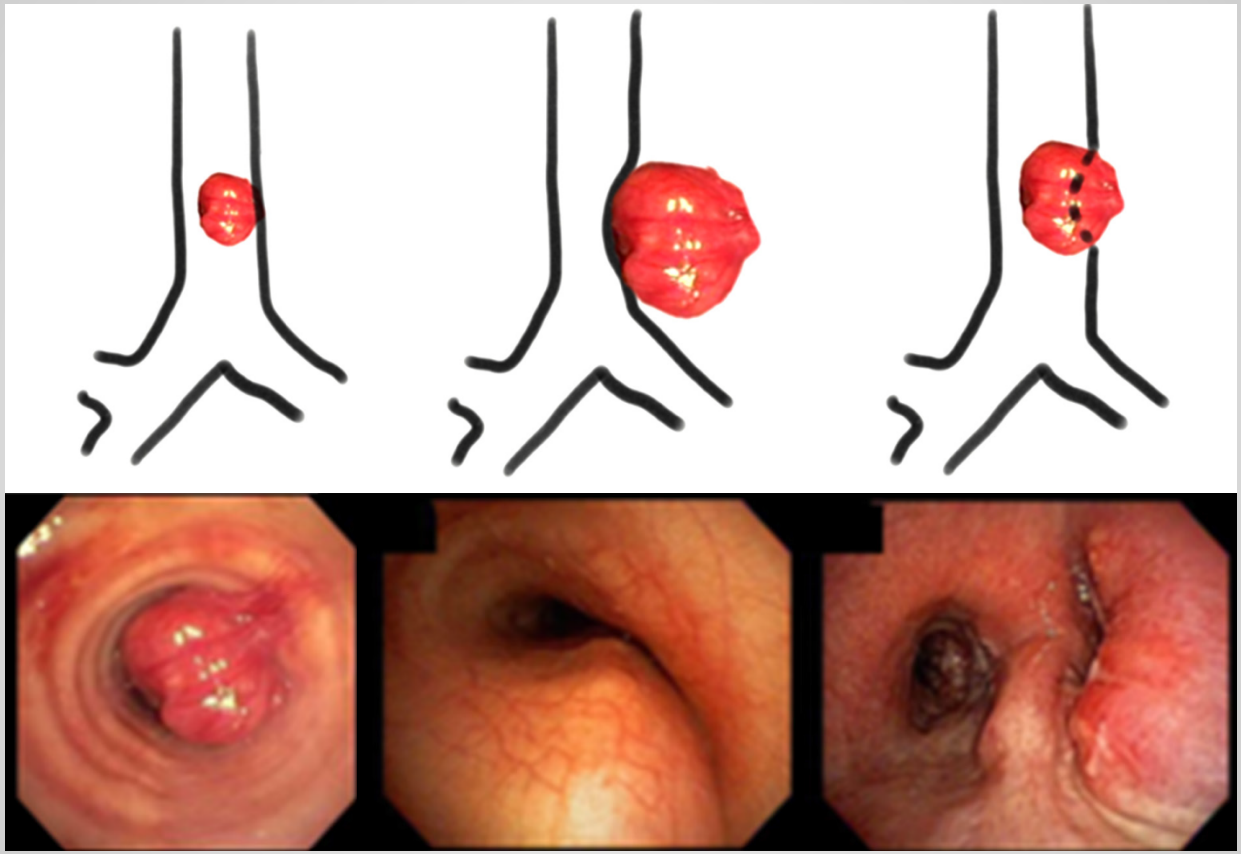
- Technical success in therapeutic bronchoscopy is typically defined as a post-intervention endoluminal diameter of at least 50% of the original airway.
- This is a largely arbitrary definition but is based on the underlying belief that symptoms generally do not occur unless airway obstruction exceeds 50% of the lumen.

Therapeutic bronchoscopy:

