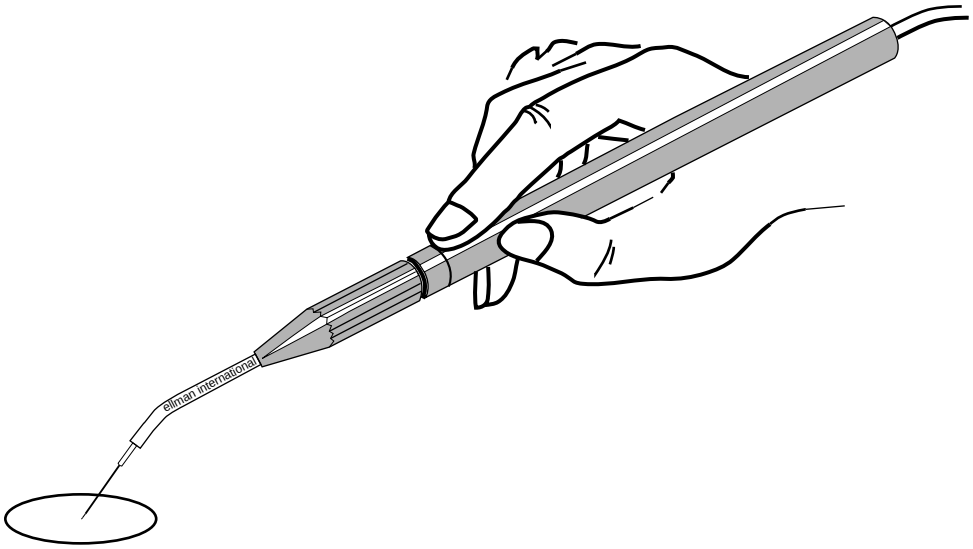
ADVANCED RADIOSURGERY

IN

VETERINARY MEDICINE



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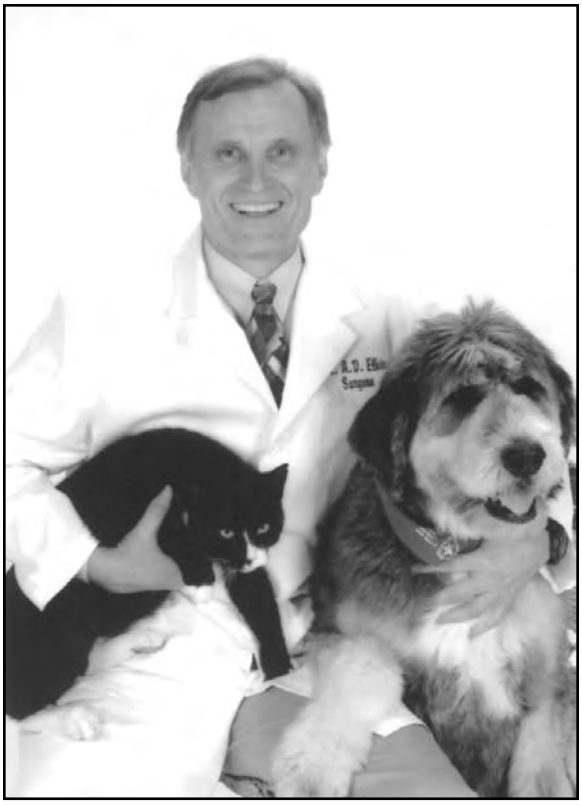

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Principles of Electrosurgery/Radiosurgery

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Some familiarity with the basic principles of electrosurgery and how it works will help you get the maximum usefulness and benefits from your system.

The Advantage of Using Electrosurgery

When used properly, electrosurgery has many unique advantages that make it invaluable in your practice. It reduces operating time and produces better operative results. It reduces postoperative pain and usually produces scar-free healing.

Other advantages are:

Smooth, even cutting without pressure.
A clear operating field with little or no bleeding.
Precise control of the incision.
No tissue destruction or sloughing.
No excessive scar tissue.
No bone damage.
Healing by first intention is rapid and uncomplicated.

What is Electrosurgery?

