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Review

Electro surgery: A Review on its application and Biocompatibility on Periodontium.

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ABSTRACT:

Electro surgery is an application of electrically generated heat energy to tissue to alter it for therapeutic Purposes. Electrosurgery has been used in dentistry for more than 75 years in dentistry since it was first used in 1847 to destroy a neoplasm by Cusen, a Russian scientist. Both opponents and advocates of electrosurgery have presented a variety of clinical studies in favour of their respective opinions, which are discussed in the following review. A critical evaluation of controlled clinical studies shows that adverse responses of epithelium, connective tissue, bone, and cementum are related to an excessive lateral heat production during the procedure. On the basis of the research reports, clinical guidelines have been developed to give practical advice to the clinician using electrosurgery. Providing that these safeguards are adhered to, scientific evidence supports the biological compatibility of electrosurgery for intraoral surgical procedures.

Key words: Electrosurgery,biocomapatability,periodontium.

Introduction:

Electrosurgery is the use of a high frequency electrical energy in the radio transmission frequency band applied directly to tissue to induce histological effects. Improvements in the electrosurgery instrument have significantly increased clinical interest in 1980s. Advocates of electrosurgery have primarily relied on reports of clinical observation to support their claim regarding the efficacy and safety of its use Armstrong et al.[1] Opponents of electrosurgery have presented equally impressive clnical reports demonstrating adverse tissue responses following the use of electrosurgery for dental procedures Simon et al.[2] Since the introduction of lasers in dentistry, use of electrosurgery has further declined.This decline may also be due to the fact that electrosurgery is not taught in most dental schools, and the presence of some conflicting reports on the healing of electrosurgical wounds may deter the dentists from using it. The purpose of this paper is to review its application and biocompatibility of periodontal tissues based on controlled clinical studies. Guidelines for the use of electrosurgery in dentistry and the safeguards that must be employed during its use will be developed from the compilation of this scientific data.

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Electrosurgery or Radiosurgery[3]:

surgical technique performed on soft tissue using controlled, high-frequency electrical (radio) currents in the range of 1.5 to 7.5 million cycles per second, or megahertz.

There are 3 classes of electrodes: single-wire electrodes for incising or excising; loop electrodes for planing tissue; and heavy, bulkier electrodes for coagulation procedures.

The four basic types of electrosurgical techniques are electrosection, electrocoagulation, electrofulguration, electrodesiccation.

Electrosection, also referred to as electrotomy or acusection, is used for incisions, exisions, and tissue planing. Incisions and excisions are performed with single-wire active electrodes that can be bent or adapted to accomplish any type of cutting procedure.

Electrocoagulation provides a wide range of coagulation or hemorrhage control by using the electrocoagulation current. The active electrodes used for coagulation are much bulkier than the fine tungsten wire used for electrosection.

The two monoterminal techniques, electrofulguraion and electrodesiccation are not used in general dentistry.

Description: issue damage may occur when the surgical site is over heated or dehydrated. This is very important to keep the surgical site irrigated and to develop proper electrosurgical technique. Two factors of proper technique art are:

1. The intensity of setting
2. The smoothness and speed of passage of the electrode over the surgical site.

These two relate to each other. Heat accumulating in the tissue is determined by many different factors, which may be summarized as follows:

The heat generated by electrosurgery depends on the duration of contact between the electrode tip and tissue, current intensity, size of tip and electrosection wave current.

Intensity of the current:

1. High intensity: the electrode will spark and may cause tissue damage.
2. Correct intensity: the heat is lowered to the threshold of evaporating the tissue cell, and the current passes through the tissue easily without any resistance of sparking.
3. Insufficient intensity: this may result in pulling, or even tearing of the tissue.

The size of the electrode tip:

1. The larger the tip is, the higher the operating power will be.
2. The smaller the tip is, the lower the operating power will be.

Electrosection waves:

Electrocoagulation has practical applications in surgery. This instrument provides hemostasis by electrocoagulation. The performance as the electrode dissects the operative site, limiting damage, and reducing trauma. About 75% of all clinical operations are performed by electrosection current waveforms.