Tools and Technical aspects

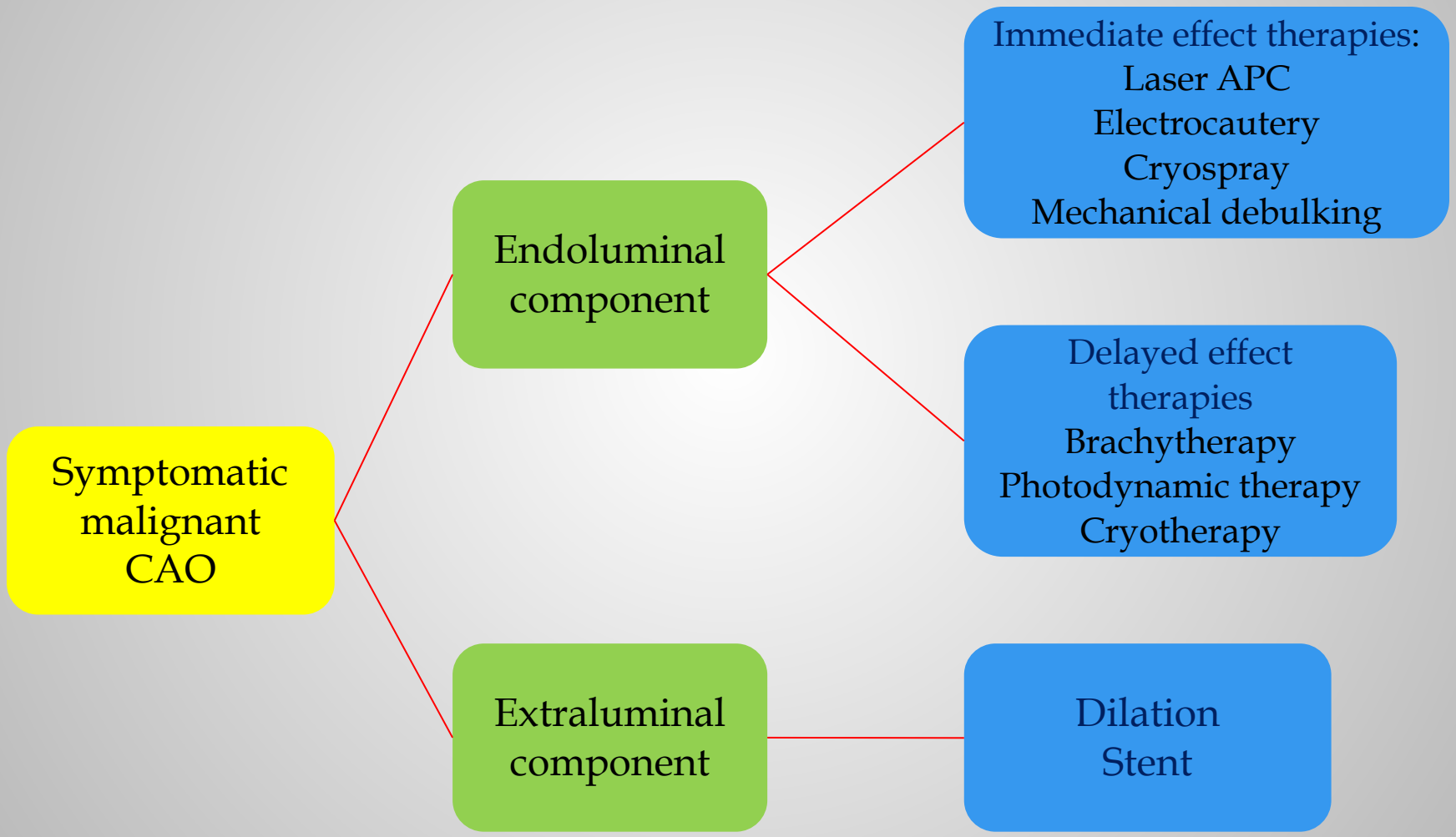
- Several techniques are currently available for relieving airway obstruction, the choice of which technique to use depends on the stenosis features, the patient's condition, available techniques and the individual operator's habits.
- Mechanical debulking and thermal techniques (laser and thermo-coagulation) are thus reserved for intraluminal tumors, while the implementation of tracheal or bronchial prostheses is the preferred management option for extrinsic components.

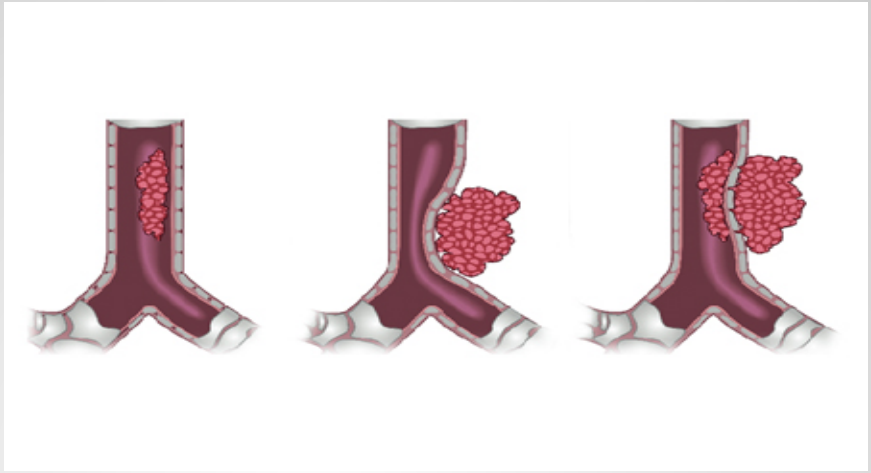
anatomical classification of malignant CAO



Endoluminal obstruction | Extraluminal obstruction | Mixed obstruction

Approach to the management of malignant CAO





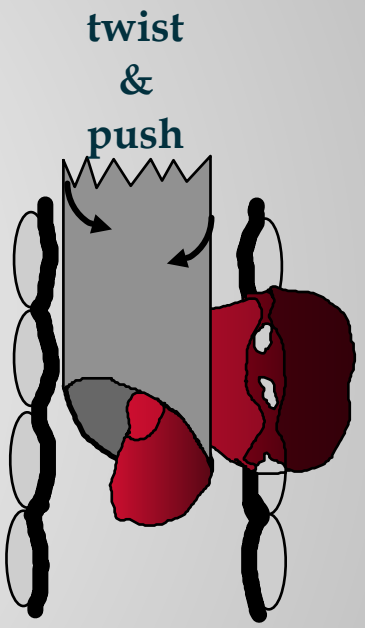
Laser, APC	++	0	++
Brachytherapy,Cryo, PDT	++	0	++
Stents	0	+++	++

