# Electrosurgery

# 116

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**Key Points**

Electrosurgery comprises

- Hot electrocautery
- Electrofulguration
- Electrodesiccation
- Electrocoagulation
- Electrosection
- Electric epilation
- Radiofrequency resurfacing (coblation)
- Plasma surgery

## General Principles

Electrosurgery and radiosurgery refer to the passage of high-frequency alternating electrical current through tissue to achieve a specific surgical effect. The mechanism of electrosurgery is heat production and thermal tissue damage. High tissue resistance to the passage of current converts electrical energy to heat adjacent to the active electrode. The depth and the rate at which heat is produced determine the final tissue effects.

Electrosurgery is mainly used to destroy both benign and malignant lesions, to cut and excise tissue and to control bleeding. In general, it is easy to perform, inexpensive, and time-honouring. The more modern radiowave surgery uses approximately 3.8 MHz as compared to the old electrosurgery technique using kHz electric current. Radiowave surgery allows cutting almost without thermal destruction of the margin and thus is very similar to $CO_2$ laser surgery. There are many different electrosurgery machines on the market permitting specific outputs to be used for various indications. A new development is plasma electrosurgery using air instead of an inert intermediate gas.

Terminology in electrosurgery is often incorrectly used. Monopolar means that the electrode has only one point, whereas bipolar means that two tips are used to coagulate or heat tissue in between them. Monoterminal refers to the use of only one electrode and biterminal when two connections or electrodes, usually an active surgical and an indifferent ground plate electrode, are used.

Table 116.1 summarizes the indications for electrosurgery.

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**Table 116.1** Indications for electrosurgery

| Electrodesiccation | Electrocoagulation | Electrosection |
|---|---|---|
| Molluscum contagiosum | Acrochordons | Condylomata acuminata |
| Flat warts | Telangiectasia | Hidradenitis suppurativa |
| Epidermal naevi | Spider naevi | Pyodermia fistulans sinifica |
| Flat seborrhoeic keratosis | Sunburst veins | Rhinophyma |
| Dermatosis papulosa nigra | Venous lake | Incisions in skin and plastic surgery |
| Sebaceous hyperplasia Syringoma | Pyogenic granuloma | |
| Xanthelasma | Granulation tissue | |
| After curettage of basal cell carcinoma ('C&D') | Bleeding vessels in surgery | |
| | Oozing lymph vessels in surgery | |
| | Hypertrichosis, hirsutism | |
| | Actinic keratosis | |
| | Nodular BCC | |

## Electrocautery

Metals are heated by electric current from a battery or an outlet-dependent device. The tip of the unit consists of a wire with high electrical resistance. When the current is turned on, the wire starts glowing. It is then gently held onto the anaesthetized lesion to be destroyed. The heat does not penetrate deeper than the papillary dermis; thus, the method is best used for superficial lesions or small pedunculated lesions, such as flat seborrhoeic keratoses or small acrochordons. When the glowing tip of the instrument touches the lesion, this starts bubbling until it becomes carbonized. A crust forms that is shed after a few days.

## Electrofulguration

An electrical spark is used to treat small superficial lesions resulting in carbonization of the skin surface. This method is often used to treat telangiectasias.

## Electrodesiccation

A high-voltage, low-amperage damped current from a spark gap unit is used in a monopolar fashion for electrodesiccation. If the electrode is held at a slight distance from the tissue, a spark is created causing very superficial destruction (electrofulguration), whereas direct tissue contact of the electrode is used for electrodesiccation. These techniques are suited for very superficial lesions such as seborrhoeic keratoses, plane warts, acrochordons, and xanthelasmas, and they also provide haemostasis for small capillary bleeding after curettage.

Electrodesiccation requires local anaesthesia except for small skin tags. Alcoholic skin cleansers must be avoided as they may ignite with electrosurgery. Postoperative care includes a sterile dressing. Delayed bleeding may occur but is very rare.

Curettage and electrodesiccation (E&D) are very often combined to treat small basal cell carcinomas. This approach has a high cure rate for nodular BCCs but is not recommended for larger, ill-defined, and all aggressive BCC types.

