

**Plasma Surgery:**  
**A Patient Safety Solution**  
**(Study Guide 003)**

**INDEPENDENT STUDY GUIDE**

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**Expiration Date**

This study guide offers 1.2 contact hours of learning until May 2012.

**Support**

Plasma Surgical, Inc. has provided Grant funds for the development of the continuing educational activity.

## **Description of Study Guide Topic**

One of the main challenges of surgery is the need to provide adequate coagulation. Various technologies have been used including electrosurgery, argon-enhanced coagulation, laser, and others. A new technology called *Plasma Surgery* has recently been introduced. This study guide will describe this unique and advanced method including plasma tissue effects, delivery systems, and safe practices.

## **Overall purpose of the study guide**

To provide information on *Plasma Surgery* and the advantages of this advanced surgical tool.

## **Objectives**

Upon completion of this study guide program, the participant should be able to:

1. Describe different energies used for tissue coagulation and cutting in surgery.
2. Discuss the principles of *Plasma Surgery*.
3. List the advantages of *Plasma Surgery*.

## **Intended Audience**

This study guide is a self-study program intended for use by perioperative nurses, surgical technologists, surgery managers and directors, surgeons, and other health care professionals interested in this topic.

## **Cut and Coagulation Energies**

Adequate coagulation is imperative during open and laparoscopic procedures. Over the years, a variety of cut and coagulation methods have been introduced and accepted including electrosurgery, argon-enhanced coagulation, and laser technology. The performance and limitations of each system depends on the type of energy that is chosen.

### ***Electrosurgery and Argon-Enhanced Coagulation***

Electrosurgery was first introduced in the 1920's. Coagulating with electrical energy involves passing a high-frequency electrical current through the target tissue while completing a circuit.

The first electrosurgery units were large ground-referenced, spark-gap units which used a monopolar circuit. In a monopolar circuit, electrical energy flows from the generator, is delivered to the target tissue through the active electrode, flows through the patient to the grounding pad on the patient's skin that collects the energy, and then directs it back to the generator to complete the circuit. The problem with the grounded electrosurgical units is that the electrical energy will flow through the path of least resistance to complete the circuit. An EKG pad or any metal touching the patient could conduct the electrical energy thus causing patient burns and many accidents from alternate path burns have been reported.

In 1968, the isolated electrosurgery unit was introduced. This unit contains a transformer that requires the electrical energy to return only to the generator; in the event of an alternate circuit, the unit is disabled. Alternate path burns were eliminated with this new technology thus creating a safer surgical environment.

Even though isolated electrosurgical generators addressed the incidence of alternate site burns accidents from electrosurgical energy continued to be reported. Burns were occurring at the grounding (return electrode) pad site where the electrical energy would be collected from the patient's body to complete the electrical path. If the grounding pad was not adhered to the patient's skin properly then the electrical energy could be concentrated in a small area thus causing a patient burn.

In the 1980's, a specially monitored grounding pad was introduced to eliminate patient burns at the pad site. This two-section pad is routinely used today. It is designed to receive an interrogation circuit to measure the impedance or resistance of the pad. If the flow of electrons encounters resistance as the energy crosses from one section of the pad to another, then the pad is not positioned properly and the generator is then disabled. With this advancement in return electrode monitoring, pad site burns are minimized and may even be eliminated.

In the 1990's the popularity of laparoscopy grew tremendously and the incidence of electrosurgical accidents increased as well. Stray electrosurgical burns in the form of direct coupling, insulation failure, and capacitive coupling were beginning to be reported frequently. Patient injuries and even deaths resulted from accidents caused by stray electrosurgical energy. During a laparoscopic procedure, surgery is performed with somewhat impaired visibility of the surgical site. Operating through small channels while using a rigid endoscope the surgical team can only see a small part of the electrosurgical probe and the surgical field, and accidents can easily occur from this decreased visibility.

Direct coupling is caused when the active electrode is inadvertently activated while in contact with a metal object. For example, during laparoscopy, a metal suction tube that is in contact with an active electrode will conduct the electrical energy and can cause a burn at an untargeted site.

Insulation failure can happen when a break or hole occurs somewhere along the length of the insulated sheath, thus allowing electrical energy to escape and burn untargeted tissue.

During capacitive coupling, electrical energy can pass from one conductor through intact insulation to another conductor (i.e., metal instrument) that is touching or is immediately adjacent to the active electrode. This energy can electrically charge the metal instrument which, in turn, can lead to a stray electrosurgical burn.

Electrosurgery burns during laparoscopy have caused more than just injuries to the patient. Deaths have been reported. Active electrode monitoring devices are now available to eliminate burns caused from insulation failure and capacitive coupling. Active electrode monitoring is slowly being accepted as the standard of care but, even today, accidents continue to occur. An added risk is that burns can occur at alternate sites in the return path to the grounding pad. These alternate site burns can cause penetration of the bowel at a site out of view of the endoscope and the risk of peritonitis goes unnoticed.