- Mechanical Debulking (RB, Large Clamp, Microdebrider)
- Thermal Therapy (Laser, Contact Electrocautery, APC)
- Cryotherapy (Probe, Spray)
- Stents
- Other Procedures

Mechanical Debulking

Rigid Bronchoscopy, Large Forceps

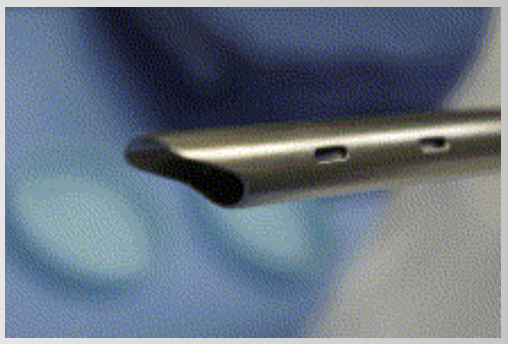
- In 1989, MATHISEN et al. reported encouraging results after performing solely mechanical debulking on intraluminal tumors with either the beveled end of different sized caliber rigid tubes or with a large clamp.



Mechanical Debulking

Rigid Bronchoscopy, Large Forceps

- The procedure was, however, associated with major complications in 20% of patients, such as pneumothorax, haemoptysis and pneumonia.



- With the exception of very proximal and low hemorrhage risk tumors, we recommend combining mechanical debulking with a complementary “thermal” techniques.

Mechanical Debulking

Rigid Bronchoscopy, Large Forceps

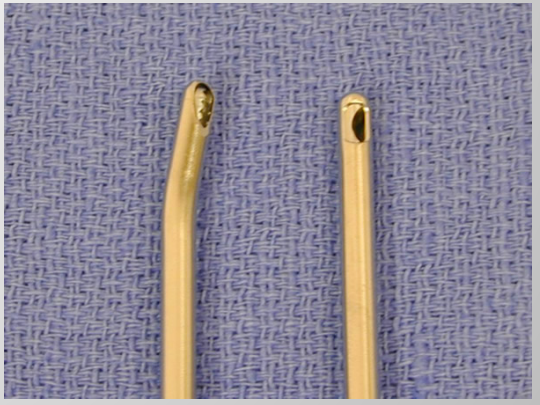
- Contraindications for rigid bronchoscopy include the presence of cervical spine instability, severe maxillofacial trauma, and obstructive buccal or laryngeal disease.

- Possibly the most important contraindication is an inexperienced or inadequately trained bronchoscopist, anesthesiologist or bronchoscopy team.

Mechanical Debulking

Microdebrider

- The microdebrider is a versatile tool for tumor debulking in the trachea and proximal mainstem bronchi.
- The device consists of a rotating cutting blade contained within a rigid metal suction catheter which can be inserted though the RB.



Mechanical Debulking

Microdebrider

- The amount of tissue shaved is proportional to the pressure applied at the target and inversely proportional to the rotation speed of the blade.
- To avoid inadvertent injury to the airway wall it is recommended to utilize suction to pull the tissue into the cutting orifice of the instrument rather than applying pressure to the target tissue.
- As a non-thermal modality, it allows for rapid debulking without the need for any reduction in the fraction of inspired oxygen (FiO2).

Mechanical Debulking

Microdebrider

- Complications are infrequent, however, resecting airway wall and perforation of surrounding vascular structures can be catastrophic.
- Currently available models all require the rigid bronchoscope

Thermal therapies

- Thermal therapies utilize the biological effects of heat on cells to produce tissue destruction.
- Based on the temperature generated at the tissue level, a range of histopathological effects have been described.
- All thermal tools have the potential to produce any of these effects depending upon factors such as the type of tissue, characteristics of the tool and operator-dependent application.

Thermal therapies

- The recommended initial power settings for airway procedures are 20–40 W and the FiO2 should be < 40% to prevent airway fire.

Effect)	Temp. (°C)	Histopathological Effects
Hyperthermia	40	Reversible cell injury, conformational changes of cells, shrinking of collagen, deactivation of enzymes
Devitalization	42	Same as above
Coagulation	60	Denaturation of proteins, hyalinization of collagen, membrane permeability changes
Desiccation	100	Tissue drying, extracellular vacuoles, rupture of vacuoles
Carbonization	200	Tissue ablation and carbonization
Vaporization	300–1,000	Vaporization of carbon

Thermal therapies

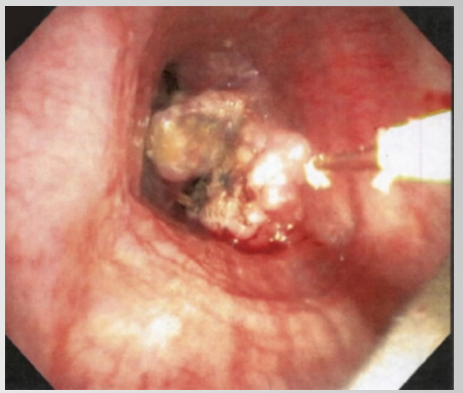
Laser

- Laser therapy is a technique using different gases, such as CO2, and KTP, Nd:YAG (The most widely used laser for the treatment of endobronchial tumors) and Diode lasers in order to coagulate or destroy tumors.