## Electrocoagulation

Electrocoagulation uses moderately damped, partially rectified current with active concentrating and dispersing neutral electrodes. The voltage is lower and the amperage higher than in electrodesiccation. It penetrates deeper, thus causing more tissue destruction.

Indications for electrocoagulation are deep tissue destruction and surgical haemostasis.

- Tissue destruction: a ball electrode is directly applied to and slowly moved over the lesion.

The charred tissue is removed with a wet gauze pad or a curette. This procedure is repeated until the lesion is completely destroyed. Usually, three passes are necessary for malignant tumours.

- Haemostasis: the electrode may directly touch the bleeder vessel or the vessel may be grasped with a fine pincer or clamped with a haemostat which is touched with the electrode. The power of the device should be set as low as possible in order to achieve coagulation of several millimetres which reduces the risk of delayed bleeding. Bipolar electrocoagulation with special forceps is used for less traumatizing pinpoint haemostasis. However, it requires a dry operative field.

Electrocoagulation is the most effective means for treating spider naevi. A needle electrode is lightly held on the central pulsating vessel and a nurse assistant slowly turns on the power. The needle sinks into the tissue, gently coagulating the feeding vessel. No scarring is observed when using this technique cautiously.

## Electrosection

Cutting is performed using slightly damped, fully rectified current in a biterminal fashion. High amperage and low voltage are further characteristics. Cutting and haemostasis are achieved by tissue vaporization. Lateral heat spread is low, reducing peripheral tissue damage. The higher the power, the easier the cutting and the less is the coagulation, and vice versa.

The narrow electrode passes effortlessly through the tissue leaving an almost dry cut surface. If the electrode drags, the power setting is too low. If it sparks, it is too high. For incision, a needle or blade electrode is commonly used. A thin loop electrode is optimal for removing tissue slices such as in rhinophyma, to excise small tumours with one stroke, and for pedunculated or protruding lesions such as condylomata acuminata. However, perianal condylomata are better first planed with scissors and only the bleeders are electrocoaglated as excessive heat damage in this area causes undue delay in wound healing. We also use the electrical loop in chronic hidradenitis suppurativa, keloidal acne, and other deep-seated infections not amenable to conservative therapy.

Radiowave electrosurgery uses higher frequencies of 1.2–4 MHz. In the cut mode, fully filtered current is used. There is minimal heat generation and therefore almost no coagulation. Specimens thus excised can be submitted for histopathological control of margins. Lateral tissue damage is even less than with the continuous wave surgical $CO_2$ laser. The device can also be set to fully rectified current for cutting and coagulation and to partially rectified current for coagulation. This machine is optimal for surgery of the face and for creating skin flaps.

## Electroepilation

Removal of unwanted hair by electrical current is usually performed by cosmeticians. Two different techniques are available as follows:

- Electrolysis
- Thermolysis

Electrolysis uses direct current to induce a chemical reaction in the hair bulb. The anode is inserted into the follicle and the patient holds the cathode as a moist pad. When being switched on, the current produces an electrochemical reaction generating sodium hydroxide, which is caustic. The procedure takes 30–60 s for each follicle to be destroyed.

Thermolysis is much faster, causing heat destruction of the hair root. In the slower technique, lower heat is generated for 3–20 s. In the flash technique, high temperatures are delivered for less than 1 s.

A blend of both methods was developed to speed up treatment and increase efficacy.

For all techniques, a very fine needle is inserted into the follicle down to the bulb. The needle tip is rounded to avoid puncturing through the follicle wall, and its length is insulated (Kromayer needle) in order to avoid damage to the superficial

follicular portion with the risk of scarring. However, the stem cells are located in the bulge region relatively high above the hair bulb and even very efficient and precise destruction of the root may be followed by a recurrence.

Side effects are rare. Electrolysis is less painful and has probably a higher success rate when carried out by an experienced therapist. Post-treatment pigmentary disturbance depends on skin type.

Devices for home self-use are not effective. Hair shafts are not conductive for electrical current; therefore, holding a hair with tweezers and applying electrical current cannot permanently destroy the hair root.

It has to be stressed that special lasers or high-energy light pulses for hair removal are now the preferred methods with at least as good results but performed with much more ease and more rapidly.