Bipolar electrosurgical devices minimize many of the safety hazards associated with monopolar electrosurgical systems. Bipolar energy limits the flow of current between two poles, such as the prongs of forceps, scissors, or graspers. Therefore, the electrical energy does not need to flow through the patient on its path to the grounding pad. Bipolar energy is inherently safer than monopolar electrosurgery as it typically uses

only small amounts of low-voltage current to achieve hemostasis. However, bipolar energy is not applicable to larger vessels or the coagulation of larger tissue surface bleeding.

Argon-enhanced coagulation is another method of electrocautery that provides coagulation during open and laparoscopic procedures. Energy from a monopolar electrocautery unit is used to partially ionize a stream of argon gas that is directed to the tissue for coagulation. Since the argon gas non-combustible, an efficient path for the electrocautery energy is created from the electrode to the target tissue. The monopolar electrical energy flows through the patient to the grounding pad where it is then returned to the generator. The tip of the delivery device, which applies the electrical current in an even and uniform surface pattern, is never in contact with the target. The flow of argon gas clears the surgical site of fluids and blood, thus enhancing the visibility of the bleeding site.

Some of the benefits promoted by argon enhanced coagulation include<sup>1</sup>:

- \*Rapid coagulation over a large area
- \*Reduced blood loss
- \*Non-contact tissue coagulation
- \*Less adjacent tissue damage from reduced depth of penetration of the electrocautery energy
- \*Less generation of surgical smoke

However, when argon enhanced coagulation is used during laparoscopy, over-insufflation and over-pressurization of the abdominal cavity can occur from the constant flow of argon gas. This pressurized flow of argon gas can also cause a gas embolism. There are many techniques to minimize these hazards including:

- \*Opening a port during activation of the argon enhanced coagulator unit to allow any excess gas to escape
- \*Using an insufflator with an audible alarm that indicates over-pressurization
- \*Limiting the argon gas flow to the lowest level possible
- \*Monitoring the patient closely for any signs and symptoms of embolism so immediate treatment can be initiated
- \*Purge the argon gas line of air before every procedure

Whenever electrocautery energy is used, safe practices must be employed since the patient or the patient's tissue is always part of the circuit. The appropriate waveform, power setting, length of exposure, active electrode size and shape, tissue resistance (impedance), eschar presence and surgical technique all must be considered to provide patient safety<sup>2</sup>. Other safety concerns involving electrocautery include:

- \*Pad placement considerations (The location of the pad, skin condition, and type of tissue must all be considered when placing the grounding pad on the patient.)

<sup>1</sup> Rothrock J, (2003), Alexander's Care of the Patient in Surgery, 12<sup>th</sup> edition, St Louis, Mosby Inc. Page 93

<sup>2</sup> Ball, Kay (2004), Lasers: The Perioperative Challenge, 3<sup>rd</sup> edition, Denver, AORN, Page 21

\*Laparoscopy considerations of insulation failure and capacitive coupling (During laparoscopic surgery, stray electrical energy burns can occur as the electrical energy can escape from a hole in the sheath of the insulated instrument or from capacitive coupled energy causing an adjacent metal device to become charged, thus resulting in a patient burn.)

\*Direct coupling (During open or laparoscopic procedures, touching an active electrode to a metal device can cause the metal device to become charged, thus leading to a patient burn.)

\*Flammable agents (Electrosurgical energy sparks when activated. Flammable agents such as alcohol used for the surgical prep must be avoided, as it is highly flammable. If an alcohol prep solution is used, it must be allowed to completely dry and dissipate before using the electrosurgery unit because the sparks generated by the active electrode can ignite flammable agents or materials.)

\*Flammable gases (Oxygen and nitrous oxide, if allowed to build-up under the drapes, can lead to fires. An oxygen-rich environment easily supports combustion.)

\*Hazards of surgical smoke (When tissue is cut, coagulated, or vaporized with electrosurgical energy, surgical smoke or plume is created. Toxic gases within the plume are responsible for the pungent odor that consists of acrolein, benzene, formaldehyde, polycyclic aromatic hydrocarbons, and other toxic gases. Most of the particulate matter within the plume is less than 1.1 microns in size and will easily flow through a regular surgical mask that filters 5 micron in size particulate matter. Whether the particulate matter is carcinogenic or mutagenic is still being researched but intact viral and bacterial DNA has been extracted from surgical smoke. A smoke evacuation system, whether it is an in-line filter or an individual smoke evacuation unit, must always be used when surgical smoke is generated.)

