Pulmonology
Use and practical tips
<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRODUCTION</strong></td>
</tr>
<tr>
<td><strong>WORKSTATIONS</strong></td>
</tr>
<tr>
<td><strong>TISSUE EFFECTS</strong></td>
</tr>
<tr>
<td>Heating effects</td>
</tr>
<tr>
<td>Cold effects</td>
</tr>
<tr>
<td><strong>TECHNOLOGIES</strong></td>
</tr>
<tr>
<td>Cryotechnology</td>
</tr>
<tr>
<td>APC technique</td>
</tr>
<tr>
<td>Electrosurgical technique</td>
</tr>
<tr>
<td><strong>CUTTING AND COAGULATION MODES</strong></td>
</tr>
<tr>
<td>Electrosurgery modes</td>
</tr>
<tr>
<td>APC modes</td>
</tr>
<tr>
<td><strong>INSTRUMENTS</strong></td>
</tr>
<tr>
<td>Rigid instruments</td>
</tr>
<tr>
<td>Flexible instruments</td>
</tr>
<tr>
<td>Electrosurgery instruments from third-party suppliers</td>
</tr>
<tr>
<td><strong>APPLICATIONS</strong></td>
</tr>
<tr>
<td>Biopsy sampling</td>
</tr>
<tr>
<td>Immediate recanalization of exophytic stenoses</td>
</tr>
<tr>
<td>Recanalization of exophytic stenoses by devitalizing with cryotherapy or electrosurgery</td>
</tr>
<tr>
<td>Stent ingrowths and overgrowths</td>
</tr>
<tr>
<td>Hemorrhages</td>
</tr>
<tr>
<td>Removal of secretion, foreign bodies containing water and granulation tissue</td>
</tr>
<tr>
<td><strong>APPLICATION OVERVIEW</strong></td>
</tr>
<tr>
<td><strong>SAFETY INFORMATION FOR APPLYING CRYOTECHNIQUES, APC SURGERY AND ELECTROSURGERY</strong></td>
</tr>
<tr>
<td><strong>GLOSSARY</strong></td>
</tr>
<tr>
<td><strong>ADDITIONAL REFERENCE MATERIALS</strong></td>
</tr>
</tbody>
</table>
Important information

While Erbe Elektromedizin GmbH has taken the greatest possible care in preparing this brochure and the recommended settings, we cannot completely rule out errors. The information and data contained in the recommended settings cannot be used to justify any claims against Erbe Elektromedizin GmbH. In the event of compelling legal justification for a claim, liability shall be limited to intent and gross negligence.

Although the information on recommended settings, application sites, duration of application and the use of instruments is based on clinical experience, individual centers and physicians also favor settings other than those recommended here. This information is intended only as a guideline and must be evaluated by the surgeon for applicability. Depending on individual circumstances, it may be necessary to deviate from the information provided in this brochure.

Medicine is constantly subject to new developments arising from research and clinical experience. This is another reason why departing from the information may be appropriate.
Erbe technologies for bronchoscopy are described in this brochure. A workstation with cryotechnology is mainly used for diagnosis and for immediate recanalization of stenoses in the tracheobronchial tract.

Tissue can be devitalized both by cold temperatures, as in cryotechniques, as well as by heat, as in the electrosurgical system.

The focus of electrosurgical applications is on staunching bleeding, but also on shrinking and devitalizing tumors. Cryosystems and electrosurgery systems complement one another, but can also be used individually.
Workstations

Electrosurgery workstation for pulmonology

The electrosurgery workstation for pulmonology consists of a master module – we recommend VIO 200 D – as well as a unit for argon-plasma coagulation, the APC 2. The complete system consists of the electrosurgery workstation with a selection of probes and applicators for interventional bronchoscopy. The applications are supported by the cutting and coagulation modes of the VIO electrosurgery system. The VIO 200 D and APC 2 are coordinated and backed up with practice-oriented plug-and-play settings.

Cryosystem for pulmonology

The system for cryosurgical procedures and diagnostic cryobiopsy in bronchoscopy consists of ERBECRYO® 2 and an equipment cart (optional) with integrated gas cylinders. The flexible cryoprobes have a diameter of 1.9 or 2.4 mm and variable length compatible with all conventional bronchoscopes. They can be used in the central lung region through to the outer lung periphery. The display provides the user with information on the connected probe, the freeze effect and the duration of freezing.
ADHESION

In cryotechniques the target tissue containing water adheres to the distal end of the cryoprobe. The probe and target tissue have microscopically fine-pored surfaces in which liquid can penetrate. Freezing causes the crystals to interlock and thus adhere together. As the tissue sticks to the probe, stenoses, for example, can be recanalized immediately, larger tissue segments biopsied and foreign bodies removed.