1. **Fully Filtered Current (CUT):** Fully filtered current is pure high frequency. The result of filtering led to a sustaining non-oscillation current. This non-oscillating current provides the required current for the operation, and is most beneficial condition for most clinical applications. Heat and tissue destruction is minimal.
2. **Fully rectified current (COAG 1):** Fully rectified currents produce short but visible oscillating effects. In some circumstance, this current may lessen the cutting effect slightly. Besides cutting smoothly, fully rectified current may perform some coagulation to the wound. This coagulation is of small range on clinical operation but is effective. A thin film may form at the coagulated site as the site begins to heal. This film will dissolve or fall away after the site is healed.
3. **Partially rectified current (COAG 2):** Partially rectified current is intermittent high frequency current. It is very effective for hemostasis, especially for wounds of 1.6 mm diameter. Partially rectified current may provide another indirect technique for coagulation. Coagulate the vessel with styptic, keeping 2.5 cm to 5 cm apart. When the partially rectified current is turned on, blood vessel will coagulate, which will make unnecessary coagulative contraction.

Variables Affecting Electrosurgery Performance

Production of Lateral Heat

Stevens et al.[4] demonstrated extremely large increases in lateral heat adjacent to electrosurgery electrodes activated within dog gingiva. The group, however, did not control many technique variables and the active electrode was left in contact with tissue for time periods much longer than would be used clinically. Kalkwarf et al.[5] showed that lateral heat production adjacent to a fine wire needle electrode emitting fully rectified-filtered current was dependent upon the time of incision. They also demonstrated that 3 successive incisions into the same site dramatically increased the amount of lateral heat production (8.0 - 48.0^{0}C) at a distance of 1 mm from the electrode. The authors demonstrated that a cooling period of at least 8 s between subsequent incisions in the same area is necessary to assure that lateral heat production capable of initiating adverse tissue responses does not occur. The same group, in a separate study[6], found that an activated loop electrode generated more energy during surgery than a needle electrode. Temperature increases in the adjacent tissue following use of the loop remained for longer periods of time than after use of a needle electrode. They calculated that a cooling interval of 15 s was necessary to properly dissipate heat between successive entries into the same area of tissue with a loop electrode. All of the studies indicate that lateral heat is produced in adjacent tissues during intraoral use of electrosurgery. If variables capable of influencing heat production are not controlled or clinical technique allows improper periods of exposure, the amount of temperature change may be capable of initiating adverse healing sequela.

Response of Tissues to Electrosurgery Contact Epithelium

Engelberger & Rateitschak[7] evaluated the healing following gingivectomy with electrosurgery in nine patients. They observed good epithelization with slightly better results than following surgery with a blade. The authors indicated a tendency towards quicker healing following use of electrosurgery compared to the gingivectomy blade. In spite of the positive evaluation of the techniques of electrosurgery, a closer examination of this analysis is impossible since the authors fail to indicate current or other parameters employed. A lot of studies have evaluated clinical response of the gingival margin following electrosurgery procedures (Ruel et al[8], Azzi et al[9], DeVitre et al).[10] While the techniques of electrosurgery and evaluation were slightly different in each study, all authors reported an initial gingival recession (0.12 mm-1.0 mm). Most of the investigations demonstrated that a portion of that recession was regained during the follow-up healing period. Electrosurgery resection at a deeper level (close to the alveolar crest) resulted in increased gingival recession as well as loss of periodontal attachment. These studies appear to support the concept that electrosurgery incision of epithelium occurs by internal volatilization of the cells along the path of the activated electrode. The lateral heat associated with electrosurgery obliterates cellular detail at the time of the procedure, but the stages of wound healing and the time intervals of those stages do not appear to be adversely affected. Resection or troughing of the gingival crevice can result in some gingival recession. Following a well-controlled procedure, the recession may be of a magnitude that is not clinically discernable. Misuse of electrosurgery may result in increased recession.

Connective Tissue

Evaluations Kalkwarf et al[11], Kalkwarf et al[12] monitored the energy output at the active electrode as well as the time and depth of electrosurgery incisions in human gingiva. The investigators found that even when optimal clinical techniques are employed, there is histoiogic modification of connective tissue adjacent to the active electrode. This change is most likely due to lateral heat and averages about 100μ in width when measured immediately following the incision. During the healing phase, this zone gradually diminishes in size until it is no longer present at 36 h. The electrosurgery wounds produced in these studies tended to demonstrate few, if any, polymorphonuclear leukocytes. This is probably due to the fact that bacteria in contact with the active electrosurgical electrode are destroyed and not impregnated into the deeper tissues as they may be during a traditional surgical blade incision. It has been validated that the initial response of connective tissue is different when electrosurgery is used than when a surgical blade is used. Following carefully controlled electrosurgery procedures a small denatured zone, produced by lateral heat, is always found adjacent to the path of Incision. This zone does not appear to interfere with the stages of wound healing and gradually disappears during a 2-week period. Improperly controlled electrosurgery procedures are capable of causing adverse alterations in connective tissue that may delay the healing response.

