ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 1, January 2014

An Alternative Technique to Perform Surgeriesin Hospital by Surgical Diathermy

S.S.Shende[1], P.B.Dahikar[2], MJ.Hedau[3], K.Y. Rokde[4]

Assistant Professor, Department of Electronics, Shivaji Science College, Nagpur, India [1]

Associate Professor, Department of Electronics, Kamla Nehru College, Nagpur, India[2]

Associate Professor, Department of Electronics, Shivaji Science College, Nagpur, India [3]

Assistant Professor, Department of Electronics, Centre Point College, Nagpur, India [4]

ABSTRACT: The present paper describes howElectrosurgeon performing surgeries using electrosurgical unit or surgical diathermy machines are routinely exposed to surgical smoke, plume and aerosols produced by instruments used to dissect tissue and provide haemostasis. The safety of the patient and its importance during surgeries are well recognized however less emphasis is placed upon the safety of the surgeon and his/her team. Use of Electro-surgical techniques has expanded greatly in recent years, depending on the nature of the surgical site and the length of the procedure; operation staffs are exposed to smoke for periods ranging from a minute or so, repeated infrequently, to several hours a day.
This review discusses the adverse effects of surgical smoke and cautious the surgeons against the risks involved during such surgeries.

Keywords:Diathermy, surgical smoke, risks, safety.

I. Introduction

Electrosurgeons who are performing various types of surgery using surgical diathermy technique or electrosurgical unit are knowingly or unknowingly exposed to harmful gaseous substances which can make them vulnerable to various deadly diseases [1].This gaseous substance is commonly called as surgical smoke. Surgical smoke has become a part of the patient care environment wherever surgical or invasive procedures are performed. It is known by variety of names, such as cautery smoke, diathermy plume, plume, smoke-plume, aerosols, bio-aerosols, vapour and air contaminants, it can be seen and also smelled [2].

Surgical diathermy is an invaluable facility widely used in operating theatre [3]. It has become an indispensable tool to the modern surgeons and is used in the majority of surgical procedures. Though this technique has proved to be the boon for surgeons by eliminating the use of conventional cutting tools and blood loss, the technique has showed the signs of flaws when it became hazardous for the person itself who wants to save the life of other person i.e. surgeons themselves and also the team assisting them during surgeries.

Surgical diathermy incorporates the use of different electrical waveforms, current is made to pass through tissues and the resistance encountered produces heat, this heat causes intracellular water to boil, the cell explode and tissues divide, for coagulation current develops less heat, causing drying and thus coagulation, both these process produces a varying degree of plume or surgical smoke[4]. Perioperative professionals and patients are routinely exposed to surgical smoke produced by instruments used to dissect tissue and provide haemostasis. Anything that produces heat can produce smoke or aerosols. Smoke and aerosol-generating procedures can pose health risks [5]

Surgical smoke generated through such processes possesses a significant biochemical hazard and has shown to be as mutagenic as cigarette smoke [6]. In an animal model, it was found that the mutagenic potency of condensates from 1 g of electrocautery destroyed tissue through ablation was equivalent of smoking six unfiltered cigarettes [7].

II. Related work

Electrosurgeons who are performing various types of surgery using surgical diathermy technique or electrosurgical Unit are knowingly or unknowingly exposed to harmful gaseous substances which can make them vulnerable to various deadly diseasesthis gaseous substance is commonly called as surgical smoke. Surgical smoke has become a part of the patient care environment wherever surgical or invasive procedures are performed. It is known by variety of names, such

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 1, January 2014

as cautery smoke, diathermy plume, plume, smoke-plume, aerosols, bio-aerosols, vapour and air contaminants, it can be seen and also smelled.

Surgical diathermy is an invaluable facility widely used in operating theatre. It has become an indispensable tool to the modern surgeons and is used in the majority of surgical procedures. Though this technique has proved to be the boon for surgeons by eliminating the use of conventional cutting tools and blood loss, the technique has showed the signs of flaws when it became hazardous for the person itself who wants to save the life of other person i.e. surgeons themselves and also the team assisting them during surgeries.

Surgical diathermy incorporates the use of different electrical waveforms, current is made to pass through tissues and the resistance encountered produces heat, this heat causes intracellular water to boil, the cell explode and tissues divide, for coagulation current develops less heat, causing drying and thus coagulation, both these process produces a varying degree of plume or surgical smoke. Perioperative professionals and patients are routinely exposed to surgical smoke produced by instruments used to dissect tissue and provide haemostasis. Anything that produces heat can produce smoke or aerosols. Smoke and aerosol-generating procedures can pose health risks.