DEVITALIZATION

Cold leads to crystallization of intracellular and extracellular fluid. At a temperature of ~40 °C and below, tissue is irreversibly damaged at a freezing speed of 10 °C/min. The devitalization process is accelerated by repeated freezing and thawing cycles. The devitalized, ablated tissue remains in situ or can be mechanically removed in a further bronchoscopy session.

Heating effects

**COAGULATION 03**

Coagulation current is used to staunch bleeding. The conversion of electrical energy produces heat. The denaturization of proteins and heating of connective tissue causes a shrinkage effect, which is further reinforced by drying of the tissue and evaporation of tissue fluid.

**DEVITALIZATION 04**

This electrosurgical technique (e.g. APC) is used to destroy specific tumors. Cell damage is irreversible at temperatures of 50 to 60 °C or more.

**CUTTING 05**

Voltages of 200 V or more produce electric arcs between the electrode and tissue. Cutting modes involve temperatures of 100 °C and higher. Intracellular and extracellular fluids vaporize so quickly that the cell membranes and cell layers rupture and the tissue is cut as a result.
OPERATING PRINCIPLE OF CRYOTECHNIQUES 01

The ERBECRYO® 2 freezing effect is based on the Joule-Thomson principle: decompression of the coolant achieves the cooling effect.

Compressed carbon dioxide is used as the coolant, which freezes the probe tip on gas decompression.

**Functionality of the probe**

The coolant flows in the cryoprobe in a closed system from the inner lumen via a constriction at the tip of the probe. On decompression, the gas flows from here via the cryoprobe’s outer lumen back to the device and diffuses into the room.

The cooling effect arises in the tip of the cryoprobe after the constriction where the gas is decompressed.

ARGON PLASMA COAGULATION (APC) 02

In APC, ionized argon gas conducts the current to the target tissue with no contact between the instrument and the tissue.

The process results in few complications, safely staunches bleeding, produces homogeneous surface coagulation and allows the surgeon to adjust penetration depth\(^8,9\). Because it is a non-contact procedure, one advantage of APC is that the distal end of the instrument cannot adhere to the coagulated tissue and tear open the scab that has formed. The plasma beam - as well as the tissue effect - depends on the type of probe. Other factors influencing this effect include the APC mode and the duration of the APC procedure.

Further information and tips on the use of APC - see chapter “Information for safe application”.
In monopolar electrosurgery, current \( I \) flows in a closed loop, first from the unit to the instrument, then through the patient’s body to the return electrode, and finally from the return electrode back to the unit. The surgical effect is produced at the tip of the active electrode (AE), which, due to its relatively small contact surface, is the location where the highest current density is reached. The second electrode, the return electrode, has a large surface area and is placed on the patient’s skin at an appropriate location in order to discharge the current.

At the points of application, the high current density and resulting heat produce effects such as an incision or coagulation. By contrast, the increase in temperature on the large surface of the return electrode is not significant due to the low current density.

**Safety issues with monopolar electrosurgery in bronchoscopy**

Two components - the NESSY return electrode safety system of the VIO 200 D and the Erbe NESSY Q return electrode - reduce the safety risks involved in monopolar electrosurgery in bronchoscopy.

NESSY tests the split return electrode to determine whether it has been positioned correctly and whether its entire surface is in contact with the patient and also constantly compares the currents flowing through the two surfaces of the return electrode.

If there are only slight differences, activation is possible. If NESSY detects major differences, however, it will produce a warning signal and interrupt activation. To prevent thermal necrosis, the surgical system cannot be reactivated until the return electrode is correctly positioned.

**Simple and safe application with NESSY Q©**

Compared with conventional return electrodes, NESSY Q (Fig. 04 ↑ and ↓) simplifies positioning and therefore enhances safety. The surrounding, insulated equipotential ring of the NESSY Q means that this return electrode can be positioned in any direction. Current is distributed evenly across the two inner contact surfaces. Because the overall contact surface is smaller than that of conventional electrodes, the NESSY Q is easier to position on the patient’s body, making it universally applicable for children and adults alike.

We recommend using NESSY Q to maximize safety in monopolar electrosurgery.
Cutting and coagulation modes

**Electrosurgery modes**

**ENDO CUT® Q**

ENDO CUT Q fractionates the cutting process into cutting and coagulation intervals. Cutting and coagulation cycles can be adjusted individually to minimize the risks in bronchoscopic incision, such as bleeding if coagulation is insufficient, or perforation if coagulation is too intense.

**SOFT COAG**

SOFT COAG is a gentle, conventional form of coagulation for deep tissue penetration, for example to devitalize target tissue. This minimizes adhesion between the electrode and the coagulated tissue (anti-sticking effect).

**FORCED COAG**

This mode of coagulation provides fast, effective standard coagulation with thermal penetration to a medium depth.
APC modes

FORCED APC 04
This argon plasma coagulation mode delivers high energy to the target tissue to effect deep coagulation and effective devitalization.

