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Case report

A new mode of ventilation for interventional pulmonology. A case with EBUS-TBNA and debulking

Paul Zarogoulidis[a,*], Haidong Huang[b], Chong Bai[b], Christoforos Kosmidis[c], Konstantinos Porpodis[d], Anastasios Kallianos[e], Lemonia Veletza[e], Georgia Trakada[e], Naim Benhassen[f], Wolfgang Hohenforst-Schmidt[g]

[a] Pulmonary-Oncology Unit, "Theageneio" Cancer Hospital, Thessaloniki, Greece
[b] Department of Respiratory and Critical Care Medicine, Changhai Hospital, The Second Military Medical University, Shanghai, China
[c] Surgery Department, "Interbalkan" European Medical Center, Thessaloniki, Greece
[d] Interventional Pulmonary Department, "G. Papanikolaou" General Hospital, Aristotle University of Thessaloniki, Thessaloniki, Greece
[e] Division of Pulmonology, Department of Clinical Therapeutics, National and Kapodistrian University of Athens School of Medicine, Alexandra Hospital, Athens, Greece
[f] Medical Clinic I, "Fuerth" Hospital, University of Erlangen, Fuerth, Germany
[g] Sana Clinic Group Franken, Department of Cardiology/Pulmonology/Intensive Care/Nephrology, "Hof" Clinics, University of Erlangen, Hof, Germany

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ABSTRACT

Lung cancer is still underdiagnosed mainly due to lack of symptoms. Most patients are diagnosed in a late stage where unfortunately only systematic therapy can be applied. Fortunately in the last five years several novel therapies and combinations have emerged. However; in certain situations local therapeutics modalities have to be applied in order to solve emergency problems as in the case that we will present. Convex-EBUS probe was used along with a novel method of ventilation which keeps PCO_2 concentration satisfyingly low.

1. Introduction

Lung cancer is till underdiagnosed due to lack of early symptoms. In late unresectable stages only systematic therapies can be applied. In the last five years tyrosine kinase inhibitors (TKIs) are being used for epidermal growth factor positive patients (EGFR) and anaplastic lymphoma kinase mutation positive patients (ALK) [1–4]. Moreover; immunotherapy either as first line or second line has been approved in the past 20 months for metastatic lung cancer disease [5]. However; there are situations where lung cancer is diagnosed under emergency situations. A mass obstructing the trachea is such a case where debulking with an interventional method has to be applied as a method to resolve lifethreatening problem. Debulking can be applied with different methods and under different set-ups [6–9]. Every emergency case is different and treatment methodology has to be individualised. There are cases where apart from debulking a silicon or metal stent has to placed and also in several cases radiotherapy might follow. In the following case we will focus on the use of convex probe EBUS for debulking and a new methodology of ventilation during these procedures.

2. Case

2.1. Ventilation

High frequency jet ventilation is used in anaesthesiology since the 1960s. Nasal jet-catheter ventilation (nJV) is a quite new mode of ventilation in interventional pulmonology which allows us to handle safely difficult-to-treat scenarios without rigid bronchoscopy and the need for anaesthesiologist stand-by. The nasal jet-catheter is applied through nose or mouth in a seldinger-technique which needs not more than 1–2 minutes. These jet-catheters are feasible to be used with thermal ablation techniques like laser or argon-plasma-coagulation. In general JV can be applied supraglottic or infraglottic, even transtracheal or in open field surgery. Due to different connectors it can be applied through all rigid bronchoscopes as well as through laryngeal mask. Depending on the jet-ventilator generator one can apply one frequency or 2 frequencies with one 'normal' frequency (maximum at 100/min) and one superimposed frequency ranging up to 1500/min. The largest reported range of operating frequencies for superimposed high frequency jet ventilation (SHFJV) was in the past in the range for 6–30/min for the normal frequency and 180–900/min for the superimposed frequency [10] whereas other reported (including a study with

* Corresponding author.
E-mail address: pzarog@hotmail.com (P. Zarogoulidis).

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Table 1
Important information regarding the new mode of ventilation.

- Underlying lung diseases plays a crucial role in the ventilation of the patient indifferent if we use navigation or not.
- Patients with a lung disease usually have a heart condition which affects their ventilation.
- In the group with lung disease the duration of the procedure is the most important factor indifferent whether navigation is used or not.
- The use of navigation is indifferent for the ventilation of the patient during the procedure.

By navigation we mean any means of navigation whether it is with a radial-endobronchial ultrasound, electromagnetic navigation or C-arm fluoroscopy.