\*Pacemakers and automatic defibrillators (When electrosurgical energy is used, the circuitry of an implanted pacemaker may be affected. An automatic implantable cardioverter/defibrillator should be deactivated immediately before surgery since the high voltages from the electrosurgery unit may cause an accidental electric shock to the patient.)

The *AORN Recommended Practices for Electrosurgery*<sup>3</sup> should be referenced for safe practices of electrosurgery and argon-enhanced coagulation. These recommended practices are intended as achievable practices that represent the optimal level of care.

### ***Laser Technology***

Laser technology was first introduced to the medical arena in the 1960's. The theories on natural light that were expressed by Dr. Albert Einstein in the 1920's served as the foundation of laser technology. Laser actually is an acronym for Light Amplification of the Stimulated Emission of Radiation. Laser energy is created when an active medium is excited to produce photons of light. These little bundles of light energy continue to be amplified until enough energy is formed that can be delivered to the tissue to cause coagulation, ablation, or cutting. The different laser systems are usually named after the active medium used to create the laser energy, such as CO<sub>2</sub>, Nd:YAG, argon,

<sup>3</sup> AORN, (2003), "Recommended practices for electrosurgery," Standards, Recommended Practices, and Guidelines. Pages 237-244

holmium, etc. Laser energy is measured in wavelengths (which is from the top of one peak to the top of the next) and is often expressed in nanometers (nm) or microns ( $\mu$ ). Laser wavelengths vary from the long invisible near infra-red waves (CO2 laser at 10,600 nm), the visible wavelengths (argon blue at 488nm), to the short invisible ultraviolet excimer wavelengths (ArF at 193 nm).

The three distinguishing characteristics of laser energy as compared to regular light (for example, light coming out of a light bulb) are:

- \*Coherent – laser energy stays together for long distances without divergence unless passed through a focusing lens
- \*Collimated – laser energy flows in an orderly manner that is very consistent
- \*Monochromatic – laser energy produces one color or one wavelength

Laser energy is delivered in the non-contact or contact mode depending on the system type and delivery device. Depending on the laser wavelength, laser energy can be reflected, scattered, transmitted, or absorbed by tissue.

The benefits of laser energy include:

- \*Sealing smaller blood vessels (dry surgical field)
- \*Sealing lymphatic tissue (less spread of malignant cells)
- \*Sealing nerve endings (less postoperative pain on select procedures)

The use of laser technology has been directly impacted by the cost of laser systems, delivery devices, and laser maintenance. Patient charges are not always reimbursed by third party carriers, therefore, surgeons are more apt to use electrosurgery to control costs.

Laser technology also requires measures to provide a safe environment for not only the patient but the surgical team too. The AORN Recommended Practices for Laser Safety<sup>4</sup> in Practice Settings should be used to reference optimal levels of practice when developing laser safety policies and procedures. Safety measures that must be addressed include:

- \*Controlled access
- \*Safety eyewear
- \*Protection against laser beam exposures (skin and other non-targeted tissues)
- \*Exposure to surgical smoke (same as with plume generated during electrosurgery)
- \*Flammability hazards
- \*Electrical hazards
- \*Staff competency
- \*Development of appropriate policies and procedures

The growth of the surgical laser has been stemmed in part by concerns over safety and the applications limited by the difficulty in some forms of laser energy over the adequacy of coagulation. Whenever a coagulation tool is chosen, the mode of action, type of delivery system, method of application, and safety measures must be considered. A new and innovative coagulation and cutting technology has recently been introduced called ***Plasma Surgery***. This new technology not only meets the requirements of effective and efficient coagulation and cutting but also minimizes many of the hazards associated with other coagulation methods.

<sup>4</sup> Ball, K, (2004), Lasers: The Perioperative Challenge, 3<sup>rd</sup> edition, Denver, (AORN, pp.301-305)

## ***Plasma Surgery***

### ***History***

***Plasma Surgery*** has recently been introduced. It utilizes an advanced and unique technology to achieve optimal cutting and coagulation with minimal tissue damage. This system sets a new standard of care in safety and effectiveness for intraoperative coagulation and cutting.

Plasma was defined as the 4<sup>th</sup> stage of matter in the 1930's. Plasma is an electrically neutral, highly ionized gas composed of ions, electrons, and neutral particles that make up about 90% of our universe. In the mid 1970's, the first experiments with a plasma coagulating device were conducted at the University of Indiana, but at that time no clinically usable device resulted. In the 1980's research continued at the Kremlin Hospital in Moscow, led by Professor Suslov, a specialist in plasma physics, and this led to the development of handpieces for ***Plasma Surgery***. Animal studies and clinical research were undertaken to understand the parameter specifications and technology limitations of ***Plasma Surgery***. Recently, a new system using pure plasma energy has been developed for use in both open and laparoscopy surgery.