Surgical smoke generated through such processes possesses a significant biochemical hazard and has shown to be as mutagenic as cigarette smoke [6]. In an animal model, it was found that the mutagenic potency of condensates from 1 g of electrocautery destroyed tissue through ablation was equivalent of smoking six unfiltered cigarettes.

III. TYPES OF DIATHERMY

Diathermy used in surgery is of typically two types**(A)** Monopolar **(B)** Bipolar.

A. Monopolar diathermy where electrical current passes from one electrode near the tissue to be treated to other fixed indifferent electrode elsewhere in the body [4]. Usually this type of electrode is placed in contact with buttocks or around the leg. The current usually flows from the generator to the active electrode through the patient to the neutral electrode from where it returns to the generator.

Fig 1. Monopolar electrodes used in diathermy

B. Bipolar diathermy where both electrodes are mounted on same pen-like device and electrical current passes only through the tissue being treated. Bipolar instruments resemble surgical forceps, with both the active electrode and the return electrode functions being performed at the surgical site. The electrosurgical energy does not travel through the patient but is confined to the tissue between the forceps [5]. Because of this configuration, bipolar delivery of energy clearly offers very little chance for unintended dispersal of current. Advantage of bipolar electrosurgery is that it prevents the flow of current through other tissues of the body and focuses only on the tissue in contact. This results in greater accuracy, safety and less tissue damage. The biggest drawback of this type of diathermy is its low power which renders it useless for cutting purposes.

Fig 2. Bipolar electrode used in diathermy

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 1, January 2014

IV. PRINCIPLE OF WORKING

An electrosurgery machine is an alternating current source that operates at radio frequencies (RF). Typical electrosurgery devices operate in the range 300 Hz to 3000 KHz [6].

There are two electrodes connected to the RF power generator. One electrode is said to be active, and has a cross sectional area that is very small in few mm w.r.t the other electrode [7]. The active electrode is usually fashioned into the form of a tool or probe and is manipulated by the surgeon. The passive probe has a much larger area than the active electrode, on the order of 100 sq.cm or larger. The current flowing into the patient plate is same as the current flowing into the active electrode, but since the active electrode has a far smaller cross sectional than the passive electrode, the current density in (A/m^2) is far greater. As a result of the difference in current density between the two electrodes, the tissue underneath the active electrode is heated to destruction.

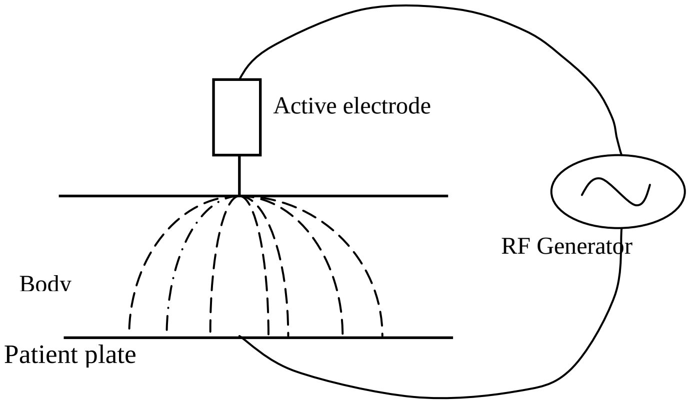

Fig.3 Basic principle behind the electrosurgical machine.

V. EFFECT OF TEMPERATURE ON CELLS AND TISSUE

Normal body temperature is 37°C and all of us, from time to time, when we have infections, experience temperature elevations that can reach as high as 40°C or so without damage to the structural integrity of our cells and tissue. However, when cellular temperature reaches 50°C cell death will occur in approximately 6 min [8] and if the local temperature is 60°C cellular death is instantaneous.

Two simultaneous processes occur internally. First is protein denaturation that occurs secondary to the impact of temperature on the hydrothermal bonds that exist between protein molecules. When the local temperature is as low as 60°C, these bonds are instantaneously broken but then quickly reform, as the local temperature cools [9]. This ideally leads to a homogenous coagulum, a process that is typically called "coagulation." If the intracellular temperature rises to 100°C or more, a liquid–gaseous conversion occurs as the intracellular water boils forming steam.

The subsequent massive intracellular expansion results in explosive vaporization of the cell with a cloud of steam, ions, and organic matter. It is suspected that the explosive force results in acoustical vibrations that contribute to the cutting effect through the tissue. When the local temperature reaches higher levels, such as temperature reaches 200°C or more, the organic molecules are broken down in a process called carbonization. This leaves the carbon molecules that create a black and or brown appearance, sometimes referred to as black coagulation.