Electrosurgery is the use of energy created by a high frequency alternating current. The resistance of the tissue to the passage of this current creates heat internally in the tissue. In electrosurgery, we use two electrodes (an electrode and a patient return plate) of greatly different sizes resulting in greatly increased current density at the point of the smaller electrode. While the electrode itself remains cold, the highly concentrated high frequency energy creates molecular heat inside each cell. By the choice of electrodes and selection and adjustment of the current, the operator controls the effect of this energy on the tissues to achieve the desired results. The ideal frequency for radiosurgery is 3.8 MHz. This frequency allows for consistent primary healing of skin incisions.

There are two principle types of current used in electrosurgery; the spark gap and the electronically generated. To generate these currents, it is necessary to convert the sixty cycle alternating current available at the wall outlet to the high frequency current needed for electrosurgery. This conversion is accomplished by passing the alternating current through a high frequency generator.

The spark gap is a highly damped current which is characterized by a continuing pattern of high peaks of voltage rapidly diminishing to zero. When the electrode is held above the tissue, this current jumps from the electrode to the tissue with a visible spark. This spark gap method is useful for coagulating a wet field with many bleeders which are difficult to pinpoint. The spark gap current will find and move to the area of least resistance. Since coagulated tissue has greater resistance to the current, the current will move to uncoagulated tissue within a limited area, thus providing coagulation of an entire site. However, because it moves over an area, this process

offers only limited control of the amount of area coagulated. While this form of current is satisfactory for coagulation, desiccation and fulguration, it will not cut.

Cutting: Fully Filtered Current/Fully Rectified Current

Cutting is done not by the electrode, but the by high frequency energy concentrated at the electrode. This high frequency energy generates molecular heat in each cell at the point where the fluids in the cell volatilize and the cell explodes. By applying this energy to individual cells in sequence, that is, by moving the electrode continuously through the tissue, the line of destruction is limited and the cutting effect is realized. At the same time, the capillaries are sealed, resulting in almost bloodless cutting.

Coagulation: Partially Rectified Current

Coagulation takes place when the high frequency current is applied to the tissues with a current density sufficiently concentrated to dehydrate the cells and coagulate their organic contents, but without penetrating deeply into the tissues.

This procedure is almost self-limiting, since the surface coagulation first created protects the underlying tissues against excessive depth of coagulation.

Spark Gap Fulguration

Spark gap fulguration is a high frequency current which generates molecular heat in cells as do the cutting and coagulating currents. Spark gap is a coagulating type current, useful for desiccation and fulguration. It often is used to destroy warts and small polyps or in perianal fistulas.

FUNDAMENTALS OF ELECTROSURGERY

As with any instrumentation or equipment used in your practice, there are some fundamental principles that should be learned in order to use electrosurgery safely and effectively.

These principles apply generally to all procedures where electrosurgery is used. Familiarize yourself with them. Many of them can be observed when doing the practice exercises.

Perform the practice exercises several times. When you are confident of the results on a piece of lean beef, working on a patient will be much easier.

The Active Electrodes

Be sure the electrodes are securely seated and firmly held in the handle so that the entire electrode shank is covered.

In general, straight wire electrodes are used for incisions and for removing fine tissue. Loops are used for removing heavier tissue and contouring. Ball electrodes are used for coagulation.

Keep the electrode clean while operating. Tissue shreds and debris on the electrode cut down the effectiveness of the current and by impeding the passage of the electrode through the tissue, slow down the stroke. This creates unnecessarily heavy coagulation which can cause sloughing and delay healing.

Anesthesia

Adequate anesthesia is indicated for all electrosurgical procedures.

Electrosurgery should not be used in the presence of flammable or explosive gases or liquids.

While it is safe and occasionally desirable to removal small tumors and perform minor procedures with topical or local anesthetics, most veterinarians prefer to use sedation or general anesthesia. In this way, preparation can be more thorough, grounding more easily effected and maintained and the patient is not suspicious of unusual sounds and smells.

The Tissues

The high frequency electrosurgical current will not cut hard tissues, such as bone. However, prolonged exposure to the high frequency current can cause bone damage. It is, therefore, important to develop good techniques which eliminate the danger of damage. Momentary contact with bone will not cause any damage.