***Plasma Surgery*** offers a number of advantages over both electrosurgery and argon-enhanced coagulation including:

- \*Improved safety due to the absence of current flow through the patient
- \*Low gas flow (~0.6 liters/min) to reduce the risks of gas embolization and over-pressurization during laparoscopic surgery
- \*High thermal and kinetic energy to improve coagulation efficiency
- \*Clinical use with positive outcomes in a variety of procedures including laparoscopy, liver and lung procedures, surgical oncology, plastic surgery, orthopedics, and OB-GYN

### ***Action of Plasma Surgery***

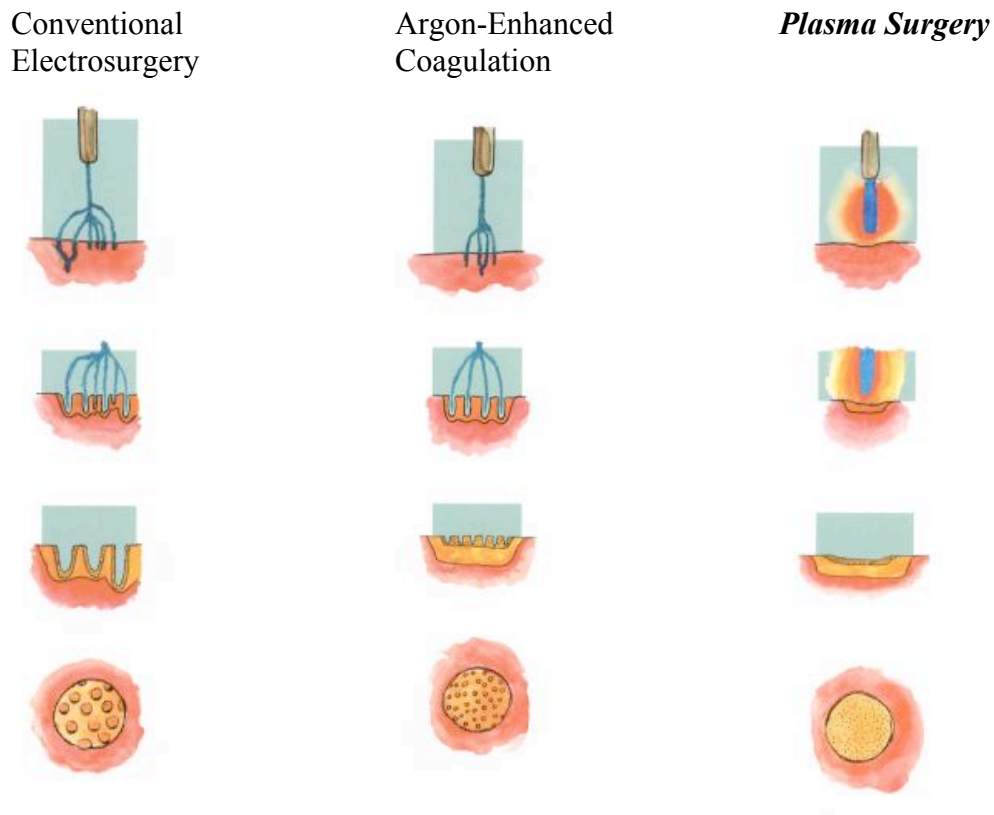
***Plasma Surgery*** uses a fine, electrically-neutral jet of pure plasma to coagulate and cut tissue. This plasma, which is highly energetic, releases its energy upon contact with tissue in the form of thermal and kinetic energy:

- \*The kinetic energy pushes aside, providing a dry surface for a more effective coagulation and cutting of tissue. At higher settings, it combines with the thermal energy and can be used to ablate tissue.
- \*The thermal energy efficiently coagulates small blood and lymph vessels, bile and air ducts to provide hemostasis, lymphostasis, biliary stoppage, and aerostasis.

The high energy plasma is generated by ionizing a low flow of inert argon gas within the insulated body of the single use handpiece. It emerges from the tip of the handpiece in a precise, pale blue jet stream. In contrast to monopolar and bipolar electrosurgery, no electrical current passes through the patient or through tissue, thus in ***Plasma Surgery***, no grounding pad is needed.

The surface temperature of the affected coagulated tissue is approximately 100° C. This high temperature causes the liquid component of the tissue to desiccate. When using a 5mm diameter handpiece, the size of the area affected ranges between 1.5 to 2.5 mm.

**Plasma Surgery** can be used on a variety of tissues to coagulate, cut and prevent fluid loss. Used at higher settings it can ablate nodules or unwanted tissue growth.