- Laser can be employed through a rigid or flexible bronchoscope.
- The laser should be directed parallel to the airway wall to reduce the risk of perforation and bronchovascular fistula.

Thermal therapies

Laser

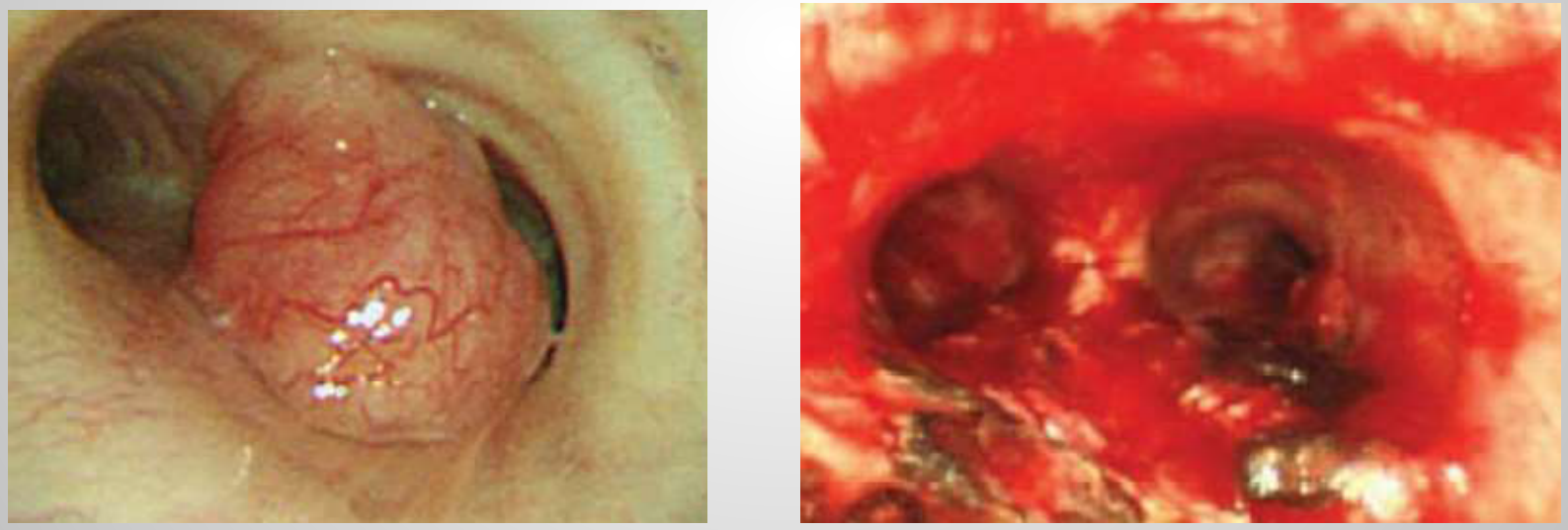


- Lasers can be used as a single modality for coagulation, hemostasis, cutting and vaporization.
- The depth of penetration depends upon the wavelength, distance of probe tip from the target lesion and optical depth (absorbance) of the tissue.
- With the Nd:YAG laser, keeping the tip of the probe at least 1cm from the tumor can minimize the risk of excessive penetration.

Thermal therapies

Laser

- A major advantage of laser when compared to other thermal therapies is that it does not interfere with pacemaker or defibrillator function.



Typical Carcinoid tumor in close proximity of the main carina, Before and After laser therapy

Thermal therapies

Laser

- In 92% of cases, the bronchial diameter is restored, especially in cases of proximal tumors (trachea and main bronchi).
- The mortality rate directly associated with the laser procedure is low, reported to be <1%.
- Hemorrhages are treated using cold serum, adrenaline local administration, compression with the tube, or short pulses of less than 30W.

Thermal therapies

Laser

- Severe haemoptysis only occurs in 1% of cases.
- There is a risk of ignition or airway fire, which is usually not serious and can be prevented by maintaining a low inspiratory oxygen fraction (<0.4).
- Potentially fatal complications include tracheobronchial wall perforations causing vascular fistula (very rare), gas embolism, and mediastinitis.

Thermal therapies

Contact Electrocautery

- Thermo-coagulation (electro-coagulation or electrocautery) involves coagulating or vaporizing a tissue by exposing it to heat produced by a high-frequency electric current.
- High-frequency electric current is delivered using a monopolar mode, by means of a flexible or rigid probe of varying diameter, a coagulation electrode, loop or hot biopsy forceps.

Electrosurgical Unit

Thermal therapies

Contact Electrocautery

- Electrocautery equipment (generator and probes) is far less expensive than laser.
- The symptom improvement observed is constant (96%) and results in a gain of 53% in FEV1, equivalent to that obtained with laser.
- Major complications are rare. The risk of perforation and inflammation is nonexistent in the soft coagulation mode.