Healing

Healing after electrosurgery is by first intention with a soft, supple scar and no excessive scar tissue.

THE POWER SETTING

The ideal power setting is the minimum setting where cutting and coagulation are achieved.

If the power is too high, the tissue will be discolored and there will be considerable sparking when the electrode contacts the surface.

If the power is too low, the electrode will drag through the tissue, tearing and "cooking" instead of cutting cleanly, and will pick up shredded and torn tissue.

Authorities agree that it is better to err on the side of too much power than too little. While excessive current may slightly dehydrate the surface of the tissue, it permits the electrode to move through unimpeded.

Power requirements will vary with the type and size of the electrode, the area of electrode surface in contact with the tissue, the nature of the tissue , whether cutting or coagulating and the depth of the incision desired. Larger electrodes, deeper incisions and tough fibrotic tissue are some indications for higher power settings.

CUTTING AND COAGULATING

While electrosurgery is in many respects different from any other instrumentation, the applications and in fact many techniques, are not very different from those you have used in your practice in the past. It is just a different instrument.

The biggest change is the development of the light touch or stroke of electrosurgery as opposed to the heavy pressure required for cold steel operations.

In the following section, cutting and coagulating are described. First, practice methods are suggested, including how to adjust the settings for optimal cutting and coagulating. Then general techniques are described which should help you determine and develop the best specific techniques for you when you use electrosurgery.

Practice is best done on lean beef. The less expensive grades with less marbled fat are preferable.

The meat should be at room temperature and should be moist. Dry meat will spark and give off an offensive odor when cut. While practicing, keep the meat moist (not wet) by wiping the surface with a soaked sponge or cloth.

CUTTING

The Criteria of Good Cutting Technique

There are three criteria of good cutting technique:

1. The electrode should "float" through the tissue without dragging or resistance.

2. There should be only very slight, if any, change in the tissue color due to dehydration or charring.

3. No tissue shreds should adhere to the electrode.

The following exercises will help you to quickly and graphically see and understand the meaning of these criteria while developing the feel of good technique.

Practicing Cutting on a Piece of Beef

1. Plug in your unit. Attach the return plate and handle. Plug handle and black cord into handpiece outlet.

2. Insert a straight or angled single wire electrode into handle.

3. Place a piece of meat, at room temperature, on the return plate.

4. Turn the power control know to its highest setting.

CAUTION: Do not use fine needle electrodes at high settings as they may be severely damaged by such use. When practicing with these electrodes, work up gradually from a low setting. Generally, you should not exceed a setting of 3 with fine needle electrodes.

5. Depress the footswitch before touching the tissue. Make an incision about two inches long and one-half inch deep using one smooth, brush-like stroke. Notice the sparking due to the excessively high power setting. Release the footswitch.

6. Examine the incision. The incised surfaces will show considerable discoloration due to dehydration because of the high power setting.

7. Reduce the power setting.

8. Make another incision, parallel to the first. Try to use the same motion, speed and depth. Notice the decreased amount of sparking at the lower setting.

9. Compare the two incisions. The second should show less surface dehydration, but still some color change.

10. Reduce the power again, this time to about number 3 on the dial.

11. Make another incision. There should be virtually no sparking while cutting, but the electrode should still float easily through the tissue. At this point, discoloration should be very slight.

12. Reduce the power again, to number 1 on the dial.

13. Now the electrode will probably not cut at all, or only with considerable pulling and dragging. If it does cut, notice the tissue shreds adhering tenaciously to the electrode.

14. Increase the power slightly until the electrode will enter the tissue and notice the changes. When the electrode drags through the tissue, you will see considerable dehydration similar to that when the power was excessively high. This points out the danger of TOO LOW, TOO SLOW cutting.

15. With the power setting between 2 and 3, make another incision. Make additional adjustments in the power until the electrode floats through the tissue, as at the higher settings, without the drag of resistance felt at the lower settings and without the discoloration and tissue shreds noticed at various levels. This is the ideal stroke and feel.