The very thin, flexible layer created by **Plasma Surgery** comprises two distinct layers of eschar. On the surface, there is a spongy necrotic layer (SNL) which forms instantly and acts as a shield against diffusion of the thermal energy. The SNL typically measures less than 0.3mm (300 microns). Underneath this layer is a compact necrotic layer (CNL) that is much denser and more elastic. This layer attaches tightly to the underlying viable tissues. Risks of re-bleeding following sudden detachment of the eschar are minimized.

As the argon gas flows, the physical force of the plasma jet actually pushes aside the fluids to provide a clear and clean surface for coagulation and cutting. During laparoscopy, the safe flow of argon gas never exceeds 0.6 liters/min while the gas flow of an argon-enhanced coagulation system may flow up to 10 times this which causes patient safety concerns for over-pressurization or gas embolism. For optimal safety, an automatic regulator on the insufflator or a separate manometric pressure release device should be used during laparoscopy.

Since the argon plasma stream is delivered in a non-contact mode, the risk of tissue adhering to the handpiece is eliminated. **Plasma Surgery** is most effective on large surfaces or parenchymatous organs, such as the liver, spleen, and kidneys, or to Lymphoseal™ subcutaneous tissue over large dissection surfaces as found in plastic and reconstructive surgery. **Plasma Surgery** also is very effective for achieving aerostasis during lung procedures. Clinical research continues to note results of **Plasma Surgery** on other tissue types.

### ***Delivery Systems***

For open surgery, a 5mm or 10mm diameter handpiece is used to deliver the argon plasma to the tissue for coagulation and cutting. The handpiece is electrically neutral as the electrodes are contained completely within the handpiece. The blue activation button, which is hermetically sealed, is ergonomically located on the handpiece for coagulation while the yellow activation button is used for the handpiece cutting mode. A soft grip material at the level of the activation buttons offers a comfortable and safe grip even in a wet environment. All handpieces are supplied sterile and are for single-use only.

The laparoscopic handpiece is operated by a footswitch. This “on/off” footswitch is also hermetically sealed to prevent fluid ingress. The electrodes are completely contained within the handpiece making the device electrically neutral. The laparoscopic delivery system is compatible with 5mm working channels and is also *only* available as a sterile single-use device.

As with all types of coagulation and tissue cutting devices, care must be taken to always visualize the device tip during laparoscopy before activating the jet of plasma.

A central channel allows a low flow of argon gas to form the plasma, and a combined hose arrangement provides electrical power, argon gas supply, and a cooling water flow to the handpiece. A single connector is used to connect the handpiece to the console of the **Plasma Surgery** system.

Since the handpieces are single-use devices, reprocessing instructions are not needed. Should the tip accidentally come in contact with tissue and get charred during a procedure, the jet of plasma should be stopped, and the tip carefully wiped with a gauze pad.

The handpiece, whether used during open or laparoscopic procedures, should never be activated when the tip is directed toward someone’s hand, toward flammable materials, or when it is out of the surgeon’s field of view (during laparoscopy). In contrast to other coagulating and cutting handpieces, the **Plasma Surgery** handpiece tip remains cool despite the argon plasma jet but the system should not be used in the presence of flammable anesthetic agents or other volatile solvents. Unlike lasers, **Plasma Surgery** does not require the use of special eye protection for the user as the argon plasma stream poses no risk for eyes if used as intended.

The **Plasma Surgery** console can be placed on a standard OR cart on a ceiling fixture, or can be contained within a custom-designed service trolley. Large castors on the service trolley provide easy maneuverability and locking capabilities. The service trolley houses the argon gas tank. The **Plasma Surgery** system is designed to operate using a supply of compressed argon gas with a purity of ~ 99.95%. The argon gas tank should not exceed 58cm (22.8 in. – B5 type of gas tank) to fit in the back of the service trolley.

The **Plasma Surgery** system is delivered with a special regulator for use with the argon gas tank. (*Pressure regulators not supplied with the system should not be used*).

The control panel on the console has a membrane keyboard on the front for easy use and display reading. The console also houses a reservoir of distilled water, which is cooled by the system and then circulated through the handpiece during operation, with no contact to the patient.

### ***Advantages of Plasma Surgery***

Some of the advantages of **Plasma Surgery** as compared to conventional and/or argon-enhanced electrosurgery include:

1. **No electrical current - Plasma Surgery** is electrically neutral as no current ever leaves the insulated handpiece to travel through the patient
  - \**There is no need for a grounding pad*, thus there are no risks of alternate site burns or grounding pad burns
  - \**There are no risks of direct coupling, insulation failure, or capacitive coupling* during laparoscopy
  - \*The technology is innocuous in the presence of metallic implants or close to sensitive tissue of structures
2. **Tissue Coagulation** – When applied to tissue, the high energy of the plasma jet rapidly creates a thin and flexible eschar layer preventing further bleeding and/or lymphatic oozing. **Plasma Surgery** also provides aerostasis in lung procedures.
3. **No thermal diffusion** in surrounding tissue or fluids allows for minimized and controlled tissue damage and improved post-operative recovery.
4. **Ability to coagulate and cut simultaneously** on a wide variety of tissues.
5. **A drier coagulated surface**- The dynamic effect of the plasma flow removes liquid from the wound surface offering visual access and control. It avoids “floating eschars” and the ensuing risk of premature detachment and rebleed.
6. **Very low gas flow**- In **Plasma Surgery** the flow of argon gas is very low at less than ~0.6 liters/min (less than one-tenth of the gas flow used by argon-enhanced electrosurgery), thus minimizing the risks of over-pressurization or gas embolism.
  - \*The lower gas flow and the absence of electric current flow through the tissue makes **Plasma Surgery** a very safe technology, especially in laparoscopy.
7. **No tissue contact** for coagulation thus no risk of tissue adhering to the handpiece.

### **Summary**

Controlling bleeding and fluid loss is the key to the success of any surgical procedure. Many different systems of coagulation and cutting are available today but the introduction of **Plasma Surgery** has provided a most effective method for consideration. This technology has proven its clinical potential and usefulness in many different types of surgery. The very quick and effective power of this new technology using an electrically neutral system along with a completely safe stream of argon plasma energy has generated excitement and interest from the surgical community. **Plasma Surgery** can now be

considered as one of the most promising surgical tools for tissue desiccation and fluid loss control in open and laparoscopic surgery.

## Glossary

**Ablate** To remove tissue, especially by cutting

**Active electrode** The accessory that directs current flow to the operative site. Examples include pencils with various tips (e.g., needle tip, blade tip, ball tip) and fulguration tips.

**Alternate site burn** Electrosurgery-related risk that causes burns to tissues that were not intended for electrosurgery. Alternate site burns result from the current choosing a path of least resistance than the route it was intended to go through between the active electrode and the grounding pad.

**Alternating current (AC)** An electric current that continuously reverses direction.

**Ampere (AMPS)** The standard unit for measuring the strength of an electric current.

**Argon gas** A colorless, odorless, inert gas making up 1% of the earth's atmosphere that was discovered in 1895. Symbol AR. Used in electric lamps, fluorescent tubes and as an inert gas shield in arc welding.

**Argon-Enhanced Coagulation** A method of coagulation in which a monopolar electrosurgical current is conducted to tissue via a *partially* ionized argon gas stream.

**Bipolar ESU (Electrosurgical Unit)** Electrosurgery unit that has both active and return electrodes in one handpiece; the electrosurgical current flows between the electrodes, causing tissue destruction.

**Capacitive Coupling** The establishment of currents between two conductors that are separated by an insulator. A charge called capacitance may be stored at these sites. Discharge of the capacitor to adjacent tissue may result in burns.

**Capacitor** Two conductors separated by an insulator.

**Carbonization** The process of charring tissue to carbon, as by partial burning.

**Circuit** A closed loop path over which current may flow.

**Coagulate** To cause transformation of a liquid into a soft, semi-solid or solid mass (hemostasis). In electrosurgery, to cause tissue dehydration without cutting.

**Compact Necrotic Layer (CNL)** Layer of necrosis that forms under the surface spongy necrotic layer (SNL) when using the Neutral Plasma Coagulator. CNL is characterized by

a dense, elastic structure, and attaches strongly to the underlying viable tissues, minimizing the risks of re-bleeding following the sudden detachment of the eschar.

**Conductor** A substance that conducts electricity.

**Current** The flow of electrons, measured in amperes (A).

**Cut** Sever tissues; electrosurgical cutting waveforms sever tissues with sparks that explode cell walls.

**Defibrillator** A device that administers an electric shock in order to arrest fibrillation of the ventricular muscle and restore the normal heartbeat.

**Desiccation** The dehydration of tissue through direct contact with the active electrode.

**Direct current (DC)** An electric current in which the flow of electrons is in only one direction.

**Dispersive Electrode** A pad, plate, or contact device that provides a large surface area for patient contact. It directs current flow from the patient back to the electrosurgical generator; its large area reduces current density as energy flows from the patient. Also known as a grounding pad, patient plate, return electrode, or passive electrode.

**Electrocautery** The coagulation of blood or tissue by means of an electrically heated wire. The current heats only the electrode and does not pass through the patient's body.

**Electrocution** Death caused by the passage of a low frequency electric current through the body.

**Electrode** A physical device close to, or in contact with the patient through which electrosurgical energy is received or transmitted.

**Electron** A negatively charged subatomic particle.

**Electrosurgery** The use of radiofrequency energy to produce cutting and/or coagulation in body tissues.

**Electrosurgical Unit (ESU)** A machine that produces radiofrequency energy for electrosurgery. Also known as a power unit, or generator.