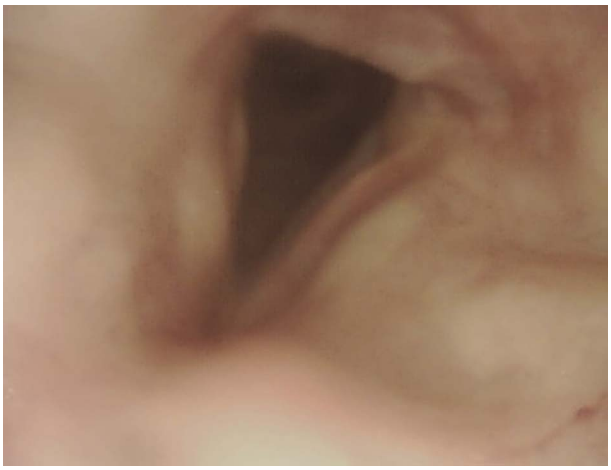

Fig. 1. Assesement of the vocal cords with STORZ anesthisiologist flexible bronchoscope.

Fig. 2. Assesement of the trachea with STORZ anesthisiologist flexible bronchoscope.

over 1500 patients) a range for the normal frequency of 12–20/min and 400–600/min for the superimposed frequency [11–14]. Today using these machines with high experience we simply adapt the settings of the both frequencies to the intended intervention in pulmonology, cardiology or radiology and measured effects in arterial blood gas analysis and hemodynamics.

Both frequencies can be adjusted in driving pressure and inspiration to exspiration ratio which has to be derived from patients monitoring and physiology. As a consequence of more constant air flow the superimposed high frequency jet-ventilation shows in general a more effective ventilation with higher tidal volumes than a high-frequency jet-ventilation (HFJV) with only one frequency. Therefore it is our absolutely preferred mode in flexible and rigid bronchoscopy [15,16].

For regular non-rigid use without anaesthesiologist in interventional

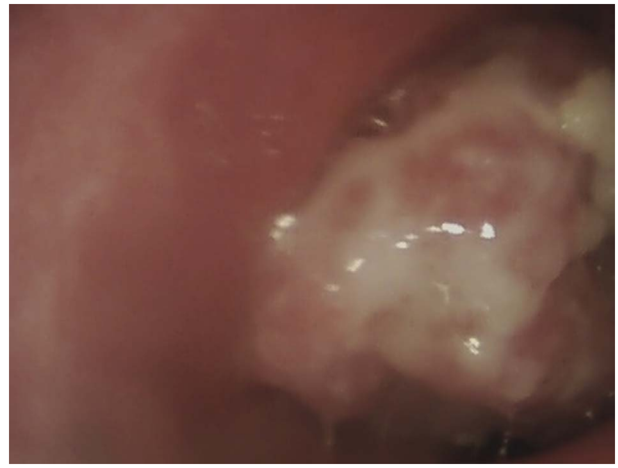

Fig. 3. Assesement of the mass lession with STORZ anesthisiologist flexible bronchoscope.

Fig. 4. The patient intubated with a STORZ rigid bronchoscope 12mm outer channel and 11mm inner channel.

pulmonology with infraglottic JV, the trachea is intubated with a LaserJet catheter (Acutronic Medical Systems AG, Hirzel, Switzerland) with the following parameters: Jet-catheter lumen with an inner diameter of 1.8 mm, a lumen for pressure measurement with an internal diameter of 0.8 mm and the external diameter of the catheter with 3.2 mm. The tip is regularly positioned 3–6 cm below the vocal cords depending on the site of action in regards to the interventional pulmonology procedure – in this case EBUS and debulking.

Our personal set-up is initially referred to the patients' body weight: The working pressure is set in reference to body weight in kg/100*0,9 bar and 12/min for the normal frequency and half of this pressure and 600/min for the superimposed frequency. This very conservative setting for the first minute minimizes the risk of barotrauma. We always start with a fractional inspiratory oxygen concentration of 80%. The inspiration-to-exspiration ratio (I:E) is set to 1:1 for both frequencies and adjusted over time in regards to measured partial pressures for oxygen (paO2) and carbon dioxid (paCO2) as well as for chest wall movement, hemodynamics, patients physiology and intended intervention. Both above mentioned frequencies are adjusted over time in reference to monitoring values knowing that the mean airway pressure (Pmean) influences mainly hemodynamics and paO2 whereas paCO2 is mainly influenced by the normal (low) frequency, its working pressure and I:E setting. Pmean is influenced by both frequency settings including working pressure and I:E and of course physiological