Bone

Azzi et al[13] applied an activated electrosurgery electrode directly to the facial margin of alveolar bone exposed in dogs by full-thickness flaps. They applied a fully rectified filtered current to the bone surface for periods of 0, 1,5 and 10 s. The amount of energy generated at the active electrode during the exposure was not documented. They found that, regardless of the length of exposure, the bone responded to contact by the active electrode with an acute infiammatory response followed by osteoclastic resorption. Necrosis of both alveolar bone and periodontal fibers was evident. A repair process, evidenced by osteoclastic activity, was evidenced in some areas at four weeks postoperatively. Reinhardt et al[14] in a study of similar design, also applied an activated electrosurgical electrode to the facial marginal bone of dogs. Their study differed, however, in that they made the incision through tissue and documented not only the exact time of active electrode contact with tissue, but also the amount of energy produced at the active electrode. The incisions took a mean of 0.95 + 0.40 s to complete and 4.25 + 0.25 J of energy was produced at the active electrode. Their histologic and morphometric analysis revealed some minor increases in endosteal remodelling at 4 h, 3 days and 14 days in electrosurgery specimens. No differences in periosteal remodeling activity could be discerned. These studies appear to reveal that careful, controlled use of the electrosurgery within accepted clinical guidelines for time of exposure and energy production may elicit minor cellular changes at the alveolar crest, but this reaction is not of clinical significance. Uncontrolled use, with long periods of exposure to the activated electrode or exposure directly to denuded bone, may result in bone necrosis and a delayed healing phenomena.

Cementum and Periodontal Attachment

Wilhelmsen et al[15] applied an active electrode producing fully rectified filtered current to the tooth surface in the region of the periodontal attachment. Histological, biometric and histometric evaluation confirmed that electrosurgery produced gingival recession, loss of connective tissue attachment and alteration of the root surfaces in the regions where electrode contact had occurred. Evaluation of the tooth surface regions contacted by the electrode revealed that they progressed to root resorption and cemental shrinkage, eventually being covered by an apical extension of the junctional epithelium. In no case was reattachment of connective tissue into this area present. This study verifies that contact of the active electrode with the root surface should be avoided in regions where reattachment of connective tissue is desired. This phenomenon is not of a concern if the affected cementum is in a postoperative location where it is in contact or coronal to the junctional epithelium.

Pulpal tissue

Krejci et al[16] placed standardized amalgam restorations in the cervical regions of dog's teeth, allowed the teeth to recover for six weeks and then subjected some of the restorations, as well as nonrestored controls, to a fully rectified filtered electrosurgery current. Contact of the restoration was made through soft tissue as well as directly to the restoration surface. The actual time of exposure and the energy produced at the active electrode during exposure were documented by an electronic monitor. It was found that both the placement of the amalgam restoration without exposure to electrosurgery and exposure of the restoration of a restored tooth to electrosurgery for periods of time less than 0.4 s produced minor pulpal stress capable of spontaneous recovery. Restorations exposed to electrosurgery for time periods in excess of 0.4 s demonstrated pulpal damage with pulpal necrosis occuring as electrode contact time with the restoration approached one second. Ruemping et al[17] histologically compared pulp tissues obtained following use of electrosurgery to accomplish pulpotomy procedures. Primary and permanent incisors and molars in monkeys were treated with both techniques and evaluated at 1 h, 1 week and 2 months. No differences in histologic response to either procedure could be identified. Pulpal studies indicate that intermittent contact of a metallic restoration by an active electrosurgery electrode (less than 0.4 s) delivering a well-controlled current will result in minor stimulation capable of spontaneous recovery. Exposures of larger than 0.4 s or of uncontrolled intensity are capable of initiating pulpai necrosis.

