

Application of the biolitec EVOLVE Laser in interventional bronchology

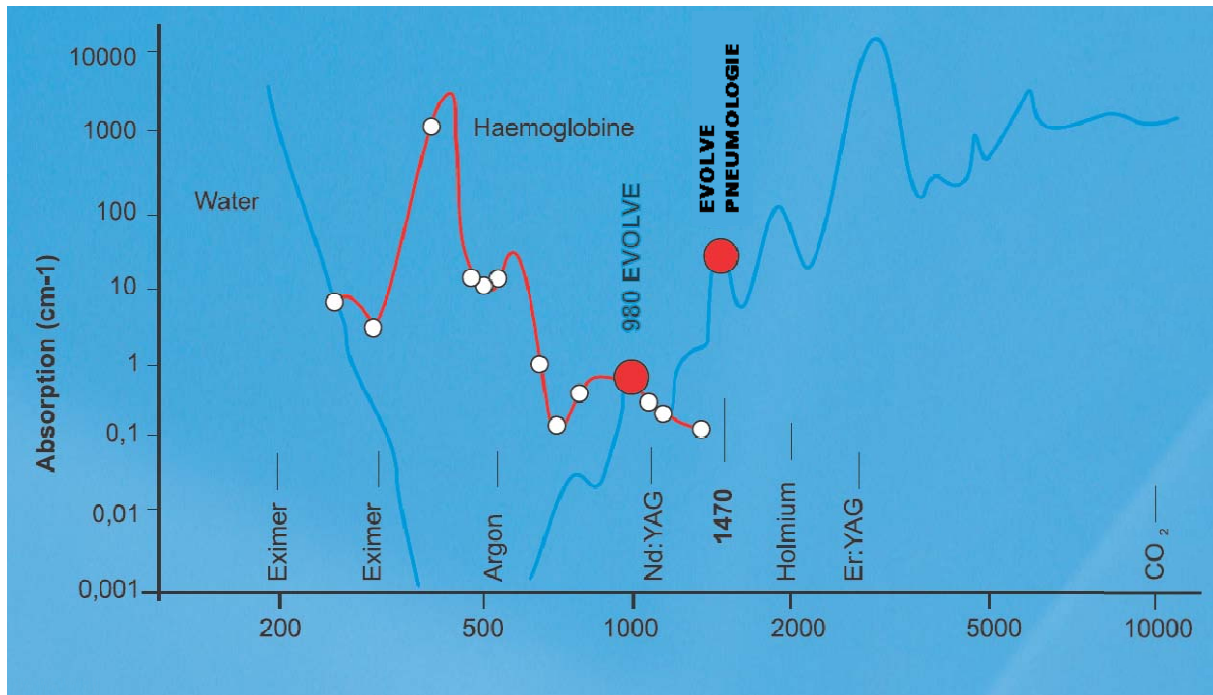
The implementation of different new techniques in therapeutic bronchoscopy led to a reduction in morbidity and mortality of critically ill patients. Within the palliative approach with a central malignant obstruction Laser resection, Electro-Kauter or the Electro coagulation, Argonplasmabeamer, the (“new”) Kryo-Recanalisation as well as airway-stenting in some cases offer chances for an immediate reduction of the symptoms. Classical cryotherapy, brachytherapy and photodynamic therapy mostly only have an effect when adopted with latency.

Clinical background

Advanced bronchial carcinomas often lead to a massive limitation of the quality of life because of an increased local tumor size. A significant obstruction of the central respiratory system with serious symptoms requires quick therapeutic measurements with an immediate rebuilding of the airway passage. The central airway obstruction is based on intraluminal tumor growth, extraluminal compression or – in many cases – on a combination of both. Most often the relocation of the airway exists in advanced cases where therapies like chemotherapy and radiotherapy cannot be applied successfully anymore. The approved therapeutic strategy contains tumor coagulation in order to reduce the risk of bleeding, followed by – if possible – mechanical ablation and – if after that there is still significant compression – the insert of a stent.

Laser-resection

Laser-resection is understood as the application of laser energy through a fixed and/ or flexible bronchoscope in order to treat endoluminal lesions in a curative or palliative way. The term Laser stands for “light amplification of stimulated emission of radiation”. The laser light is applied through optical fibers, which are appropriate for bronchoscopy. The impact of the laser is characterized by: 1. power adjustment of the laser; 2. absorption and diffusion coefficient in the tissue; 3. the application system. The effect of the laser is influenced by laser type, tissue characteristics and application duration. Besides vaporization a laser which is suited for bronchoscopy allows a fine coagulation of the tissue. Because of that the Nd:YAG laser is used in bronchoscopy. Recently also other lasers like the diode laser are offered and used by us. Normally, fibers for the use in contact mode and non-contact procedure are offered. Coagulation is achieved by a greater distance of the fiber to the tissue, vaporization through a shorter distance to the tissue and through modifications of the settings. The selected tactic is dependent on the availability of fixed bronchoscopy. With the fixed or combined procedure the tumor is coagulated at first and ablated mechanically with a fixed pipe under a reduced risk of bleeding. The suction of the smoke via the fixed pipe is reasonable. The flexible procedure also coagulates; afterwards the tumor is either vaporized totally or ablated mechanically with smaller instruments. Thereby of course the procedure is limited. The laser-resection requires a high quality anesthesia, with the flexible procedure mostly as local anesthetics with sedatives or general narcosis, with the fixed procedure normally as a general narcosis with muscle relaxation.