**Embolism** A sudden blocking of an artery by a clot or foreign material which has been brought to its site of lodgment by the blood current. A gas embolism occurs when gas bubbles enter the blood stream after trauma or surgical procedure.

**Endoscopy** Examination of the interior of a canal or hollow organ by means of a special instrument, called an endoscope.

**Eschar** A slough (dead tissue) formed as a result of thermal burn, corrosive application or gangrene.

**Frequency** The number of wave cycles in a unit of time; measured in Hertz (Hz).

**Fulgurate** Coagulating tissue, by sparking of electric current with a coagulating waveform through air to the tissue.

**Ground** A conducting body, such as the earth or an object connected with the earth, that has the ability to neutralize a charged particle.

**Ground-referenced ESU** An ESU in which the dispersive electrode is grounded to the metal chassis of the generator. Current will flow from the active electrode when it touches any grounded object.

**Hemostasis** The stoppage of bleeding.

**Hertz** A unit of frequency, equal to one cycle per second.

**Impedance** The total opposition offered by an electric circuit to the flow of an alternating current; measured in ohms. Also known as resistance.

**Isolated ESU** An ESU in which RF current will only return to the dispersive pad and not to alternate ground points on the patient. For current to flow, there must be a complete circuit pathway from the active electrode to the dispersive electrode.

**Insulator** Material that does not conduct electricity; also referred to as a dielectric.

**Kinetic energy** Energy produced by motion.

**Laparoscopy** Examination of the contents of the peritoneal cavity with a laparoscope, which is passed through the abdominal wall.

**Laser** Acronym for Light Amplification by the Stimulated Emission of Radiation.

**Monopolar ESU** An ESU with an active electrode that requires the use of a dispersive pad to complete the circuit.

**Ohm** The unit of electric resistance or impedance.

**Open surgery** Non-closed surgical technique as opposed to laparoscopy or endoscopy.

**Pacemaker** A device, which may be implanted in the chest with electrodes attached to the external cardiac surface, that controls the heart's rhythm by artificial electric discharges.

**Plasma** Fourth stage of the matter discovered in the 1930's. Plasma is an electrically neutral, highly ionized gas composed of ions, electrons and neutral particles that makes up 90% of our universe.

**Plasma Surgery** A new, innovative method of utilizing a high power jet of pure plasma to achieve optimal coagulation and cutting, or- under certain conditions of use- optimal tissue ablation without the use of an electric current that passes through the patient's body.

**Polarity** The condition of having a positive or negative charge.

**Power** The rate at which energy is used; measured in watts.

**Radiofrequency (RF)** An electric current occurring at high frequencies, usually greater than 400,000 cycles per second.

**Resistance** The factor that impedes or limits the amount of direct current that flows through a conductor; measured in ohms.

**Spongy Necrotic Layer (SNL)** Low depth necrotic layer (< 0.3 mm) that forms at the surface of bleeding tissues immediately upon applying the Neutral Plasma Coagulator. SNL is characterized by a spongy structure of grayish color resulting from early tissue desiccation.

**Terminal** An initiation point on an electric circuit or conductor.

**Voltage (volt)** The electromotive force that drives electrons; the difference in potential between two points in an electric field; measured in volts.

**Watt** The unit of electric power; a measure of the work necessary to overcome resistance to the flow of electrons.

**Waveform** The shape of a graph of electric voltage versus time.

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**Further References**

Iannelli, Antonio; Bafghi, Abdol Reza; Patrono, Damiano; Sautot-Vial, Nicolas; Gugenheim, Jean- Use of PlasmaJet™ System in Patients Undergoing Abdominal Lipectomy following Massive Weight Loss Resulting from Bariatric Surgery: Early Experience, Obesity Surgery. Volume 16, Number 11, November 2006, pp. 1504-1507(4)

Denis F. Branson- PlasmaJet Neutral Plasma Coagulation: Preliminary Experience, American Society of Aesthetic Plastic Surgery, Orlando, FL, April 2006

Argon plasma coagulation minimizes the risks of injury, Same-Day Surgery , April 2006; 42-43

Knivett, V., 'Plasma Progress', New Electronics 39 no 8 (2006) 19-20

**Resources:**

[www.plasmasurgical.com](http://www.plasmasurgical.com)

## Review Questions

1. Isolated electrosurgical units were introduced to eliminate the incidence of
  - a. Grounding pad burns
  - b. Alternate path burns
  - c. Bipolar burns
  - d. Capacitive coupling
  
2. Return electrode monitoring was introduced to measure the \_\_\_\_\_ within the grounding pad.
  - a. Voltage
  - b. Monopolar circuitry
  - c. Impedance (resistance)
  - d. Current
  
