Radiosurgery

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BASIC THEORY OF RADIOSURGERY

It is essential to understand the three basic principles of Radiosurgery.

1. It is necessary to be familiar with the equipment used and understand the basic physics and mechanics of this equipment.

2. It is essential to comprehend the types of current and know what surgical techniques they are used for.

3. There are specific electrosurgical techniques which must be mastered and applied to minimize excessive tissue alteration.

By definition, Radiosurgery is the application of radio frequency waves to cut and alter tissue. Modern electrosurgery employs the use of a high frequency power oscillator, which is equivalent to a radio transmitter, operating between 0.5 - 7.5 MHZ.

The radiosurgical unit also employs a step-up and step-down transformer which increases and decreases the power in watts.

The application of high frequency radio waves to tissue produces alternating fields of electromagnetic waves. These radio waves result in heat production that causes volatilization 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[1].

The radiosurgical incision occurs by controlled internal volatilization of the cells along the path of the electrode while the electrode tip remains cool.

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

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Electrosection is the surgical transection of tissue utilizing radiosurgical instrumentation. Electrocoagulation is the alteration of tissue using bi-terminal, high frequency electric current. Coagulation breaks down and condenses tissue into a necrotic mass.

The advantages of radiosurgery to the avian surgeon are:

improved hemostasis and the significant decrease in surgical time. It also facilitates contouring the surgical incision.

To develop sound radiosurgical skills, it is not only necessary to be knowledgeable about the equipment being used but thoroughly understand the basic principles of radiosurgery.

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

In 1979, Maness et al[2] 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[1] is the only radio surgical unit currently available which utilizes four currents and operates at 3.8 MHZ and 140 watts. It is compact and ideally suited for small animal and avian surgery.

To learn the basic technique of radiosurgery it is necessary to know the four types of currents used and what each current does[1].

<u>Fully rectified filtered current</u> 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 utilized for skin incision when a minimal amount of scarring is required. This is the only current that can be used to take biopsies. This current is used exclusively for electrosection.

<u>Fully rectified current</u> gives approximately 50% cutting and 50% coagulation. This

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[1] **Ellman International Mfg. Inc, 1135 Railroad Avenue, Hewlett, NY USA**

current is utilized for incision and dissection and cannot be used for coagulation alone. It is a cutting mode. When used properly, there is very little tissue destruction and excellent hemostasis. This current is used for subcutaneous dissection and cutting muscle in small animals and for all avian surgical procedures except biopsy.

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

Fulgurating current superficially chars tissue in a controlled manner and has little application for avian surgery. See Chart.

Contraindications

1. Radiosurgery cannot be used in proximity to an individual wearing an unshielded pacemaker manufactured prior to 1973.

2. Radiosurgery cannot be used in the presence of explosive gas ie. ether, methane (bowel gas) or flammable fluids (e.g. alcohol).

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

4. Improper grounding can cause unintentional shocks and burns.

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

6. Channeling 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. 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). Some plastic products and styrofoam can act as a resistor between the patient and the passive electrode. LATERAL HEAT is the most destructive force of radiosurgery and all factors influencing lateral heat should be minimized as much as possible. Lateral heat can be expressed in the following formula[3].

$$\text{Lateral Heat} = \frac{\text{time x electrode size x current selection x power}}{\text{tissue impedance}}$$

Adhering to the following basic principles and techniques is essential to proper use and can make radiosurgery a simple, routine and essential part of surgery[5].

1. Energy is distributed along the entire non-insulated 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 minimize lateral heat. The slower the movement of the electrode tip over the tissue, the greater the lateral heat and resultant coagulation.

2. The finer the electrode tip, the less amount of energy (watts) necessary. The fine wire and loop electrode are the most suitable for avian surgery.

3. 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 carbonizes and over coagulates the tissue.

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

5. 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 hemostasis or coagulation, the electrode can be in contact with the tissue before it is energized.

6. If an incision is to be deepened or gone over a second time, ten to fifteen seconds should elapse between each stroke of the electrode to allow cooling of the tissue.

7. The electrode handle should be held comfortably in the hand and passed quickly over the tissues without any pressure. The electrode handle should be held as one would hold a pen while signing their name and not like a scalpel. The electrodes are made of tungsten wire and will eventually volatilize 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 energized.

4. After each procedure, the electrode should be cleaned in an ultrasonic cleaner for three minutes.

5. Electrodes should be sterilized by cold or gas sterilization. Autoclaving is possible, but decreases the electrode's life.

If, while using the Surgitron FFPF during a surgical procedure, a problem occurs and the unit malfunctions or is not functioning properly, the following step-by-step trouble-shooting flow chart should be implemented to correct the problem. This flow chart is applicable to the Surgitron FFPF.

Troubleshooting Flow Chart for the Surgitron FFPF

1. If the red A/C power light does not go on - there is no current to the Surgitron or the fuse in the unit has blown. If the A/C power light goes on - go to Step 2.

2. If the white R/F light does not go on -

    a. The unit is not generating R/F waves
    b. The foot pedal is not functioning (either "a" or "b" indicates a problem within the unit)
    c. The current selector switch is in the "OFF" position If the R/F light goes on - go to Step 3.

3. If there is no current generating from the end of the electrode

    a. The electrode is not seated properly in the hand piece
    b. The wire to the electrode handle is broken
    c. check to see if the jacks are properly plugged in
    d. improper power setting
    e. check to see if the tissue is too dry. If the above are functioning properly - go to Step 4.

4. If there is insufficient current generating from the electrode

    a. check to see if the ground plate is positioned properly or if the jack is plugged in.
    b. check to see if the current selector is in the proper position.

Ninety-nine percent of the problems can be solved by following the above procedure.

If all of the above functions seem to be normal and there is still a problem, contact the manufacturer.

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

Choosing the Correct Current and Electrode		
Function	Type of Current	Electrode Type and Size
Incision skin	Fully rectified, filtered or unfiltered	straight fine wire
Incision muscle	Fully rectified, unfiltered	straight fine wire
Incision connective tissue	Fully rectified, unfiltered	straight fine wire
Biopsy	Fully rectified, filtered	fine wire loop
Coagulation	Partially rectified	ball or bipolar
Desiccation	fulguration	straight heavy wire

Excerpted from "Introduction to Avian Surgery", Proceedings Association of Avian Veterinarians 1995.

Suggested Reading

1. Altman, RB: Principles and Applications of Electrosurgery: 1993 AAV Conference Guide to Practical Labs, pp 69-72.

2. Maness, WL, Roeber, SW, Clark, RF, et al: Histological evaluation of electrosurgery with varying frequencies and wave forms. *J. Prosthetic Dentistry* **40**:304, 1978.

3. Sherman, JA: Principal and Theory of Electrosurgery. In Oral Electrosurgery, London, 1992, PP 1-11.

4. Fucci, V, Elkins AD: Electrosurgery: Principles and Guidelines in Veterinary Medicine, *The Compendium on Continuing Education* **13(3)**, 407-15, 1991.

5. Krause-Honenstein, U: Electrosurgery: fundamental requirements for successful use. *Quintessence Intl*. **14**:1-19, Nov/Dec 1983.