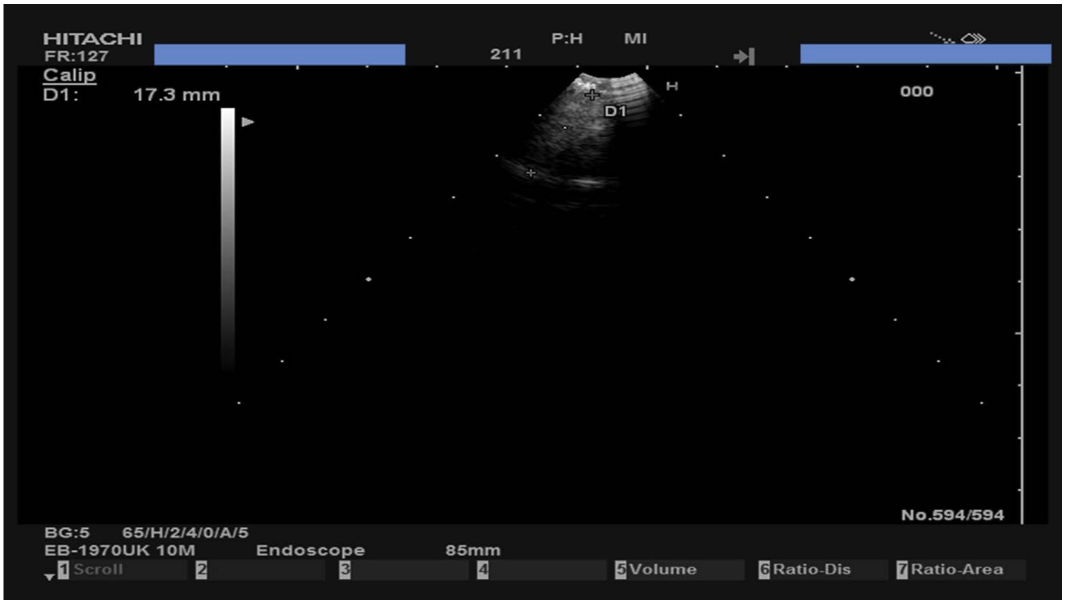

Fig. 5. The EB-1970UK PENTAX probe (U/S tip) is looking the depth/volume of the mass in a certain position while in direct contact with the mass without a baloon in front.

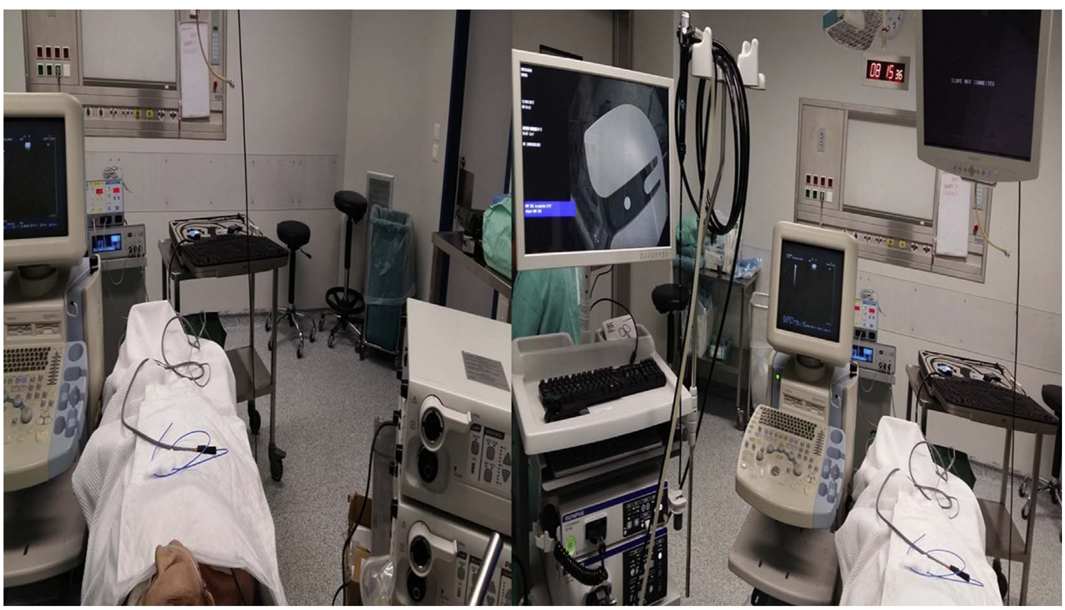

Fig. 6. Process set-up.

variables of the patient itself like compliance and airway resistance. Positive end-exspiratory pressure (PEEP) is predominantly influenced by all variables of the second (high) frequency in SHFJV.

The physiology of an open high frequency jet-ventilation is still not thoroughly understood, therefore theoretical yet highly effective for oxygenation and satisfying for carbon-dioxid removal with only modest increase of intrapulmonary positive pressure and influence on cardiovascular hemodynamics in comparison to conventional closed tube ventilation: Taylor and convective dispersion, cardiogenic mixing, molecular diffusion, pendelluft and bulk flow [17].

