Electrosurgery

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BASIC THEORY OF ELECTROSURGERY

The terms electrosurgery and radiosurgery are often used interchangeably. By definition, electrosurgery is the application of electric current to cut and alter tissue. Modern electrosurgery is radiosurgery and employs the use of a high frequency power oscillator, which is equivalent to a radiotransmitter, operating between 0.5-7.5 MHz. The radiosurgical incision occurs by internal volatilisation of the cells along the path of the electrode while the electrode tip remains cool.

The application of high frequency radiowaves to tissue produces alternating electric fields of electromagnetic waves. These radiowaves result in heat production that causes volatilisation of intracellular fluids at the point of active electrode contact. The heat production is created by the resistance of the tissues to the alternating fields of electromagnetic waves.

High frequency energy is concentrated and emitted from the end of the electrode tip. This energy causes molecular heat in each cell. The optimal cutting frequency is 3.8 MHz. Neuromuscular twitching occurs below 10,000 Hz.

Terms such as electrosection, electrocoagulation, electrocautery and hyfrecation are often confused with and used synonymously with electrosurgery.

Electrosection is the surgical transection of tissue utilising electrosurgical instrumentation. Electrocoagulation is the coagulation of tissue using bi-terminal, high frequency electric current. Coagulation breaks down and condenses tissue into a necrotic mass.
The first application of electricity to treat diseased tissue was the use of alternating current of low frequency, low wattage, and low voltage passed through a metallic resistance to produce incandescent heat. This cautery or "branding iron" created third degree burns.
Fulgurating current creates a spark gap which is produced by passing a high frequency alternating current of low wattage and high voltage. This generates a spark between tissue and

the electrode tip and burns the surface of the tissue. The burned carbonised surface of the tissue serves as a protective insulation to the underlying tissue. The effects are superficial. This type of electrosurgery is known as hyfrecation.

The advantage of electrosurgery to the veterinary surgeon can be determined by the improved haemostasis and the significant decrease in surgical time. In order to excel in electrosurgical technique, it is essential for practitioners to familiarise themselves with the fundamental concepts of these techniques.

To develop sound electrosurgical skills, it is necessary to be knowledgeable about the equipment being used and understand the basic principals of electrosurgery.

The skill of the electrosurgeon is limited by the capacity of the equipment being used. Therefore, it is crucial that the power output of the equipment be optimal.

Maness *et al*. (1979) proved that 3.8 MHz was the optimal frequency for radiosurgery. Knowledge of the operational radio frequency capacity, wattage capacity and the ability to autoclave the electrode handles are factors which must be evaluated when making the decision to purchase electrosurgical equipment. The Surgitron FFPF (Ellman International Manufacturing, Inc, 1135 Railroad Avenue, Hewlett, NY 11557 - Distributed in Australia by The Lyppard Group.) is the only radio surgical unit currently available which utilises four currents and operates at 3.8 MHz and 140 watts. It is compact and ideally suited for veterinary surgery.

To learn the basic technique of radiosurgery it is necessary to know the four types of current used and what each current does.

Fully rectified filtered current is the purest current and gives 90% cutting quality and 10% coagulation. Therefore, this current offers the least amount of tissue alteration as well as the least amount of coagulation. Fully rectified filtered current is utilised for skin incision when a minimal amount of scarring is required. This is the only current that can be used to take biopsies.

Fully rectified current gives approximately 50% cutting and 50% coagulation. This current is utilised for incision and dissection in the avian patient. When used properly, there is very little tissue destruction and excellent haemostasis.

Partially rectified current is used solely for haemostasis. The current gives 10% cutting and 90% coagulation. It is used for coagulating blood vessels and tissue.

Fulgurating current is used to superficially destroy tissue and has little application for avian surgery.

Adhering to basic principles and techniques is essential to proper use and can make radiosurgery a simple, routine and necessary part of surgery.

CONTRAINDICATIONS

1. Any of the contraindications which apply to standard surgery are applicable to radiosurgery.

2. Radiosurgery cannot be used in proximity to any individual wearing an unshielded pacemaker (prior to 1973).

3. Radiosurgery cannot be used in the presence of explosive gas (e.g. ether) or flammable fluids (e.g. alcohol).

4. Radiosurgery will not function properly in areas of fluid accumulation (e.g. saliva or pooling of blood). The field must be moderately dry for radiosurgery to be effective.

5. Improper grounding can cause unintentional shocks and burns.

6. Improper tuning can cause burns from excessive lateral heat.

7. Channelling is a hazard caused as the result of high frequency passage of current through a narrow channel of tissue that is more conductive than the tissue surrounding the surgical site. As a result, coagulation can occur at a point that is some distance from the electrode. Channelling rarely occurs at normal power levels; however, conduction and heat production down a nerve or major blood vessel may result at excessive power levels.

    The indifferent plate (ground plate or passive electrode) in radiosurgery acts like an antenna and focuses the energy. The ground plate does not have to be in direct contact with the patient, but merely close to the electrode tip (active electrode).

Lateral Heat is the most destructive force of radiosurgery and all factors influencing lateral heat should be minimised as much as possible.

$$\text{Lateral Heat} = \frac{\text{Time x Electrode size x Current selection x Power}}{\text{Tissue impedance}}$$

Energy is distributed along the entire surface area of the electrode. Therefore it is essential when making an incision or dissecting tissue, to keep the electrode tip perpendicular to the tissue to minimise lateral heat. The slower the movement of the electrode tip over the tissue, the greater the lateral heat and resultant coagulation.

The finer the electrode tip, the less amount of energy necessary. The fine wire and loop electrode are the most suitable for small animal surgery.

Sparking occurs as the result of an electrical discharge of short duration between the electrode and the tissue and causes blanching of tissue. This results from excessive power and is destructive because it carbonises and over coagulates the tissue.

Drag results from inadequate current, resulting in the dragging of the electrode through the tissue with tissue shreds sticking to the electrode.

Proper tuning utilises a power setting which results in no drag, no spark, and very little blanching of tissue. It is better to have slightly too much than too little current.

When an incision is to be made, the current should be initiated before the electrode is touched to the tissue. This will dispel the initial current surge. However, for haemostasis or coagulation, the electrode should be in contact with the tissue before it is energised. If an incision is to be deepened or gone over a second time, ten seconds should elapse between each stroke of the electrode. The electrode handle should be held comfortably in the hand and passed quickly over the tissues without any pressure.

The electrodes are made of tungsten wire and will eventually volatilise and break if improperly cared for.

PROPER ELECTRODE CARE

1. Use the ground plate.
2. The instrument should be properly tuned.
3. The electrodes should be cleaned by wiping with a wet gauze sponge while the electrode is energised.
4. After each procedure, the electrode should be cleaned in an ultrasonic cleaner for three minutes.
5. Electrodes should be sterilised by cold or gas sterilisation. They should not be autoclaved.

By understanding the concept of lateral heat and following the basic principles of radiosurgery the practitioner will find this modality an invaluable asset to his/her surgical skills.

Surgical speed will be greatly increased, thereby decreasing anaesthetic time. Controlled haemostasis will decrease the potential of postsurgical haemorrhage, maintain a relatively blood-free surgical field and significantly increase surgical speed.

These advantages relate to a significantly higher avian surgical success rate.

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