PULSED APC® 05
This APC mode is based on pulsed (on-off) activation. PULSED APC is versatile and can be used both for coagulation and for tissue devitalization. The favorable dosing characteristics of PULSED APC result in homogeneous tissue effects.
These APC instruments are designed for rigid bronchoscopy. The shaft length of the APC applicators is 300 mm or 500 mm.

The coagulation probe is suitable for high precision contact coagulation with dosable hemostasis. The suitable mode for achieving a good depth effect is SOFT COAG. Contact coagulation is a technique for staunching hemorrhages and can be used as an alternative to APC. Together, the thermal coagulation effect and compression on the contact point provide a high degree of safety.
**FIAPC PROBES 03**

The FiAPC probes (patent protected) have a selectable probe diameter of 1.5 or 2.3 mm and are used in the central bronchial tract. The connecting cable and filter are completely integrated in FiAPC probe. This prevents any possible contamination of the APC unit due to the return flow of blood or secretion. The probes are flexible and have axial, lateral or radial beam exit nozzles and thus reach almost every intraluminal target area. Different modes, such as PULSED APC or FORCED APC, can be selected for the various applications like hemostasis, devitalization or tumor debulking.

**CRYOPROBES 04**

The cryoprobes have different lengths and diameters – dependent on the application. They are suitable for use in the central and peripheral lung regions. Probes with 2.4 mm diameter tend to generate larger biopsy samples, with 1.9 mm they tend to be smaller.

**COAGULATION PROBE, FLEXIBLE 05**

The probe has a length of 1.5 m and a diameter of 1.5 mm. It is suitable for focused and precise contact coagulation in the central airways. Medium to high coagulation penetration depths can be achieved with the selection of the mode. The spectrum of applications extends from coagulation of smaller hemorrhages through to targeted and deep tissue devitalization.
Electrosurgery instruments
from third-party suppliers

SNARE

Electrosurgical resection with the snare is suitable for pedunculated lesions. The cutting-coagulating effect of the FORCED COAG mode is advantageous for this application. The tissue resected with this mode can be histologically evaluated.

MONOPOLAR FORCEPS

Monopolar forceps can be used to staunch arterial bleeding. The tissue is elevated slightly from the base and is coagulated with SOFT COAG.

XXL FORCEPS

Tissue fragments are removed with these forceps, for example following tissue devitalization with APC. As a result of the size of the XXL jaws, this instrument can only be used in rigid bronchoscopy. As, in contrast to thermal techniques, the target tissue is not frozen or coagulated by electrosurgery, the risk of hemorrhaging is increased with this technique. The hemorrhages can be coagulated with APC.
Applications

Cryotechnology is extremely well suited for biopsy of tissue samples from the endobronchial and transbronchial lung regions\(^1, 10, 21, 22\).

In cryotechniques the target tissue containing water adheres to the distal end of the cryoprobe. The probe and target tissue have microscopically fine-pored surfaces that interlock through the formation of crystals and cause adhesion. The freezing process can be followed and controlled visually in the central lung segment. The choice of probe, effect level and the freezing duration, as well as the contact pressure, allows the size of the biopsy sample to be influenced.

The morphological cell structure is preserved in the freezing process\(^7\), as the tissue is not squashed as in forceps biopsy. The biopsy quality is not reduced due to hemorrhages. This procedure is also greatly superior to that of a forceps biopsy in terms of quantity, enabling biopsy samples that are three times larger without increasing the risk of hemorrhaging\(^9\). Both size and quality are essential for the high diagnostic value of the biopsy sample, enabling a clear diagnosis\(^{12}\). Repeat biopsies are reduced; the patient and budget are spared.

Another advantage is that almost every target tissue can be accessed, even in areas where forceps are not suitable. The probe can not only be applied frontally, but also tangentially.

For recanalization of respiratory tract stenoses of a benign or malignant cause, cryosurgery or cryoextraction are effective techniques. The probe tip is placed on the tumor or cautiously pressed into the tumor. As a result of the cryoadhesion, the tumor sticks to the probe tip and can then be extracted together with the bronchoscope. The icing process can be followed visually in the central lung region and stopped in good time before reaching the bronchial wall.

The procedure is repeated as necessary until the complete tumor is removed from the endobronchial lung segment.

The risk of hemorrhages is minimized by freezing the tumor and the surrounding tissue\(^{11}\). The flexible probe can be placed frontally, as well as tangentially, so that almost every target area can be reached. This is an essential advantage of cryosurgery compared with other techniques such as the laser or forceps.

An important aspect: cryotechniques are especially advantageous in acute respiratory tract stenoses because they can be used immediately and uncomplicatedly without extensive preparation, and above all, allow the stenosis to be eliminated immediately\(^8\).