Electrocautery knife

electrocautery forceps

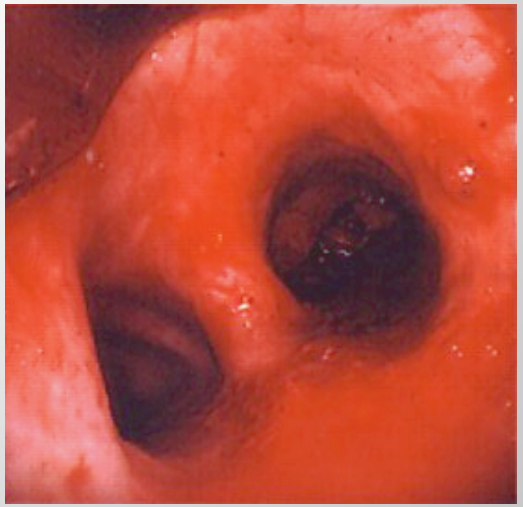
Thermal therapies

Contact Electrocautery

- Circumferentially-applied thermo-coagulation entails a risk of scarring stenosis.

Before

NSCLC

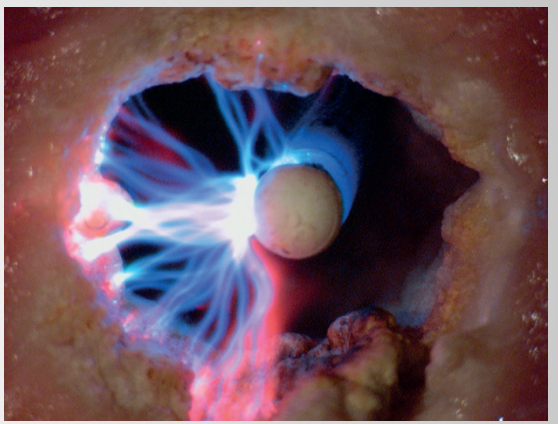


After

Thermal therapies

APC

- The limitations of thermo-coagulation include
  - Restricted access to the apical segments
  - Loss of efficacy in cases of electric current-induced bleeding.

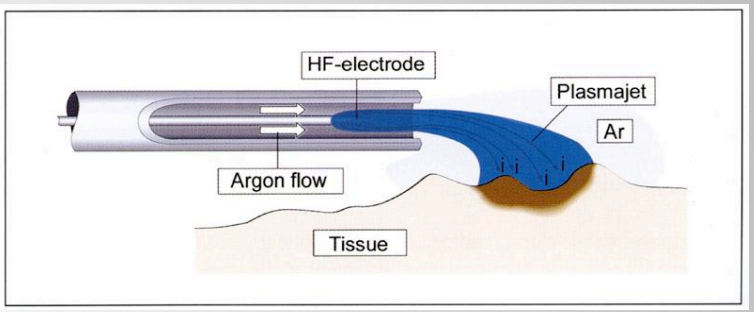


- These two drawbacks are overcome by using Argon as a carrier gas (non-contact method), a technique requiring an additional probe and generator

Thermal therapies

APC

- APC is particularly suited for extensive and hemorrhagic lesions.

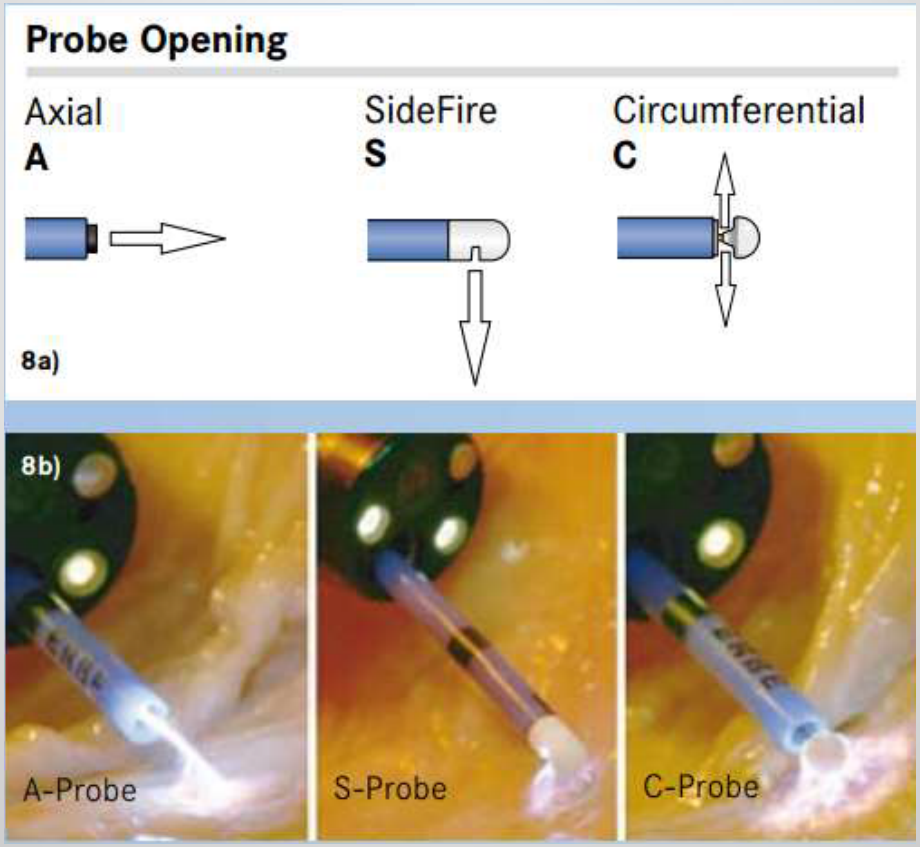


- Indeed, as argon (and thus electric current) is transported to the affected vessels through the bloodstream, haemostasis can be achieved even if the origin of bleeding cannot be precisely identified.
- APC is particularly effective for controlling haemoptysis (100%)