Its use is growing rapidly: Beside classical indications like ENT or thoracic surgery and interventional pulmonology, difficult to ventilate rescue situations, hemodynamic instable patients to ventilate it is increasingly used in situation of 'precision' medicine in which any targeted organ movement is linked to reduced treatment success: Laser treatment of lung tumors [18], minimal invasive tumor treatment with all kinds of (thermal) ablation techniques in percutaneous, laparoscopic or open approaches [19–22] during electrophysiological abaltion of atrial fibrillation [23], and during shock wave lithotripsy [24]. Immobilisation of targeted areas is essentially needed for any approach with image fusion techniques [19,21]. Especially in regards to this set-up we have a vast experience in nasal jet-catheter controlled SHFJV intermediately applied in change with a hyperinflation mode in cone beam computer tomography guided endobronchial navigation for small solitary pulmonary nodules [25,26].

Moreover the last author has a lot experience in the field of interventional cardiology like coronary angioplasty or interventional treatment in structural heart disease like left atrial appendage closure supported by jet-ventilation.

In the hereby mentioned case it was unclear if we had to stent the patient after the debulking, therefore it was decided to start directly with rigid bronchoscopy supported by SHFJV with the Carl Reiner Jet-Ventilator TwinStream. We summarized the most important information for this method in Table 1 based on our unpublished experience.

Fig. 7. APC-ERBE system during the debulking procedure.

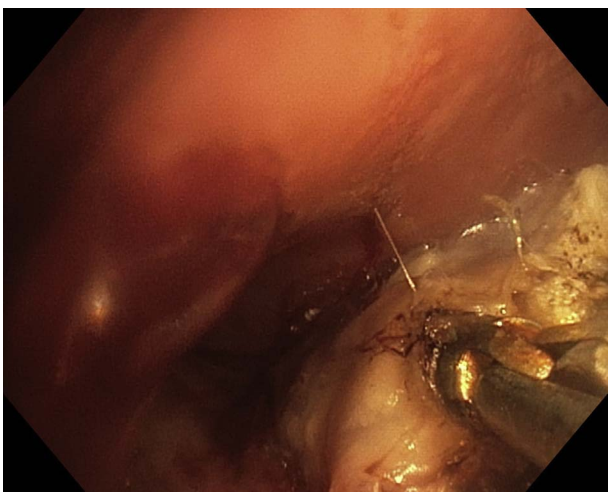

Fig. 8. Electrocautery forceps during the debulking procedure.

2.2. Debulking

A 60 year old patient presented in the emergency room reporting intermitent dyspnea for the past 30 days. Saturation was between 87 and 96%. Saturation was observed to change with the patients's secretions. He was immediately admitted and a chest CT was performed. Biochemical results were normal, however; a mass was observed in the middle of the patients trachea along with atelectasis of the right lung. The patients clinical condition was stable and bronchoscopy was performed in order to evaluate the mass of the trachea with the concept to perform debulking. Initial bronchoscopy was performed with a STORZ anesthiologist bronchoscope and after evaluation of the obstruction intubation was performed with the rigid STORZ bronchoscope 12mm outer channel and inner 11mm working channel (Figs. 1–4). We used a PENTAX EB-1970UK convex probe in order to evaluate the volume of the mass and surrounding architecture, we were interested mostly for vessels (Figs. 5–8). We then used argon plasma coagulation system (ERBE) along with electrocautery forceps, rigid forceps and electrocautery rigid forceps until the debulking process was completed.

3. Discussion

In emergency situations where central lung cancer masses obstruct either the trachea or a central airway, then an intervention has to be performed in order to release the obstruction. In central masses of the trachea we can use several techniques with either rigid bronchoscope with rigid tools or semi rigid technique with the flexible bronchoscope [8,9]. We also use a tracheal tube along with the flexible bronchoscope and its tools. There are different tools that can be used for debulking such (YAG) laser, argon plasma coagulation, electrocautery, forceps, cryo probe and electrocautery forceps. It depends from the equipment and method of intubation which tools can be used. Moreover; the site of the mass plays a crucial role for the methods that can be used. A stent might also be necessary if the architecture of the airway collapses. The stent that is going to be inserted (silicon/non-silicon) depends on further treatment of the patient and patient status. In most cases systematic treatment administration might be necessary or even radiation might be applied as adjuvant therapy locally [27]. We present a case where convex probe ebus was used for evaluation of the depth of the lession that could be cut and of course we were able to evaluate the vessels in the surrounding region. Furthermore; with our new ventilation model that we applied we were able to keep pCO_2 concentrations at low levels for a longer period of time. Possibly with this method of ventilation we can finish a debulking process or an interventional pulmonary process quicker that with another ventilation protocols, however; further studies have to be made for evaluation.

Conflict of interest

None to declare.

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