In contrast to energy-based techniques, such as electrosurgery, APC or laser, combustion of the respiratory mixture is ruled out with cryotechniques.

However, in consideration of the safety criteria, APC is ideally suited for shrinking or devitalizing endoluminal tumors\(^1\). The FORCED APC mode is suitable for tumor debulking. The immediate shrinkage effect arises by denaturing the protein structure and by further heating through desiccation. The stenosis can also be recanalted with immediate effect using an electrosurgical snare\(^8\).
STENT INGROWTHS AND OVERGROWTHS

Stent ingrowths and overgrowths are ideally treated with ablation or devitalization. All three techniques – cryosurgery, APC and contact coagulation – provide an effective basis for reducing the tumor tissue to the stent level.

The approach is the same as recanalization with the ablative effect of devitalization (see left column). When using a stent, care should be taken in all techniques that damage to the stent is avoided.

With immediate effect
In case of highly obstructive stenoses, extraction or tumor debulking may also be necessary. Tumor destruction is performed by APC or contact coagulation. For APC the FORCED APC mode is recommended; for coagulation, FORCED COAG.

The tissue can be frozen and extracted using cryotechniques. The degree of icing can be followed visually and can be stopped in good time before reaching the stent.

STENT INGROWTHS AND OVERGROWTHS

Recanalization with delayed effect
Various techniques can be selected for recanalization of respiratory tract stenoses. The therapy is dependent on the position, size and nature of the stenosis.

For stenoses caused by impression of tumors outside the lumen, see Fig. 3b) and c), plastic or metal stents can be inserted, for example. Cryosurgery, as well as contact coagulation and APC, are suitable for exophytic stenoses (Fig. 3a) and hybrid forms c).

Devitalization with cryosurgery
In devitalization, the target tissue remains in the bronchus and is reabsorbed by the body, ejected postoperatively (by coughing) or is removed mechanically. The degree of devitalization in cryosurgery can be regulated and is dependent on the factors:

- Effect setting on the device
- Repetitions of the freezing and thawing cycles
- Freezing duration
- Freezing temperature
- Freezing speed

Devitalization with electrosurgery or APC
The target tissue can also be devitalized with APC (FORCED APC mode) or using contact coagulation with FORCED COAG. In these electrosurgical techniques, the coagulation mode and the activation duration influence the degree of devitalization.

Tissue can be frozen and extracted using cryotechniques. The degree of icing can be followed visually and can be stopped in good time before reaching the stent.
REMOVAL OF SECRETION, FOREIGN BODIES CONTAINING WATER AND GRANULATION TISSUE

With cryotechniques, foreign bodies or secretion can be recovered simply and safely from the endobronchial region. Fluid material freezes on the cryoprobe and can be recovered safely and completely with cold adhesion. Even solid foreign bodies, such as nuts, adhere in a freezing process as a result of the surrounding fluid. In order to optimize adhesion, it is recommended to wet the foreign body with fluid or to recover it with the surrounding secretion.

Porous foreign bodies can also be retrieved as a whole using cryoadhesion. Using forceps, porous foreign bodies can only be extracted in fragments.

Once the target tissue, such as a foreign body, granulation tissue or secretion, has adhered, the probe together with the flexible bronchoscope is retrieved from the rigid pipe or the flexible tube. As cartilage contains little water, penetration of the ice front into these structures is limited accordingly, which additionally increases safety.

HEMORRHAGES

Hemostasis with APC
Flexible APC is predestined for the coagulation of surface bleeding or diffuse hemorrhages in the entire bronchial tract. Essential advantages: The thermal effects are achieved without contact with the tissue. This means that vessels are not ripped open again after coagulation, as is the case for contact coagulation, for example. The APC beam can be ignited frontal, lateral or “around the corner” depending on the exit of the probe. In this way, APC reaches almost every target area. Rigid APC applicators can be used with rigid bronchoscopy in the central lung segment. Flexible probes are advantageous in the distal lung segment.

Contact coagulation
The focal coagulation effect can be followed and controlled well visually in the central lung region.
Like APC, this technique can be applied using a rigid or a flexible probe - in order to better reach the target area.

Removal of blood clots
Blood clots can be recovered after icing in their frozen, solidified form with cryotechniques. Recovery of soft or fluid consistencies is almost impossible with forceps. These substances can be iced over a large area and extracted with the flexible cryoprobe, even in deeper sections and narrower lumina.

Removal of foreign bodies
Foreign bodies or the secretion adhering to the bronchial mucosa can be removed safely and completely with cryoadhesion.