Thermal therapies

APC

APC Accessories



Cold therapy

Cryotherapy

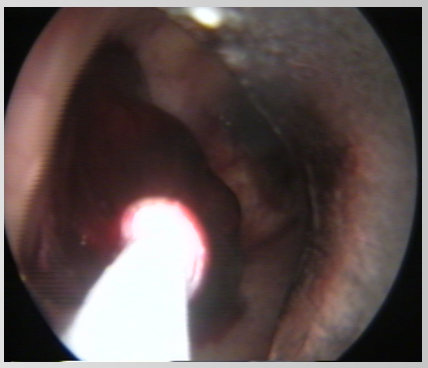
- Cryotherapy consists of delivering very low temperatures, obtained by the expansion of a cryogenic liquid gas, to the tissues in order to destroy them.
- This process requires a console, a cryoprobe and cryogenic gas (N_2O, N_2, CO_2).

Cryotherapy system

Cold therapy

Cryotherapy

- The destructive damage inflicted by cryotherapy is both immediate (dehydration and cellular crystallization) and delayed, involving apoptosis and ischemia (microthrombi formation), leading to a delayed and prolonged result.



- The flexible cryoprobe (available in 1.1, 1.9 and 2.3 mm in diameter) can be passed through the working channel of a flexible bronchoscope for application.

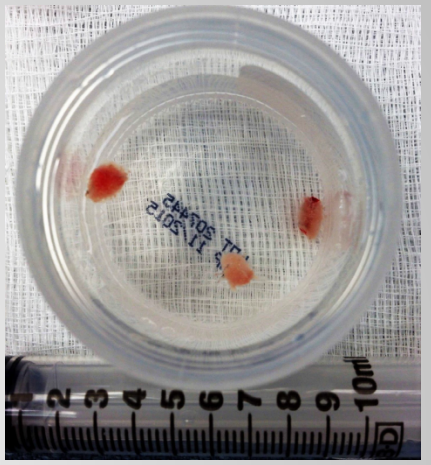
Cold therapy

Cryotherapy

- Rigid and semi-rigid cryoprobes which are inserted through the rigid bronchoscope are now unavailable as they do not provide significant advantage over the flexible probe.
- The techniques of application of cryotherapy vary based on the indication:

Cold therapy

Cryotherapy, Recanalization



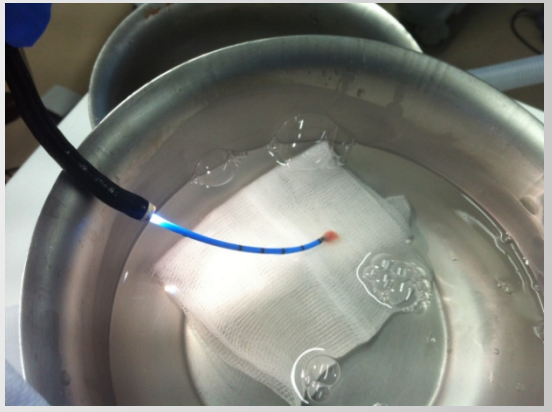
- Cryo-recanalization is the broad term applied to the use of cryotherapy to establish patency of an occluded airway.

- In this case, a cryoprobe is placed in contact with the target tissue, malignant or benign, and activated for a short duration to create an “ice ball” of tissue at the tip of the probe.

Cold therapy

Cryotherapy, Recanalization

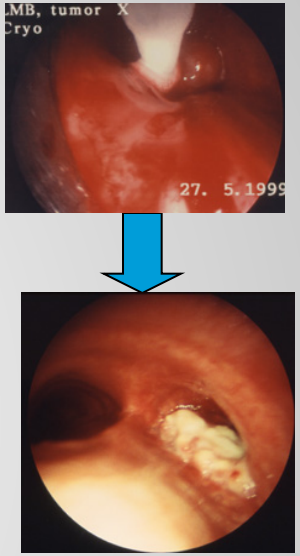
- The duration of activation to allow tissue adhesion with the probe has been reported from 2 to 20 s.
- The probe and bronchoscope is then pulled away from the lesion to remove attached tissue.



Cold therapy

Cryotherapy, Freeze-thaw Cycles

- When cryotherapy is used to treat early stage lung cancer or benign endobronchial lesions such as papillomatosis, several cycles of cooling and thawing are applied to the target lesion.

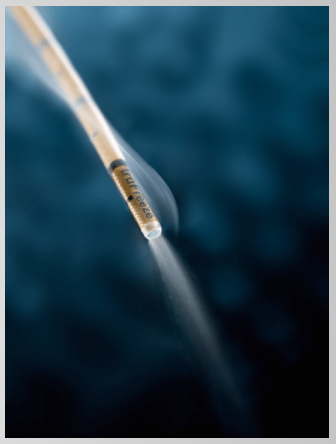


- These cycles are performed by placing the probe on the lesion of interest, activating for 30 s and then allowing the target to thaw completely before repeating this maneuver usually with 3 freeze-thaw cycles.