Picture 1: Different laser types, their wave lengths and the relation to the absorption curve of water and hemoglobin. The diode laser applied has a wave length of 1470nm.

Clinical experience and results

After the first laser-resection publications in 1976 by Laforet et al. this became the most commonly used non-surgical method for malignant, semi-malignant or even benign diseases of the endoluminal respiratory system. The indication for laser-resection exists for obstructive lesions of the trachea, of the main bronchia, of the bronchus intermedius or of lobe orifices, which have a bad impact on ventilation or cause symptoms like stridor, cough, hemoptysis or secretion retention. The laser therapy for lesions which are more in the periphery are indicated only exceptionally. Laser therapy is most often used for inoperable lung or bronchial carcinomas with endoluminal manifestation for a palliative purpose. It is often combined with other types of treatment like external exposure, brachytherapy and/or the application of a stent.

Contraindications are mostly relative. The absence of an intraluminal component is an absolute contraindication. Relative contraindications are fistulas and coagulopathy. Complications of the laser-resection are hypoxemia, bleeding, perforation and the formation of fistulas as well as endo-bronchial fire. Due to that reason laser resection should be done with FiO_2 below 0,4.

The procedure using a fixed bronchoscope or tracheoscope allows sufficient ventilation, the application of the laser fiber and the application of suction-catheters at the same time. Furthermore, fixed pipes enable good dilatation of the airways. Because of that, the fixed technology is preferred by most doctors who have a command of this. If possible, patients should be treated in those centers which have a lot of experience with these technologies.

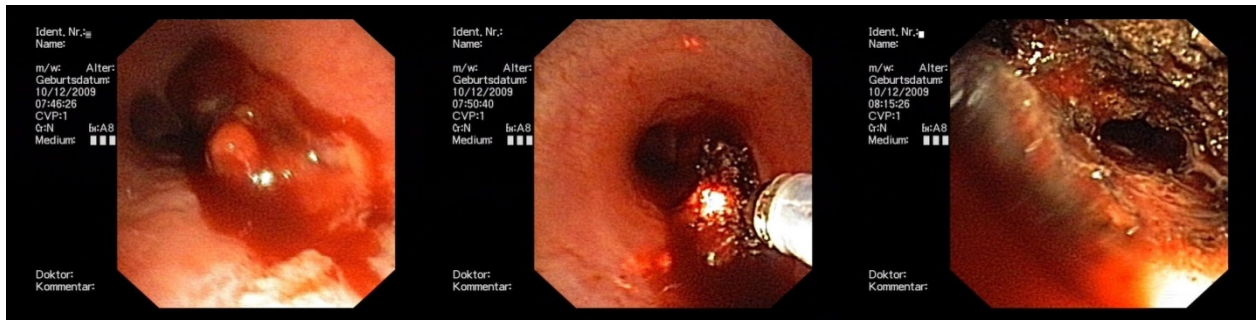
Experience with biolitec EVOLVE™

The EVOLVE™ offers a high spectrum of applications, also for the use in the interventional bronchology. The diode laser has a wave length of 1470nm.

The procedure used within the bronchial system is dependent on the diagnostic findings. Normally tumors are ablated by fixed bronchoscopy. Here we additionally use the flexible bronchoscope under jet-ventilation and general anesthesia with muscle-relaxation via the fixed pipe. This procedure is much safer. The fixed bronchoscope serves as access and tubus for ventilation. It allows the removal of the fiberscope at any time and the cleaning of the lens and the laser fiber. The fiber is applied through the flexible bronchoscope and is controlled by a direct visible check with the help of the fiberscope and the pilot-beam. If necessary, interventions can be done through the fixed pipe, especially in cases of serious bleedings or if additional mechanical ablations are reasonable.