Hemostasis with argon plasma coagulation
Flexible APC is predestined for the coagulation of surface bleeding or diffuse hemorrhages in the entire bronchial tract. Essential advantages: The thermal effects are achieved without contact with the tissue. This means that vessels are not ripped open again after coagulation, as is the case for contact coagulation, for example. The APC beam can be ignited frontal, lateral or “around the corner” depending on the exit of the probe. In this way, APC reaches almost every target area. Rigid APC applicators can be used with rigid bronchoscopy in the central lung segment. Flexible probes are advantageous in the distal lung segment.

Contact coagulation
The focal coagulation effect can be followed and controlled well visually in the central lung region.
Like APC, this technique can be applied using a rigid or a flexible probe - in order to better reach the target area.

Removal of blood clots
Blood clots can be recovered after icing in their frozen, solidified form with cryotechniques. Recovery of soft or fluid consistencies is almost impossible with forceps. These substances can be iced over a large area and extracted with the flexible cryoprobe, even in deeper sections and narrower lumina.
# Application overview

## Biopsy sampling

<table>
<thead>
<tr>
<th>Application</th>
<th>CRYO</th>
<th>APC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible cryoprobe</td>
<td><strong>Flexible cryoprobe</strong></td>
<td>FiAPC probe</td>
</tr>
<tr>
<td>Effect 2, Freezing time 3–5 sec</td>
<td>Effect 2, Freezing time 5 sec (and longer)</td>
<td>Trachea and bronchi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1st order: FORCED APC, 30–50 W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2nd order: FORCED APC, 20–40 W</td>
</tr>
</tbody>
</table>

## Immediate recanalization of exophytic stenoses

<table>
<thead>
<tr>
<th>Application</th>
<th>CRYO</th>
<th>APC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible cryoprobe</td>
<td><strong>Flexible cryoprobe</strong></td>
<td>FiAPC probe</td>
</tr>
<tr>
<td>Effect 2, Freezing time 5 sec</td>
<td>Effect 2, Freezing time 5 sec (and longer)</td>
<td>Trachea and bronchi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1st order: FORCED APC, 30–50 W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2nd order: FORCED APC, 20–40 W</td>
</tr>
</tbody>
</table>

## Recanalization of exophytic stenoses by devitalizing with cryotherapy (delayed effect) or electrosurgery (immediate effect)

<table>
<thead>
<tr>
<th>Application</th>
<th>CRYO</th>
<th>APC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible cryoprobe</td>
<td><strong>Flexible cryoprobe</strong></td>
<td>FiAPC probe</td>
</tr>
<tr>
<td>Effect 2, Freezing cycles 2–3</td>
<td>Effect 2, Freezing cycles 2–3</td>
<td>Trachea and bronchi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1st order: FORCED APC, 30–50 W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2nd order: FORCED APC, 20–40 W</td>
</tr>
</tbody>
</table>

## Stent ingrowth and overgrowth

<table>
<thead>
<tr>
<th>Application</th>
<th>CRYO</th>
<th>APC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Devitalization</td>
<td><strong>Flexible cryoprobe</strong></td>
<td>FiAPC probe</td>
</tr>
<tr>
<td>Effect 2, Freezing cycles 2–3</td>
<td>Effect 2, Freezing cycles 2–3</td>
<td>Trachea and bronchi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1st order: Forced APC, 20–30 W, Effect 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2nd order: Forced APC, 10–25 W, Effect 2</td>
</tr>
</tbody>
</table>

## Extraction

<table>
<thead>
<tr>
<th>Application</th>
<th>CRYO</th>
<th>APC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible cryoprobe</td>
<td><strong>Flexible cryoprobe</strong></td>
<td>FiAPC probe</td>
</tr>
<tr>
<td>Effect 2, Freezing time 2–5 sec</td>
<td>Effect 2, Freezing time 2–5 sec</td>
<td>Trachea and bronchi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1st order: PULSED APC, 20–30 W (Effect 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2nd order: PULSED APC, 10–25 W (Effect 2)</td>
</tr>
</tbody>
</table>

## Hemorrhages

<table>
<thead>
<tr>
<th>Application</th>
<th>CRYO</th>
<th>APC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible cryoprobe</td>
<td><strong>Flexible cryoprobe</strong></td>
<td>FiAPC probe</td>
</tr>
<tr>
<td>1st order: PULSED APC, 20–30 W (Effect 2)</td>
<td>Trachea and bronchi</td>
<td></td>
</tr>
<tr>
<td>2nd order: PULSED APC, 10–25 W (Effect 2)</td>
<td>1st order: FORCED APC, 30–50 W</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2nd order: FORCED APC, 20–40 W</td>
</tr>
</tbody>
</table>