3. Stray electrosurgical burns are a hazard during laparoscopy when monopolar electrosurgery is being used as the following can occur
  - a. Capacitive coupling
  - b. Direct coupling
  - c. Insulation failure
  - d. All of the above
  
4. Argon-enhanced coagulation involves
  - a. Energy from a bipolar electrosurgical unit
  - b. A partially ionized stream of argon gas
  - c. A completely ionized stream of argon gas
  - d. An argon laser beam
  
5. When argon-enhanced coagulation is used during laparoscopy, the following are concerns to address:
  - a. Overinsufflation
  - b. Overpressurization
  - c. Gas embolism
  - d. All of the above
  
6. Plasma is
  - a. An electrically neutral, highly ionized gas composed of ions, electrons, and neutral particles that make up about 90% of our universe
  - b. A technology that was originally described during World War II
  - c. An electrically neutral, partially ionized gas composed of ions, protons, and neutrons
  - d. An electrically positive, highly ionized gas composed of atoms that make up about 50% of our universe

7. When using **Plasma Surgery**, the following processes occur:
  - a. A stream of electrons is delivered to the tissue, a coagulation layer occurs, bleeding is stopped
  - b. A plasma is formed within the handpiece, the low temperature of the plasma freezes the target site, bleeding is stopped
  - c. An argon plasma stream is emitted from the handpiece, the physical force of the argon plasma removes liquid blood from the tissue surface, the energy of the plasma is transferred to the tissue causing tissue coagulation
  - d. A stream of plasma is emitted from the handpiece, the high temperature of the electron sparks coagulate the tissue in layers, bleeding is stopped
  
8. In **Plasma Surgery**, no electricity escapes the handpiece so a grounding pad is not needed.
  - a. True
  - b. False
  
9. When **Plasma Surgery** is used during laparoscopy, the safe flow of argon gas never exceeds \_\_\_\_\_ liters/minute while the gas flow of an argon-enhanced coagulation system may flow up to \_\_\_\_\_ liters/minute which causes patient safety concerns for over pressurization or gas embolism.
  - a. 0.6 liters/min, 6 liters/min
  - b. 4 liters/min, 10 liters/min
  - c. 10 liters/min, 0.4 liters/min
  - d. 0.6 liters/min, 1 liter/min
  
10. Advantages of **Plasma Surgery** include:
  - a. No electrical current
  - b. No tissue contact for coagulation
  - c. Very low gas flow
  - d. All of the above

**Answers:**

1. B
2. C
3. D
4. B
5. D
6. A
7. C
8. A
9. A
10. D

# Plasma Surgery: A Patient Safety Solution

## REGISTRATION FORM

Date: \_\_\_\_\_ Hospital Affiliation: \_\_\_\_\_

Participant Name: \_\_\_\_\_

License #: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_  
City State Zip Code

Phone #: \_\_\_\_\_ E-Mail address: \_\_\_\_\_

## ANSWER FORM

- |    |   |   |   |   |     |   |   |   |   |
|----|---|---|---|---|-----|---|---|---|---|
| 1. | A | B | C | D | 6.  | A | B | C |   |
| D  |   |   |   |   |     |   |   |   |   |
| 2. | A | B | C | D | 7.  | A | B | C |   |
| D  |   |   |   |   |     |   |   |   |   |
| 3. | A | B | C | D | 8.  | A | B |   |   |
|    |   |   |   |   |     |   |   |   |   |
| 4. | A | B | C | D | 9.  | A | B | C | D |
|    |   |   |   |   |     |   |   |   |   |
| 5. | A | B | C | D | 10. | A | B | C | D |
|    |   |   |   |   |     |   |   |   |   |

## Plasma Surgery: A Patient Safety Solution EVALUATION FORM

**I.\* Please rate the effectiveness of this continuing education activity.**

Objectives Achieved	Excellent	Good	Fair	Poor
<b>Objective 1</b> Describe different energies used for tissue coagulation and cutting in surgery	□	□	□	□
<b>Objective 2</b> Discuss the principles of <i>Plasma Surgery</i>	□	□	□	□
<b>Objective 3</b> List the advantages of <i>Plasma Surgery</i>	□	□	□	□

**II.\* Please evaluate the Study Guide.**

Study Guide	Excellent	Good	Fair	Poor
Study Guide Content	□	□	□	□

**III. How long did it take to complete this task:**

**IV. How do you plan to use this information in your practice setting?**

**V. General comments and/or suggestions:**

Send or fax the completed *registration form/ answer form* and *evaluation form* to:

**Plasma Surgical, Inc.**  
**Study Guide 003**  
**1125 Northmeadow Parkway**      **Fax: 678-578-4395**  
**Suite 100**  
**Roswell, GA 30076**