VI. EFFECT OF ALTERNATING CURRENT ON CELLS

The process called electrosurgery is based on the ability of the RF current to elevate cellular, and consequently, tissue temperature to attain the desired tissue effect [10]. There are at least two basic mechanisms whereby RF electricity increases cellular and tissue temperature. The most important is by the conversion of electromagnetic energy to mechanical energy, which then is converted to thermal energy by frictional forces. A second, and likely less important mechanism, is resistive heating, where current flowing across a resistor causes an increase in the temperature of that resistor. A third and indirect mechanism of tissue heating is conductive heat transfer, the tissue adjacent to that which undergoes the direct effects of RF electricity.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 1, January 2014

VII. EXPERIMENTAL SETUP

The heart of the system is the logic and control part, which produces the basic signals and provides various timing signals for cutting.

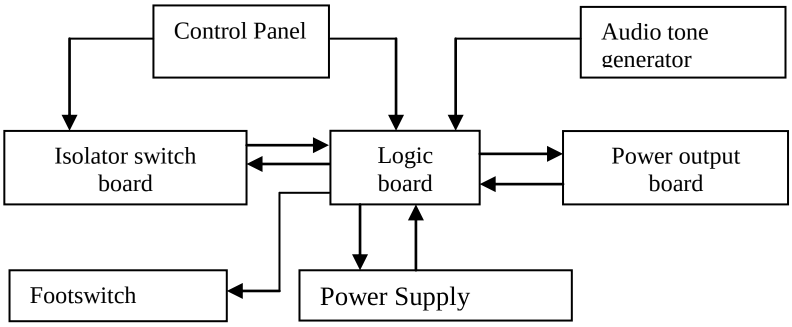

Fig.4 Block diagram for surgical diathermy machine.

An astable multivibrator generates 500 kHz square pulses. The output from the oscillator is divided to a number of frequencies by using binary counters [7]. These are the frequencies, which are used as system timing signals. A 250 kHz signals provides a split phase signal to drive output stages on the power output circuit. A 15 kHz signal which make up the coagulation output. The pulse width of this output is set at about 12µS.

The 250 kHz signal used for cutting is given to power output stage where it controls the push-pull parallel power transistor output stage. The output of this high power push-pull amplifier is applied to a transformer which provides voltage step up and isolation for the output signal of the machine. In order to meet the high power requirement, as much as 20 transistors are used in a parallel Darlington circuit.

Apart from these basic functional circuits, logic circuits are used to receive external control signals and operate the isolating relays, giving visual indications and determine the alarm conditions. The logic circuits receive information from the footswitch, finger switch and alarm sensing points. A thermostat is sometimes mounted on the power amplifier heat sink. In case of over temperature, it becomes open circuited, signalling an alarm and interrupting, the output.

VIII .RESULTS AND DISCUSSION

The power output graphs have been optimized to provide effective cutting and coagulation over the wide range of tissue impedances that may be encountered. The low impedance region of the profiles, below the normal operating range, is controlled by a current limiting circuit designed to protect the equipment and accessories connected to it.

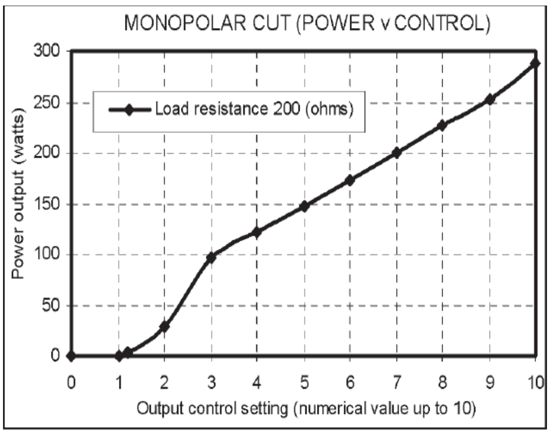

Fig. 5 Graph of Power vs. Control settingsfor Monopolar diathermy.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 1, January 2014