## Removal of secretion, foreign bodies containing water and granulation tissue

<table>
<thead>
<tr>
<th>Application</th>
<th>CRYO</th>
<th>APC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible cryoprobe</td>
<td><strong>Flexible cryoprobe</strong></td>
<td>FiAPC probe</td>
</tr>
<tr>
<td>Effect 2, Freezing time 3–5 sec</td>
<td>Effect 2, Freezing time 3–5 sec</td>
<td>Trachea and bronchi</td>
</tr>
</tbody>
</table>

## Overview of flexible cryoprobes and recommended application areas

<table>
<thead>
<tr>
<th>Article number</th>
<th>Length</th>
<th>Diameter</th>
<th>Central</th>
<th>Peripheral</th>
<th>Biopsy sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>20402-032</td>
<td>900 mm</td>
<td>2.4 mm</td>
<td>■</td>
<td>■</td>
<td>●</td>
</tr>
<tr>
<td>20402-037</td>
<td>900 mm</td>
<td>1.9 mm</td>
<td>■</td>
<td>■</td>
<td>●</td>
</tr>
<tr>
<td>20402-040</td>
<td>1150 mm</td>
<td>1.9 mm</td>
<td>■</td>
<td>■</td>
<td>●</td>
</tr>
</tbody>
</table>
Application overview

Application CRYO APC CUT COAG

Biopsy sampling
Flexible cryoprobe Effect 2, Freezing time 3–5 sec

Snare ENDO CUT Q, Effect 2-1-6

Immediate recanalization of exophytic stenoses
Flexible cryoprobe Effect 2, Freezing time 5 sec (and longer)
FiAPC probe Trachea and bronchi
1st order: FORCED APC, 30–50 W
2nd order: FORCED APC, 20–40 W
Snare ENDO CUT Q, Effect 3-1-6

Coagulation probe for contact coagulation (rigid or flexible)
FORCED COAG, Effect 2, 40 W
Activation time 1–2 sec

FiAPC probe Trachea and bronchi

Coagulation probe for contact coagulation (rigid or flexible)
SOFT COAG, Effect 4, 60 W
Activation time 2 sec (and longer)

Recanalization of exophytic stenoses by devitalizing with cryotherapy (delayed effect) or electrosurgery (immediate effect)
Flexible cryoprobe Effect 2, Freezing cycles 2–3

Coagulation probe (rigid or flexible)
FORCED COAG, Effect 2, 40 W
Activation time 2 sec (and longer)

Stent ingrowth and overgrowth

Devitalization
Flexible cryoprobe Effect 2, Freezing cycles 2–3
FiAPC probe PULSED APC, 20–30 W, Effect 2
FORCED APC, 30 W
Coagulation probe (rigid or flexible)
FORCED COAG, Effect 2, 40 W
Activation time 2 sec (and longer)

Extraction
Flexible cryoprobe Effect 2, Freezing time 2–5 sec
FiAPC probe PULSED APC, 20–30 W, Effect 2
FORCED APC, 30 W
Coagulation probe (rigid or flexible)
FORCED COAG, Effect 2, 40 W
Activation time 2 sec (and longer)

Hemorrhages
FiAPC probe 1st order: PULSED APC, 20–30 W (Effect 2)
2nd order: PULSED APC, 10–25 W (Effect 2)
Coagulation probe (rigid or flexible)
SOFT COAG, Effect 4, 60 W
Activation time 2 sec (and longer)
FORCED COAG, Effect 2, 40 W
Activation time 1–3 sec

Removal of secretion, foreign bodies containing water and granulation tissue
Flexible cryoprobe Effect 2, Freezing time 3–5 sec

FOR VERY SUPERFICIAL LESIONS / IN THIN-WALLED STRUCTURES: 1–3 SEC
STANDARD APPLICATION: 1-3 SEC
TUMOR ABLATION: 3 SEC AND LONGER

Information on APC application times:

For further information on the recommended settings, please see the back side of individual brochures.
Safety information
for applying cryotechniques, APC surgery and electrosurgery

PREPARATION, SEDATION, AIRWAY MANAGEMENT
The more complicated and complex a bronchoscopic intervention and diagnosis, the more important is good sedation. Either the patient is deeply sedated, intubated with a flexible tube and breathes spontaneously or he is given general anesthesia, is intubated using a rigid tube, and is artificially ventilated. Airway management should be ensured with a flexible or rigid tube, as the flexible bronchoscope has to be withdrawn from the patient’s bronchial tract to take the biopsy sample.

TIPS FOR CRYOTECHNIQUES
☐ Prior to each application, check the instrument for function and leak tightness.
☐ For cryoapplication in the central lung region, observe the propagation of the freezing effect in the tissue.
☐ Take care that there is no damage to healthy tissue.
☐ The cryofunction should be activated until the probe used for biopsy or recanalization has been recovered safely.