## Plasma Surgery

Pulsed radiofrequency generates a plasma along the exposed rim of an insulated blade of a plasma scalpel. This is able to precisely cut tissue at a cellular level with less heat damage despite simultaneous haemostasis. Compared to classical electrosurgery, wound healing is almost not delayed.

Plasma surgery can also be operated without direct tissue contact, which is used for treatment of ulcers and coblation. For dermoid cyst coblation, the cyst is completely emptied, an ionic solution injected into it. A non-ionic 5% dextrose solution is injected perilesionally to protect the surrounding tissue from the ion agitation and heating.

## Radiofrequency Resurfacing

The removal of superficial skin layers including skin resurfacing is a new electrosurgical method although it may have been used for similar purposes decades earlier. Whereas $CO_2$ laser resurfacing works by thermal damage, this is replaced by a much cooler and more controlled ablation (hence the new term ‘coblation’). A fine layer of an electrically conductive solution, usually physiological saline, is sprayed on the skin or run through the handpiece of the device. The hand-held bipolar electrode-tipped wand of this special radiofrequency device is set on this layer on the target. When the current is switched on, the saline between the electrodes is converted into an ionized vapour layer, called plasma. Ions accelerate across this gradient towards the skin, dissociating molecular bonds within tissue structures, thus removing tissue layers and ultimately causing collagen neosynthesis and improved skin appearance. The process runs at only 80–90 °C as compared to 300–600 °C with the $CO_2$ laser and also at significantly lower temperatures than conventional electrosurgery. Heat damage to the surrounding tissue is considerably lower, suggesting that the risk of persistent erythema, pigmentary disturbance, and scarring is lower and wound healing considerably faster. The main indications in dermatology are the ageing face and deep acne scarring. Coblation can be combined with injections of soft tissue fillers, blepharoplasty, or face lift. Herpes simplex prophylaxis is recommended in patients with recent outbreak or frequent recurrences. Antibiotic treatment may be directed against skin flora bacteria.

## Risks of Electrosurgery

Preoperative discussion includes information about the procedure, healing time of at least 2 weeks for small wounds, scab formation, and scarring. Preoperative evaluation discusses bleeding disorders, hepatitis, human immunodeficiency virus, immune defects, individual scarring and susceptibility to develop keloids, pacemaker, prosthesis, and other electronic implants. Microdermal implants (piercings) need not be removed although they should not get into contact with the electrode.

Some risks are inherent to electrosurgery, such as ignition of inflammable gases and fluids. Therefore, preoperative disinfection requires non-alcoholic solutions. Electrosurgical electrodes are not self-sterilizing and spread of infection is possible if they are not properly sterilized. Furthermore, the plume generated by the heat may

contain intact virus particles and effective smoke evacuation is therefore mandatory. Smoke evacuation is also recommended for large operations such as hidradenitis suppurativa. Experience has shown that drying up the wound is easier for the patient immediately after surgery but takes longer to heal than occlusive or semi-occlusive treatment.

Delayed postoperative bleeding is due to incomplete coagulation of vessels, particularly when local anaesthesia with vasoconstrictors was used. Postoperative pain may be intense. Some reddening around the wound is frequently seen. Eschar formation and sloughing of necrotic tissue are obligatory. Electrosurgery carries the risk of delayed wound healing and hypertrophic scarring. They are dependent of the amount of tissue coagulation. Hyperpigmentation in dark-skinned and hypopigmentation in fair-skinned persons are common. Electrosurgery is thought by many to be contraindicated on the soles of the feet as it may cause very painful hypertrophic scars and even keloids. Histopathologic examination of electrosurgical excision specimens is often hampered by the important heat artefacts making margin examination and control difficult or even impossible. Improper contact with the ground plate electrode may cause large burns. However, also the epoxy resin of the ground plate may cause allergic contact dermatitis potentially misinterpreted as a burn. Patients with sensitive electrical facilities such as demand-dependent pacemakers or implantable cardioverter defibrillators are at risk. There may also be interference with cardiac monitoring devices in anaesthesiology. In patients with a deep brain stimulator, a hand-held battery-operated heat-generating electrocautery device may be used to avoid electromagnetic interference.

## Further Reading


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