16. Repeat the entire procedure (steps 1 through 15) using a large loop electrode, diamond, large round, oval or blade electrode. You will notice that somewhat higher power settings are needed to pass the larger electrode through the same tissue with comparable effects. In general, the larger the area of electrode contacting tissue, the more power is required.

Repeat steps 1 through 15 using the other electrodes in your electrosurgery system (except fine needle electrodes) noting the differences in tissue response and cutting feel with the various electrodes. Practice to become comfortable using the entire system.

Cutting Techniques

When cutting, always activate the electrode by stepping on the footswitch before contacting the tissue.

Plan the stroke. Before activating the electrode, take one or two practice strokes to be sure you can complete the planned stroke comfortable and correctly. At this time, you can evaluate the size and shape of the electrode and the speed and depth of the stroke.

Make the cut. When the practice stroke is comfortable, step on the footswitch and make the planned cut.

Use a smooth brushing motion without pressure. The electrode should pass through the tissue without dragging at a deliberate but not slow speed. It is not necessary to race through the tissue, but a too slow motion will generate undesirable lateral heat in the tissues, with the possibility of subsequent necrosis and sloughing.

Keep the electrode moving. Prolonged contact with any one part of the tissues can create excessive coagulation.

COAGULATING

Practicing Coagulating

Coagulating can be practiced on the same piece of beef as cutting.

Coagulation appears as a white spot on the surface of the tissue, emanating from the point of contact of the electrode. It is easy to determine the depth of coagulation since the depth is approximately equal to the lateral spread of coagulation.

In contrast to cutting, when coagulating the electrode should contact the tissue before depressing the footswitch.

Start with a LOW power setting, using the COAGULATING current.

Contact the surface of the tissue lightly with the electrode. Depress the footswitch to activate the current, coagulating the area for several seconds. Then release the footswitch and remove the electrode from the tissue.

Notice the appearance of the tissue. It should appear blanched. Turn the power intensity up step by step, repeating the procedure. Observe the characteristics of the coagulated tissue with each setting. The degree of coagulation obtained at a particular setting will vary with different tissues and different conditions. Determine which setting is best for various procedures. When treating

any condition, if proper coagulation is not apparent after one application, immediately increase the intensity setting. Never repeatedly apply the current to the same area; this may create heat and serious damage in underlying tissue.

Practice coagulating with a hemostat or metal instrument, as described in the following techniques.

Coagulating Techniques

The ball electrode is extremely useful when you are controlling hemorrhage. When applied for a second or two, it will coagulate small capillaries easily. Larger vessels can be picked up with hemostats which in turn may be touched by the ball electrode. The current will pass down the forceps and seal all tissues which are held in the jaws of the forceps.

Spot Surface Coagulation

Turn the Power Intensity Control to the desired setting.

Contact the tissue lightly with a coagulating electrode before depressing the footswitch.

Depress the footswitch to activate the current and keep it depressed until the procedure is completed.

NOTE: Contact the tissue lightly before activating the current in any coagulation procedure.

Severed Vessels

Clamp the bleeder with a hemostat.

Touch a ball electrode to any part of the hemostat.

Depress the footswitch to activate the current for several seconds. Then release the footswitch and remove the electrode. Be sure the current is as high as is necessary to achieve coagulation.

After the application of coagulating current, remove the hemostat. Bleeding should have stopped. If not, repeat the procedure.

When using electronically generated current, it is quite safe to hold the hemostat in one hand while holding the electrode handle in the other during this procedure. Do not use this technique with spark gap current.

APPLICATIONS

Electrosurgery has many applications in your practice. It is excellent for initial skin incisions because it is neat and virtually bloodless. Electrosurgery is effective at any level and for any body tissue except bone (and tooth), although it is slightly more difficult for it to cut through fat than through other tissues. Coagulating blood vessels is another applications where electrosurgery is

most helpful. Hemostasis also may be achieved during procedures by using a hemostat and coagulating current. In addition to these applications which can aid you in many procedures, electrosurgery is a valuable instrument for many specific procedures. As you become more and more accustomed to your system, you can perform more difficult and varied procedures with it. You probably will continue to discover new uses for your electrosurgery system to make your practice safer, easier and more effective.