TIPS AND RULES TO AVOID BURNS IN AN APC APPLICATION IN THE BRONCHIAL TRACT
When staunching bleeding and devitalizing with APC, a vapor mixture arises that can mix with oxygen and may become a highly combustible gas mixture. If possible, extract the gas mixture using a flexible or rigid endoscope with a suction channel of an APC applicator (we recommend the IES 2 device for fume extraction). Tip: The formation of vapor can be reduced with short activation times.

Information on the oxygen content: The higher the oxygen concentration, the higher the likelihood of combustion.
And the nearer the oxygen is to the vicinity of the APC applicator, as in high frequency jet respiration, the higher the risk of fire or explosion.
☐ If possible, activate APC in the apnoea phase. The oxygen content of the respiratory mixture should be below 40%.
☐ Just before or during APC application, do not introduce any oxygen or other combustible and flammable gases/fluids into the tracheobronchial system.
☐ All other gases, such as nitrogen, noble gases, atmospheric air or inhalation anesthetics are non-combustible.

GENERAL TIPS AND RULES FOR ELECTROSURGERY AND APC
If applied properly, electrosurgery is almost free of hazards to the patient and the operating personnel. This checklist is to alert the user to the risks in order to eliminate them.

General notes
☐ Familiarize yourself with system features and with how to operate the system properly before using it (see German Medical Devices Operator Ordinance, or MPBetreibV). In addition to its User Manual, Erbe also offers training and accompanying literature.
☐ Because the electrosurgery unit, instruments and accessories are designed to work together, use either recommended accessories and equipment that has, as far as possible, been obtained from a single manufacturer. See Erbe User Manuals for additional information.
☐ Inspect the electrosurgery unit, instruments and accessories before use to ensure they are in proper working condition and free of damage.
Patient positioning
☑ The patient must be dry and insulated when placed into position. OR table overlays or cloth covers that are wet must be replaced during surgery.
☑ Place a urinary catheter for relatively long procedures.
☑ The patient must not touch any electrically conducting objects, such as drip stands or the metal parts of the OR table.
☑ Avoid skin-to-skin contact points with the patient (e.g., hand/thigh).
☑ Do not install connecting cables on top of other cables or in places in the OR where they could cause someone to trip.
☑ Place instruments on the instrument table and not on or next to the patient.
☑ Be careful with disinfectants: electrical sparks can ignite the alcohol in these agents. For this reason, disinfectants must always be dried off completely.

Operations on patients with artificial pacemakers
☑ Follow the artificial pacemaker manufacturer’s recommendations.
☑ Avoid allowing current to flow across the artificial pacemaker, probe or cardiac muscle.
☑ The return electrode should be positioned as close as possible to the operating field but at least 15 cm from the artificial pacemaker.
☑ Bipolar application is preferable to monopolar application.
☑ Select low settings.
☑ If possible, deactivate the artificial pacemaker or ICD prior to application.
☑ Monitor the artificial pacemaker before, during and after surgery for any potential malfunction.
☑ Brief activation bursts should be avoided. The artificial pacemaker could interpret these as cardiac arrhythmia and generate stimulus signals as a result.

TIPS FOR POSITIONING THE RETURN ELECTRODE

With today’s state-of-the-art technology, the risks incurred during monopolar electrosurgery are very low. The use of the return electrode does, however, give rise to questions and issues that we would like to clarify in this section.

In addition to carefully positioning the return electrode and ensuring contact across its entire surface, we also recommend working through the following safety checklist.

☑ Check cables and plugs for any damage.
☑ Do not cut the return electrode.
☑ Position the return electrode with the long edge facing the operating field.
☑ The area of application should be dry and smooth with no disinfectant, body hair, skin folds or lesions.
☑ Avoid air pockets between the skin and return electrode; do not use contact gel.
☑ Do not place the return electrode on scarred or inflamed areas of skin, on bony structures or near metallic implants that should not lie in the flow of current.
☑ Conductive muscular tissue with low electrical resistance should be preferred to areas with subcutaneous fatty tissue. We recommend the upper arm or thigh.
☑ Position the return electrode in such a way that ECG cables and electrodes do not lie in the flow of current.
☑ If the patient is repositioned, the placing of the electrode and all connections should be rechecked.
☑ The NESSY return electrode is not designed to be reused and should be replaced each time it is removed (e.g., when correcting its positioning).
☑ Position the return electrode as close to the operating field as possible.
☑ When positioning the return electrode, implants must be taken into consideration. They must not lie in the flow of current.

Application on children
☑ If the upper arm and thigh are too thin, the return electrode can also be placed on the patient’s body.
☑ In infants, the return electrode should always be placed on the body. Whenever possible, work in bipolar mode only with at low power (below 50 W).
☑ Return electrodes for children should only be used when a larger return electrode cannot be positioned correctly. The larger the return electrode, the less the skin warms up.

