Basic knowledge in plasma surgery

Argon plasma coagulation
Principles of plasma surgery

ARGON PLASMA COAGULATION

Argon plasma coagulation (APC) is an electrosurgical procedure. Here, high frequency alternating current is transferred to the target tissue from the tip of the probe via the ionized argon gas. This procedure reliably arrests bleeding with an effective and metered surface coagulation and devitalizes tissue. The APC is contact-free so that the distal end of the instrument cannot adhere to the coagulated tissue and tear open the scab that has formed. A further advantage is the limited penetration depth of the APC which minimizes the risk of perforations.1

Due to its numerous application advantages, the procedure is employed in endoscopy and open surgery.

PHYSICAL PRINCIPLES2-4

In APC, the energy is transferred to the tissue via ionized, electrically conductive argon plasma using an APC probe with monopolar technology. The thermal effects are coagulation, dessication or devitalization of the target tissue.

In contrast to lasers, the energy between the electrode and the target tissue is transferred via an electrical field in APC and not optically. The argon plasma beam follows the path of least electrical resistance.

1 Kähler, G F et al. Investigation of the thermal tissue effects of the argon plasma coagulation modes pulsed and precise on the porcine esophagus, Ex vivo and in vivo; Gastrointest. Endosc., 2009

2 Eickhoff A, Repici A, Manner H, Enderle, MD. Electrosurgical Pocket Guide for GI Interventions; Erbe Elektromedizin GmbH

3 Eickhoff, A et al.: Prospective nonrandomized comparison of two modes of argon beamer (APC) tumor desobstruction: effectiveness of new pulsed APC versus forced APC; Endoscopy 2007

4 Zenker, M. Argon plasma Coagulation; GMS Krankenhyyg Interdiszip. 2008
Tissue effects

The tissue effect of the APC is provided by the current which flows through the tissue and the resulting endogenous heating. One distinguishes between various thermal effect zones in the tissue, depending on the achieved target temperature.


The tissue effect spreads radially in depth.4

FACTORS INFLUENCING THE TISSUE EFFECT1,4

The degree of the thermal effect of the APC on the tissue depends on several factors. The most important factors on coagulation depth in order of priority:

1. Application duration (especially for static application)
2. Power setting or effect stage
3. Probe distance (working distance)
4. Other factors: type of tissue, static/dynamic application

1 Kähler, G F et al. Investigation of the thermal tissue effects of the argon plasma coagulation modes pulsed and precise on the porcine esophagus, ex vivo and in vivo, Gastrointest. Endosc., 2009
4 Zenker, M. Argon plasma Coagulation; GMS Krankenhhyg Interdiszip. 2008
Tissue effects

**Coagulation depth**

<table>
<thead>
<tr>
<th>Duration of application [sec]</th>
<th>Power setting [W]</th>
</tr>
</thead>
<tbody>
<tr>
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<td>3.0</td>
</tr>
<tr>
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**APPLICATION TIME – THE MOST IMPORTANT FACTOR**

The longer the APC is activated, the deeper the effect on the target tissue. For this reason, we recommend starting with short activation times and to increase the duration step by step until the desired effect is achieved. In case of longer APC application at a single point, the depth effect increases strongly and if the application duration is too long, the tissue may be carbonized and perforated.

In dynamic application, the APC probe should be moved under visual control in slow, controlled movements (brushstrokes) over the target tissue.

**POWER SETTING**

The coagulation depth is dependent on the power setting and should be set according to the localization and indication.
**PROBE DISTANCE**

The greater the probe distance, the lower the penetration depth. If the probe distance increases, a point can be reached where ignition is no longer possible.

**FURTHER FACTORS: TYPE OF TISSUE**

The structures of biological tissue differ in their sensitivity, which has to be considered with electrosurgery and particularly with APC in the power setting and application duration.

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2 Eickhoff A, Repici A, Manner H, Enderle, MD. Electrosurgical Pocket Guide for GI Interventions; Erbe Elektromedizin GmbH
3 Eickhoff, A et al. Prospective nonrandomized comparison of two modes of argon beamer (APC) tumor desobstruction: effectiveness of new pulsed APC versus forced APC. Endoscopy 2007
4 Zenker, M. Argon plasma Coagulation. GMS Krankenhhyg Interdiszip. 2008
The constant voltage control of the plasma modes enables consistent quality and reproducibility of the tissue effects.22

**forcedAPC**

Effective devitalization with forcedAPC.

Unlike forcedAPC, preciseAPC® operates in the lower energy range. This allows uniform coagulation effects to be precisely adjusted in the target tissue, which enables a homogenous tissue effect particularly in thin-walled structures or peristaltic movement.

**preciseAPC®**

The preciseAPC® mode used in thin-walled structures.

This mode offers effective coagulation and devitalization. The HF power is voltage-controlled up to 120 Watt and is applied as a continuous energy transfer.

**pulsedAPC®**

The pulsedAPC® mode used for tissue ablation and coagulation.

This mode is based on pulsed activation (on–off). pulsedAPC® is variable in use, for abrating or coagulating tissue. pulsedAPC® is easy to meter and offers homogenous tissue effects as a result. In pulsedAPC®, powers of 1 to 120 Watt may be set. 2 different pulse frequencies can be set.
Applications

Applications in flexible endoscopy, gastroenterology and pneumology

- **Chronic bleeding** (Fig. 1)
  - GAVE syndrome (watermelon stomach)
  - Radioproctitis
  - Angiodysplasia

- **Coagulation of bleeding in the resection base following EMR**

- **Devitalization of tumor residues following EMR**

- **Immediate recanalization of exophytic stenoses**

- **Coagulation of diffuse and acute bleeding in the entire gastrointestinal and bronchial tract**

- **Devitalization of stent ingrowth or overgrowth**

- **Trimming of stents in the gastrointestinal or bronchial tract**

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Applications in gynecology, urology and general surgery

- Coagulation of extensive bleeding in breast surgery (Fig. 1)
- Argon-assisted resection of mammary layers and mammary gland tissue (Fig. 2)
- Coagulation of a resection base in partial nephrectomy (Fig. 3)
- Coagulation of the liver bed base with the APC function of the APCapplicator (Fig. 4)
- The liver capsule is opened with an argon-assisted incision. (Fig. 5)
Erbe products* for plasma surgery

The Erbe equipment for plasma surgery consists of the workstation with VIO® 3 and APC 3 as well as open surgical, laparoscopic and endoscopic probes and applicators. The workstation supports the instruments and applications with the forcedAPC, preciseAPC® and pulsedAPC® modes. Virtually all indications can be treated with these modes, ranging from selective flat coagulation of minor bleeding to the devitalization of extensive lesions.

FiAPC® probes in various lengths and designs.

Beam forms

Axial Beam A
Side Fire Conical Beam SC
Circumferential Beam C

The FiAPC® probes have axial, lateral and circular beam forms.

* Current patents: www.erbe-med.com/ip
The electrosurgery workstation with the electrosurgery unit VIO® 3 and APC 3 on a Cart. The APC 3 is operated via the display of the VIO® 3.
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