Cold therapy

Cryotherapy, Spray

- Another method of application is spray cryotherapy in which liquid nitrogen is sprayed through a flexible catheter on the target lesion producing temperatures as low as −196 °C without contact, producing immediate effects. Like argon plasma coagulation.



- This technique appears particularly suitable for treating very hemorrhagic and extensive tumors, especially when the origin of the bleeding cannot be precisely identified.

Cold therapy

Cryotherapy

- The most common complication is the retention of tumor material, requiring a bronchial aspiration to be performed 1–2 days later.
- The risk of perforation is nonexistent, since the cartilage is extremely cryoresistant.

Cold therapy

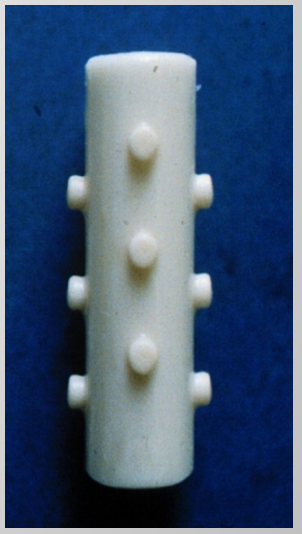
Cryotherapy

- Cryotherapy is indicated as a palliative treatment of non-obstructive proximal stenoses without acute respiratory distress due to its delayed effects.
- With cryo-recanalization, a normal bronchial caliber can be recovered in 61–91% of cases, allowing for the removal of 57% and 76% of total and lobar atelectasis, respectively.

Airway Stent

- In 1965, MONTGOMERY developed a T-shaped tracheal stent, which required tracheotomy.

- This stent was further adapted by DUMON in 1990, who designed a silicone stent by cutting off the horizontal limb of the T-tube, and adding studs along the anterior wall to reduce the risk of migration and contact from mucosa.



Airway Stent

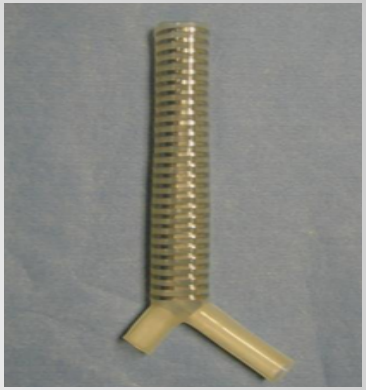
- At the same time, self-expandable metallic stents were shown to be of great value, first using endovascular stents (Gianturco) and later on, dedicated airway stents .

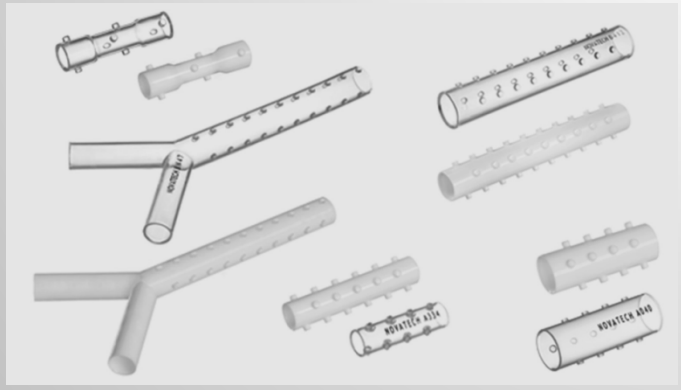
- The ideal prosthesis should: 1) be cost-effective, 2) be easy to place and remove, 3) not migrate, 4) be rigid enough to resist airway compression, yet still flexible enough to mimic airway physiology, 5) not impair mucociliary clearance, and 6) not induce granulation tissue.

Airway Stent

Silicone Stent

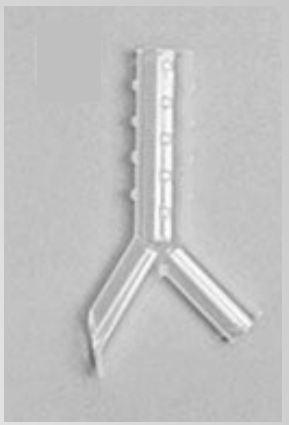
- Montgomery T tube
- Dumon
- Hood,
- Dynamic
- Polyflex





Airway Stent

Silicone Stent

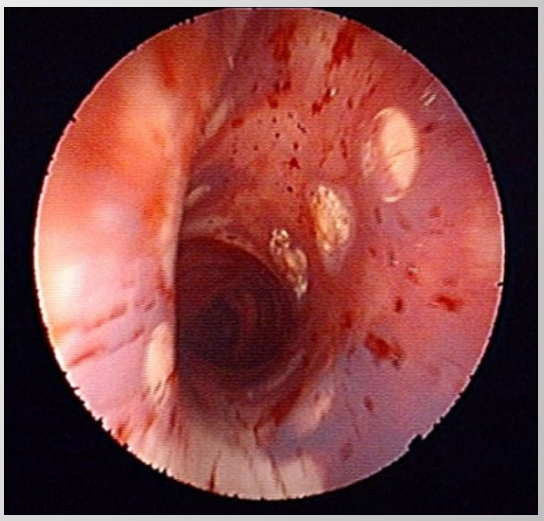


- These stents can be straight or bifurcated for stenoses involving the carina.
- The diameter and size are chosen (and then possibly adjusted by cutting).
- These stents are often recommended as first line treatment since they are easy to place and remove, are well tolerated, and cause few granulomatous reactions.