General tips
☑ Arc flashes may occur during monopolar electrosurgery if the user activates uninsulated forceps using a single-pole electrode (improper use!). Because their use is not uncommon in practice, we recommend using insulated forceps.
☑ ECG interference caused by electrosurgery can be avoided by using monitor filter systems or compatible accessories.

Procedures on patients wearing jewelry (piercing, necklace, ring, etc.)
☑ We recommend always removing the jewelry (piercing, necklace, ring, etc.).
☑ Performing electrosurgery on patients with piercings that cannot be removed is not contraindicated, however, provided the following rules are observed:
☑ Jewelry must not come in direct contact with the active electrode or return electrode.
☑ Neither the active electrode nor the return electrode may be used in the direct vicinity of piercings.
☑ The piercing must not be located in the flow of current between the active electrode and return electrode.
☑ Jewelry must not come in contact with electrically conducting materials.

And after the procedure ...
☑ Carefully peel the return electrode off the skin to prevent injuries to the skin.
**Active electrode**
The part of the electrosurgical instrument that transmits the current to the site of patient tissue where the tissue effect is intended. Acronym: AE

**Argon plasma coagulation**
Monopolar non-contact coagulation. Electrically conductive argon plasma transmits the current to the tissue. Acronym: APC (Argon Plasma Coagulation)

**Bipolar electrosurgery**
Electrosurgical procedure in which both electrodes are integrated in a single instrument

**Burning under return electrode**
Burning of the skin due to extreme generation of heat as a result of excessive current density under or at the return electrode

**Carbonization**
Carbonization of biological tissue

**Coagulation**
1. Denaturation of proteins. 2. Electrosurgical effect in which proteins coagulate and tissue shrinks, thereby making an essential contribution to blood clotting

**Cryoablation**
Tissue rejection through previous devitalization by icing

**Cryoadhesion**
Adhesion of tissue (containing fluid) or materials by icing

**Cryobiopsy**
Tissue removal with cryoadhesion and subsequent extraction

**Cryorecanalization**
Elimination of a constriction (stenosis) with cryoadhesion and subsequent extraction of the stenosing tumor

**Cryotherapy**
Tissue devitalization/ablation by freezing

**Current density**
Current flow amount per cross-section area. The higher the current density, the more heat is generated

**Cutting**
Electrosurgical effect in which the intracellular fluid is explosively vaporized and the cell walls burst

**Dessication**
Drying out of biological tissue

**Devitalization**
Destruction of biological tissue

**Electrode**
Conductor that transmits or receives current, e.g. active electrode, return electrode

**Electrosurgery**
Use of high-frequency electric current on biological tissue with the goal of using heat to generate a surgical effect. Synonyms: HF surgery, diathermy, radio frequency (RF) surgery

**Exophytic stenosis**
Actually "growing out of a surface". In bronchoscopy: Endobronchial tissue growth

**Frequency**
Number of periods per second during which the current direction changes twice. Unit: Hertz (Hz). 1 kHz = 1000 Hz

**Granulation tissue**
Porous granulated tissue that temporarily arises in the wound healing process

**Hemostasis**
Stauching of bleeding

**High frequency generator**
Device or device component that converts direct current or low-frequency alternating current into high-frequency electrosurgical current

**High frequency**
In terms of electrosurgery (standard: IEC 60601-2-2): frequency of at least 200 kHz. Acronym: HF; also radio frequency (RF)

**Incision quality**
The nature of the incision, especially the extent of coagulation at the incision margin. The desired cutting quality depends on the application

**Joule-Thomson effect**
Temperature change due to pressure change of gases. In cryosurgery: cooling by decompression of gases

**Lesion**
Damage, injury or disruption to an anatomical structure

**Monopolar electrosurgery**
Electrosurgical procedure during which the active electrode is used at the operative site and the electrical circuit is closed by a return electrode

**Necrosis**
Pathological cell death

**Power**
Energy per second. The electrical power is the product of current and voltage. Unit: Watt (W)

**Return electrode**
Conductive surface, which is attached to the patient during a monopolar application in order to reabsorb the current. It feeds the current back to the electrosurgical unit in order to close the electrical circuit. Acronym: RE (return electrode). Synonyms: neutral electrode, return electrode

**Stent ingrowth/overgrowth**
Tumor tissue that grows into the stent or beyond the stent

**Thermofusion**
Fusion of tissue through coagulation

**Vaporization**
Vaporization of tissue


LEAFLETS AND BROCHURES

85402-100 Product leaflet ERBECRYO® 2
85140-120 Product leaflet VID® D
85134-100 Product leaflet APC® 2
85800-103 Fundamentals of electrosurgery
85800-127 Use of electrosurgery with practical tips

Additional information:
Up-to-date product and application information is available at www.erbe-med.com and in publications such as our accessories catalog.
Up-to-date user videos are available at www.medical-video.com