Biopsy - Fully Filtered Current

The use of electrosurgery for biopsy has two particular advantages. First, since electrosurgery seals the capillaries and lymphatics as it cuts, the danger of metastasis through those channels is minimized. Second, since electrosurgery does not destroy any depth of cells on the line of incision, the specimens are highly acceptable to the pathologist.

The specimen should, whenever possible, include two to three millimeters of attached normal tissue.

Small (up to one half inch) masses should be removed in one piece. Using cutting current at a relatively high setting and a wire electrode, incise all around the mass in an elliptical pattern, including tow to three millimeters of attached normal tissue.

Small masses may also be removed by using a suitable loop electrode, larger than the mass itself so that is can excise two to three millimeters of attached normal tissue at the same time.

Specimens from larger masses should be taken in the form of pie-shaped wedges. Using a needle electrode and cutting current, start the apex of the wedge at the center of the suspicious mass. The base of the wedge should include two to three millimeters of attached normal tissue.

Surgery On and Around the Eye - Fully Filtered Current

Surgery in this area requires careful mastery of electrosurgical techniques. Less current is needed on the eye and ocular structures than elsewhere.

Entropion

A. 1. Place a tongue depressor or other similar device behind the lid to protect the eyeball.
   2. Use a blunt needle electrode and coagulating current.
   3. Penetrate the skin of the lid with the electrode, making one or two rows of punctures 4 to 5 mm from the lid margin. The punctures should extend into the tarsal area of the lid but not through the palpebral conjunctiva.

B. Another electrosurgical method for treating limited entropion is to make one horizontal or two vertical incisions in the lid with a fine needle electrode using the cutting current.

Ectropion

Electrosurgery should be used to treat only ectropion of a limited degree. The procedure is:

1. Clamp fixation or lid forceps on the everted eyelid.
2. Use a blunt needle electrode and coagulating current.
3. Make punctures through the exposed conjunctiva and the muscle, but do not penetrate the skin. Approximately six punctures parallel to the lid margin and 4 to 5 mm away from it should be made.
4. Apply an antibiotic - steroid ointment several times a day after this procedure.

Distichiasis

1. Protect the eyeball by placing a tongue depressor beneath the lid.
2. Set the coagulation current to one (1).
3. Use a fine epilation needle electrode.
4. Insert the electrode into the orifice alongside each lash until it reaches the base of the cilium.
5. Activate the current when it becomes difficult to insert the electrode farther.
6. The cilia often cling to and come out with the electrode. If the do not, they can be removed easily with epilation or tissue forceps.

Lid Tumors

1. Set current as low as possible for this type of surgery.
2. Use a loop electrode and cutting current to "shave" the tumor from the lid edge and conjunctival surface.
3. Destroy the base of the growth with a needle electrode.

Atypical Pannus

1. Use coagulating current and ball electrode.
2. Coagulate each vessel leading from the conjunctiva to the corneal granulation tissue, touching just back of the limbus.
3. Apply a steroid preparation.

Laboratory Exercises - Electrosurgery

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Exercise I - Paintbrush Exercise

Pressure is not necessary for electrosection. The cutting is done by the radio waves emanating from the electrode tip. The tip stays cool. Gentle, free movement of the electrode is similar to using a paintbrush. Therefore, with the paintbrush and ink, make a number of "straight line" incisions. The line should be thin, even and unbroken. Next, make "full circle" incisions by painting around the poker chip without touching the chip. Try several "S" shaped lines.

Exercise II - Tuning the Unit

1. Plug in the handpiece and groundplate using the color coded jacks. Insert the fine wire electrode, place the meat on the groundplate (do not remove the plastic cover to the groundplate). Turn the current select to **filtered, fully rectified** (cut). Put the power selector to high. Initiate the current by depressing the foot pedal. Make an incision. There will be a great deal of sparking and smoke. Gradually turn the power setting down until you feel drag on the electrode, the tissues blanches and tissue shreds adhere to the electrode tip. The power selector switch should then be turned up slightly until there is no drag and minimal spark. This is the optimal cutting current. The electrosurgical tip should not encounter resistance. The cut should be microsmooth, requiring no pressure on the electrode.