Airway Stent

Silicone Stent

- Their major drawbacks include :
  - Systematic need for GA and RB,
  - Slightly higher migration rate,
  - Narrower internal diameter due to wall thickness, and
  - Altered mucociliary clearance.



Airway Stent

Self-expandable metallic stents (SEMS)

- The most recent prostheses are SEMS (Ultraflex ; Alveolus ; Aerstent), which can be placed under video-bronchoscopic or radioscopic guidance.
- Their theoretical advantages include :
  - Possibility of placement using FB,
  - Lower risk of migration,
  - Better preserved mucociliary clearance and
  - Larger internal diameter.

Airway Stent

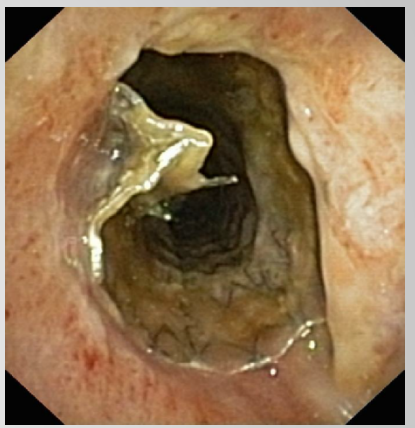
Self-expandable metallic stents (SEMS)

- Covered stents are preferred in neoplastic stenosis, but uncovered stents still have their place in tight and highly distorted stenosis where they maintain a constant diameter even within kinks.
- Self-expandable coated stents are particularly suitable for covering a fistula, and stop recurrent septic pneumonias.

Airway Stent

Self-expandable metallic stents (SEMS)

- The major drawbacks include :
  - Risk of granulomatous reactions on the extremities,
  - Re-epithelialization of uncovered stents rendering the stent difficult to remove after 3–6 weeks, and
  - Increased risk of ischemic mucosal necrosis and, thus of perforation (with Gianturco stents).



Other Procedures

Endoscopic dilatation

- Endoscopic dilatation consists of inflating (to 3–6 atm pressure) a balloon placed in the centre of an obstructive lesion via radioscopic or video-endoscopic guidance (using a guide wire).
- Due to its transient efficacy, this procedure must be considered as the first step of an interventional bronchoscopy, preparing the trachea or the bronchus for stent placement.

Other Procedures

Photodynamic therapy

- PDT involves destroying a tumor by activating a systemically or locally administered photosensitizing agent (most commonly a haematoporphyrin derivative e.g. photofrin) using a light source (laser fiber emitting nonthermal light) with a specific wavelength (630 nm) , which induces a phototoxic reaction and cell death.
- The photosensitizing drug is eliminated from most tissues within 72 h, yet remains preferentially stored in the skin, liver, spleen and, above all, in the malignant cells.

Other Procedures

Photodynamic therapy

- Subsequently, FB is performed in which a light source (usually a laser fiber emitting nonthermal light) emitting the optimal wavelength for the photosensitizer is introduced through the working channel and activated near the target tissue.

Other Procedures

Photodynamic therapy

- A second bronchoscopy must be performed 1–2 days later to remove necrotic tumor tissue and then after 5–7 days to expose residual tissue to a second illumination.
- Like cryotherapy, PDT achieves marked, yet delayed, symptom improvement and is, therefore, not suitable for critical proximal obstructions.

Other Procedures

Brachytherapy

- Brachytherapy involves applying radioactive isotopes (Iridium 192) in a highly localized manner to the tumor in order to preserve neighboring healthy tissues by using a graduated radio-opaque catheter under video-endoscopic guidance.
- While symptoms and functional parameters usually improve with this technique, the rate of severe complication is substantial and reported as between 13 and 20%.

Other Procedures

intratumoral chemotherapy (ITC) and transbronchial needle injection (TBNI) of chemotherapy

- ITC and TBNI of chemotherapy has been well studied for delivery of chemotherapeutic agents (such as Cisplatin, 5-Fluorouracil, Bleomycin and Carboplatin).
- Advantages included: more precision drug delivery, higher tumor drug concentration and less or no systemic toxicity.

Other Procedures

intratumoral chemotherapy (ITC) and transbronchial needle injection (TBNI) of chemotherapy

- However, emerging evidence suggests that this modality has systemic benefits (and toxicity) and may be used as an adjunct with other interventions such as low dose chemotherapy.
- In these procedures, chemotherapeutic agents can be injected directly into luminal tumors or into thoracic lymph nodes with the assistance of EBUS.

Combination of techniques

- Although some of the techniques appear to compete with one another, for example laser and thermocoagulation.
- Others can be complementary, e.g. stent placement following debulking.
- The synergistic combination of laser, used for immediate effect, and brachytherapy, used for a lasting effect, has been proven to achieve excellent symptomatic responses and extended survival.
- The use of cryotherapy associated with a mechanical debulking treatment and/or thermal therapy is probably an interesting option for an immediate and quick effect as well as a prolonged cytotoxic effect.

"there is more hope with the bronchoscope"

Shigeto Ikeda (1925-2001)


Thank You!