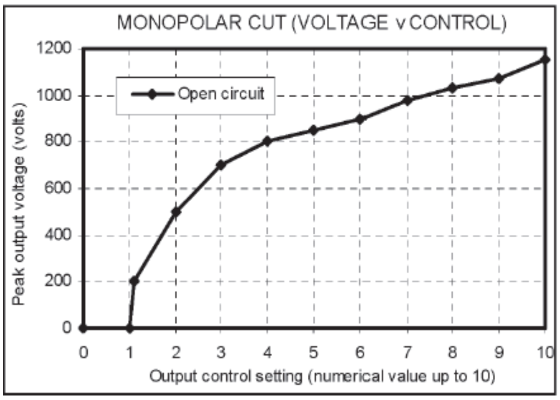

Fig. 6 Graph of Voltage vs. Control for Monopolar diathermy

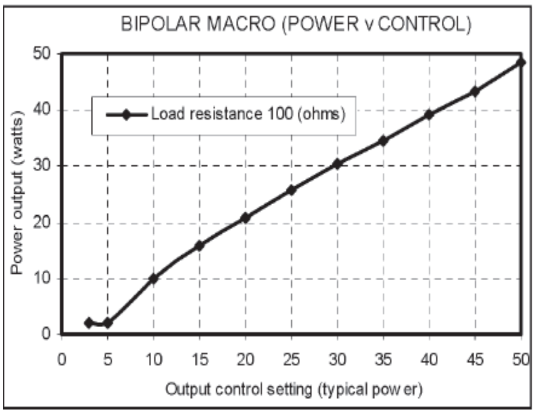

Fig. 7 Graph of Power vs. Control for Bipolar diathermy

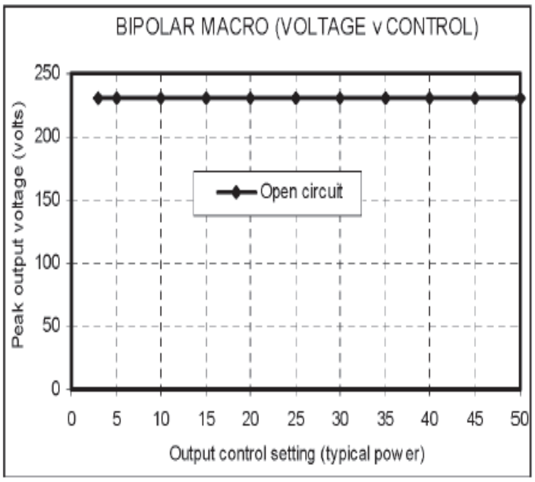

Fig. 8 Graph of Voltage vs. Control for Bipolar diathermy

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 1, January 2014

IX. CONCLUSION

RF electrosurgery used appropriately allows the surgeon to perform a wide spectrum of procedures safely, effectively, and with minimal undesired tissue trauma. Advances in medical technology have produced better and safer diathermy equipment which has led to the expansion of the uses of diathermy in various branches. Used without proper care, education, and training, electrosurgery, like other instruments and energy sources, has the potential to cause excessive tissue trauma, and increased operative morbidity, sometimes of a life-threatening nature

REFERENCES

1. R. Soderstom, "Principle of electrosurgery as applied to gynecology", In: Rock JA, Thompson JD, eds. TeLinde's operative gynecology.8th ed. Philadelphia: Lippincott-Raven,pp. 321–326, 1997.
2. E. Moak, "Electrosurgical unit safety: the role of the perioperative nurse".AORN J 53, pp. 744-752, 1991.
3. C.Saberton, "Diathermy in Medical and Surgical Practice", Cassell and Company Ltd, pp. 15-22, 1920.
4. J.E. Rioux, "Bipolar electrosurgery: a short history". J Minim Invasive Gynecol, 14, pp. 538–41, 2007.
5. S.D. John Wesley: "Philosopher of electricity".MedInstrum. 7:307, 1973.
6. C.C.Nduka, "Cause and prevention of electrosurgical injuries in laparoscopy". J AmCollSurg; 179: pp. 161–170, 1994.
7. S.K.Venkata Ram, "Biomedical electronics & instrumentation", Galgotia, New Delhi, pp. 214-215, 2000.
8. GoldbergSN, Rosenthal."Radiofrequency tissue ablation: importance of local temperature along the electrode tip exposure in determining lesion shape and size". AcadRadiol. 3:212–8, 1996.
9. M. J. Hedau, M. P. Dhore, P. B. Dahikar, "Application of Wireless Signal Simulation Via Cell-Phone "International Conference on circuit system and simulation, , pp. 92–95, Vol.7, IACSIT Press, Singapore, 2011.
10. M. J. Hedau, M. P. Dhore, P. B. Dahikar, "Application of Microcontroller in Technical communication"International Journal of ETA and ETS, IACSIT ISSN No 0974-3588Vol.5Issue 1,2012.
11. P. B. Dahikar M. J. Hedau, S. C. Moholkar "Application of Microcontroller in Receiving Unit of the Technical Communication" International Journal of ETA and ETS, IACSIT ISSN No 0974-3588 Vol.5 Issue 2, 2012.