2. Remove the groundplate and make an incision. It will be necessary to turn up the power to achieve optimal cutting.

3. Place current selector on **fully rectified** (cut/coag) and make several incisions Compare this current to the filtered current.

4. Using a loop electrode, take (biopsy) samples from the muscle. This must be done on filtered current. The electrode should be moved as rapidly as possible.

5. Without depressing the footswitch, insert a Brown-Adison forceps through the electrode loop and grasp a bit of muscle and pull upwards. Depress the footswitch and pull the handpiece towards you. This is the technique used for both biopsy sampling and the removal of small tumors.

6. With the loop electrode, try the **TROUGHING** technique on both filtered and fully rectified currents. Move the loop electrode backwards and forwards over the same area to trough out an area. The loop electrode should be kept perpendicular to the surface. This technique can be used for rapid debulking of a tissue mass.

Exercise III - Hemostasis

1. Turn the current selector switch to **partially** rectified (hemo). Insert the ball electrode, turn the power dial up several lines from the optimal setting, touch the ball electrode to the muscle

surface without any pressure and depress the footswitch for one second. Move the ball electrode a few centimeters and repeat this step using 2, 3, 4 and 5 seconds respectively.

2. Repeat as above with a 2 second current surge, but turn up the power dial after each application. You should now have 2 lines of discolored dots. Take the scalpel blade and cut across the middle of each line to determine the depth of coagulation created both by increasing the time and the power.

3. Place the ball electrode on the tissue with the power setting between 3 and 4 and in a circular motion, coagulate the surface of the tissue in a 3 to 4 cm area. This technique will be used for coagulation of an oozing muscle area. With the scalpel blade, cut across the blanched area to determine the depth of coagulation.

4. Grasp the tissue with a hemostat. Raise the hemostat and touch the ball electrode to the hemostat. Initiate the current and the tissue at the end of the hemostat will blanche. Be sure to grasp the hemostat **FIRMLY**. In this way, there will be no sparking from the hemostat to the hand.

Exercise IV - Fulguration

1. Plug the handpiece into the white portal marked handpiece fulgurate. Using a ball electrode, fulgurate several areas . Notice the spark gap and the superficial nature of the tissue destruction.

Radiosurgery - Questions and Answers

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1. **What is Electrosurgery? Is it different from Radiosurgery?**

   Electrosurgery is the use of radio frequency (R.F.) energy to cut and/or coagulate tissue. The American Dental Association defines Electrosurgery as "the passing of higher (ratio) frequency current through the tissues to achieve surgical effect". Therefore, the terms Electrosurgery and Radiosurgery may be used interchangeable, as they are the same thing. However, one must be careful in that 3.8 MHz is the ideal frequency for radiosurgery. If the frequency is lower than this, thermal damage may occur in the tissue.

2. **What is radio frequency?**

   Radio frequency is high frequency electrical current. This energy is concentrated at the tip of the electrode. When contact is made with tissue, the cells in immediate contact with the electrode overheat and vaporize. Since the electrode only serves as a conductor of the R.F. current, it does not itself get hot. The heat is created internally in the tissue by the R.F. energy. Again, many sources have proven that 3.8 MHz is the ideal frequency in order to achieve consistent results.

3. **Explain the basis types of current:**

   There are four basic types of current:
   1) Normal or Fully rectified Current (full wave) which cuts smoothly with measured amount of coagulation, so that it is possible to get simultaneous cutting with hemostasis but without necrotic destruction.
   2) Fine or Filtered current (continuous wave) which cuts very smoothly but provides almost no hemostasis.
   3) Partially rectified (1/2 wave) or coagulation Current which is less destructive than spark, cuts rather coarsely with heavy coagulation approaching necrosis.
   4) Spark or Fulguration Current which is very destructive and useful only for tissue destruction and to stop heavy bleeding.

4. **Explain mono-polar vs. bi-polar electrode.**

   Monopolar has one active tip and a separate ground, usually via a ground plate; bi-polar has two active tips (i.e. forceps) working at the same time so that the energy passes from one to the other rather than radiating around one tip.