At first, smaller tumors are coagulated then vaporized before ablated totally without any bleeding. It is especially of advantage working in non-contact mode using a gas-cooled CERALAS fiber. This leads to a cooling-effect and also to “cleaning” the surroundings. The initial setting we prefer is 15 to 20 Watts. Within small distance (only a few millimeters) to the tissue the pilot beam is run over the surface of the tumor until a whitely discoloring can be seen. Normally the application period can be controlled by the pedal switch under visual check. By that a reduction of bleeding can be achieved. After that tissue is ablated – if necessary by a stepwise increase of power of 5 W at a time up to a total of 30 W – until reaching the mucous membrane level. By doing that, tissue is carbonated first, then vaporized and finally it clears away. An important advantage of the laser is that it is a very precise and well controllable instrument for ablating tissue. Modifications are possible by changing the application period of the laser beam with the pedal switch and, if necessary, by increasing the laser power. Perforation is prevented by working gradually and from one layer to the next one. Navigation through the normal surface and the continuity of the airways helps not to get too deep into the tissue and not to create a via falsa. The result of that is that a visual insight into the operation field is a precondition for working with a laser.

For larger tumors an identical procedure is possible generally, sometimes even practical. This concerns especially strongly vascularized tumors with a higher bleeding risk. The extended treatment duration is a disadvantage. With a combined procedure using a fixed bronchoscope and a fiberscope a reduction of the treatment duration can be achieved through ablating exophytical parts mechanically either primarily or secondarily after coagulation. For globular tumors the sling (mostly without electricity) is increasingly used in bronchology. In other cases optical instruments like pincers or scissors are used. Also the tip of the fixed pipe is an excellent and well-tried instrument for ablation (so-called coring out). But it is important to treat the basis of the tumor with the laser. The laser coagulation stops or reduces bleeding. The coagulation of the basis also reduces the risk of re-obstruction. The laser has a coagulation effect which reaches a few millimeters into the wall. By that tumor cells are damaged in a way that it takes them longer to grow new tumor tissue.



Picture 1-3: Bleeding tumor on the right side of the distal trachea. Laser coagulation and ablation. Rebuilding of the lumen to the right main and intermediate bronchus.



Picture 4, 5: Rebuilt lumen of the distal trachea with compression from right ahead. Intact lumen of the intermediate bronchus with passing to middle lobe and clear inferior lobe bronchus.

Picture 6: Protection of the rebuilt lumen by a Y-Metal-Stent.

In many cases a successful recanalisation is identifiable if loads of atelectasis-secretion or – in case of infections – mucous ichor drains out of the formerly closed airways. Radiologically the reopening and the elimination of the atelektasis can be well documented. Normally the patient experiences a drastic improvement of the accompanying rest and exercise dyspnea. The improvement can also be demonstrated when controlling the function of the lung.



Picture 7-9: Occlusion of the left main bronchus because of a squamous-cell carcinoma. Minimal lumen left of the superior lobe bronchus. Laser coagulation and vaporization with reopening of the superior lobe bronchus.



Picture 10: Occlusion of the inferior lobe bronchus because of carbonized tumor tissue, open superior lobe bronchus.

Picture 11: Recanalisation of the inferior lobe bronchus through vaporization of the tumor tissue with a CERALAS fiber. The red pilot beam is visible.

Picture 12: One can see the superior lobe carina on the left side which formerly was covered by the tumor.



Picture 13: Completely clear superior lobe bronchus with no visible tumor infiltration.

Picture 14: End of the Ultraflex-Stent in the basal inferior lobe bronchus with clear segment orifices.

Picture 15: inferior lobe bronchus on the left side with lying Ultraflex-Stent to ensure recanalization, clear superior lobe bronchus. A good result of the intervention.

The treatment after the laser ablation is organized differently. Often systemic steroids are applied within the post interventional phase, which reduce the potential toxic effects of the smoke and the local flammable effects. But there controlled studies available for this. At least for sanious infections it is undisputable to apply antibiotics. Checking the diagnostic findings after laser ablation is very important. Normally a strong local reaction occurs with fibrin exudation with the sticky covering within the laser field. These often cannot be coughed up, they have to be removed mechanically with the help of the fiberscope or pincers or with the fixed pipe. Because of that we normally execute a control bronchoscopy two days after the intervention. By doing that it can also be checked if the ablation effect was sufficient. In case of additional compression of the airways or for growing of new interfering tissue a stent could be considered useful to protect the lumen. The combination with brachytherapy or the extern exposure is also a reasonable alternative in palliation of inoperable tumors, if necessary.

Summary

The biolitec EVOLVE is a diode laser which is perfectly suited for applications within the respiratory system. We prefer working in non-contact mode whilst using a gas-cooled CERALAS-Fiber via the flexible bronchoscope with a combined fixed system. The standard settings of the lasers are 15 to 30 W; the application of the laser beam can be controlled by a visual check. Excellent coagulation and vaporization of the tissue can be pointed out. The biolitec EVOLVE laser is a reasonable extension of the interventional bronchology.

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