5. **Explain mono-terminal vs. bi-terminal use of the unit.**

   Mono-terminal has one active electrode and uses the environment (operatory) as a return path for R.F. energy. Bi-terminal has one active electrode and a passive one (ground plate) that provides direct R.F. return to the unit.

6. **If I purchase a Radiosurgery unit, in what areas of surgery would I most likely use the unit?**

   No one answer applies here. In essence, the electrosurgical unit may replace cold steel in virtually any phase of veterinary surgery. More specifically, one would probably find the unit most useful in procedures where there is a considerable amount of bleeding or in delicate surgery. Procedures such as removal of tumors, tonsillectomies, ear cropping, biopsies, removal of warts, entropion, ectropion, epilation and certain periodontal procedures come to mind initially.

7. **How can one determine if the power is adjusted correctly for a procedure?**

   There will be drag (with coagulum adhering to the electrode) if power is set too low. If coagulum adheres to the electrode it should be removed using a moist sponge or scalpel as coagulum on the electrode will increase resistance and decrease efficiency. Power set much too high will result in heavy sparking and excessive necrosis of tissue due to cellular destruction over too wide a path.

8. **Where and how should the ground plate be placed?**

   The coated ground should be placed as close to the site of surgery as possible, thus decreasing the resistance and allowing the lowest power setting. The coated ground plate does not require skin contact, eliminating the need for jelly or adhesives.

9. **What degree of simultaneous coagulation may be expected while using the surgery handpiece using the fully rectified current?**

   Usually, normal tissue will be cut with minimal bleeding. If the tissue is very vascular (hemorrhagic) there may be more bleeding requiring use of the coagulation handpiece. Employ the partially rectified current.

10. **What is the procedure for sealing larger capillaries or small vessels that aren't sealed during the cutting procedure?**

    Insert a ball into the handpiece and apply it to the capillary opening while depressing the foot pedal for 1-2 seconds. For larger vessels, a hemostat may be used clamping the vessel to be sealed then touching an electrode to the beaks of the hemostat and activating the coagulation (i.e. partially rectified) current for a second or two. Bi-polar forceps may also be used for more delicate coagulation in birds and smaller species. For arterial bleeders or larger venous bleeders, ligatures should be applied. Bleeders that are normally ligated when employing cold steel should also be ligated when using electro/radiosurgery.

11. **Is there any way one can get shocked while using an Electro/Radiosurgical unit?**

    There is no way you can get electrical shock. It is possible to get a high frequency burn if you make light contact with the patient or metal instrument with bare skin while current is being applied. (R.F. energy goes to the point of least resistance).

12. If tissue sloughing occurs after electrosurgery, what's the cause?

Sloughing usually indicates improper technique, causing tissue necrosis. Either the power setting was too high, or the electrode moved too slowly, or both.

13. When cutting, muscle spasms are sometimes noted. Is this normal?

Yes. Muscle contraction (facilitation) frequently occurs during electrosurgery.

14. How does electrosurgical healing compare with the use of steel cutting instruments?

It is roughly comparable. As in any surgery, remove the sutures only when the suture line is ready. Research indicates that this would probably be in the vicinity of ten days. If the scar has widened or has a scab, don't pull the sutures. (See Dec. 1, 1971 J.A.V.M.A. Vol. 159 #1, Pages: 1447-52 "Healing of Sharp Incisions and Electroincisions in Dogs" C.D. Knecht, VMA Et. Al.)

15. In what procedures should I use Bi-Polar Forceps?

In general, bi-polar forceps are employed in coagulating extremely small blood vessels in extremely small animals. When discussing bi-polar applications, veterinarians generally mention its use in birds as far as species is concerned; in eye and neurosurgery when speaking of anatomy. A basic course in electro/radiosurgery is recommended for the finer applications using the bi-polar technique.

16. Can the handpiece, cords and electrodes be sterilized?

The handpieces, cords, bi-polar forceps and electrodes may be autoclaved, but temperatures should not exceed 250 degrees F; 20 minutes is adequate. Sterilization at higher temperatures may cause cracking of the handpieces. Handpieces and cords should be checked periodically for cracks and frayed insulation.