Other Considerations

Research reports have been published that evaluate other effects of electrosurgery during various clinical procedures. Stark et al[18] utilized electrosurgery to provide gingival retraction in monkeys. Their study showed that electrosurgery procedures resulted in a significant rise in systolic and diastolic blood pressures. Kalkwarf et al[19] used an electrosurgery instrument to produce "fulgurate on-type'" sparks during a study of hemorrhage control procedures, Electrosurgery fulguration provided hemorrhage control for an abraded oral wound in a mean of 13.5 + 5.0 s. Pressure with a dampened gauze required 79.9 ±64.1 s to produce the same results. The fulgurated wounds, however, demonstrated significant delays in the clinical and histologic healing sequence during the first seven postoperative days. Rathofer et al[20] evaluated the clinical healing in a splitmouth study following the use of electrosurgery or surgical blades to remove inflammatory papillary hyperplasia. No difference in clinical healing could be detected between the two techniques. Yoshino T et al[21] exposed Calvarial bone from thirty rats to contact and non-contact Er:YAG laser irradiation (115 mJ/pulse, 10 Hz) without water coolant, or electrode contact. The treated surfaces were analyzed by scanning electron microscopy (SEM), and the healing process was histologically observed until 12 months post-surgery. Electrosurgery produced a large area of thermal necrosis without ablation, and the damaged area was not replaced with new bone.

Clinical Guidelines Based Up on Research Reports[3]: From the documented research reports available., the following clinical guidelines can be developed. (1) Incision of intraoral tissues with electrosurgery should be accomplished with a higher frequency unit tuned to optimal power output and set to generate a fully rectified-filtered waveform. (2) The smallest possible electrode should be selected to accomplish the incision. (3) Electrosurgical incisions should be made at a minimum rate of 7 mm/ s. (4) A cooling period of 8 s should be allowed between successive incisions with a needle electrode at the same surgical site. The period must be increased to fifteen seconds when a loop electrode is utilized for excisional procedures. (5) The clinician should anticipate a slight amount of gingival recession when an electrosurgical incision is used for troughing or excision of the gingival crevice, (6) Contact of the activated electrosurgery electrode to the cemental surface of a tooth must be avoided in regions where connective tissue reattachment is desired. (7) Intermittent contact of an active electrode delivering a well-controlled current to alveolar bone will initiate only slight osseous remodeling which will not result in clinical changes. Incorrect current control or extended contact with alveolar bone may produce irreversible changes capable of resulting in diminished periodontal support. (8) Contact of an active electrosurgery electrode with metallic restorations should be limited to periods less than 0.4 s. Longer periods of contact may result in pulpal necrosis. (9) Electrosurgery may be used effectively for pulpotomy procedures. (10) Use of electrosurgery to provide fulgurating sparks for use in obtaining hemorrhage control should be used only after all other clinical methods have been tried, A delayed healing response following the use of fulguration should be expected. (11) Electrosurgery may be used safely and conveniently to excise inflammatory papillary hyperplasia. Providing that these guidelines are adhered to, scientific evidence supports the biological compatibility of electrosurgery for intraoral soft tissue surgical procedures.[21]

Indications[3]:

- Superficial procedures such as removal of gingival enlargements
- Gingivoplasty
- Relocation of frenum and muscle attachments
- Incisions of periodontal abscesses
- Pericoronal flaps

Contraindications[3]

- A patient with pace maker cannot be treated with electrosurgery.
- Should not be used for procedures that involve proximity to the bone such as flap operations, or for mucogingival surgeries.

Advantages[3]

- Permits adequate contouring of tissues.
- Controls the haemorrage
- Access to difficult - to - reach areas is increased.
- Healing discomfort and scar formation is are minimal.
- Chair time and operator fatigue are reduced.
- The technique is pressure less and precise.

Disadvantages[3]

- The initial cost of the equipment is far greater than the cost of a scalpel
- Cannot be used in poorly shielded cardiac pace makers.
- Treatment causes unpleasant odor
- Heat generated by injudicious use can cause tissue damage and loss of periodontal support when the electrode is used close to bone.[22]

Notes:

- While replacing the electrode tip, make sure that the foot is removed from the pedal to prevent contact of electrode tip with the skin.
- Do not operate this equipment in a room with flammable and explosive liquid or gas in it.
- Any parts not in use can't be put near the patient or on the towel. It may catch fire.
- If the electrosurgery is not in use, or the suitable setting is not determined, operator should begin with low power, increasing it slowly and carefully until the suitable condition is determined.

Operation guide

Learning how to use electrosurgery:

Before contacting the electrode with tissue, suitable power intensity should be chosen, during the operation a smooth motion without pressure is important, even slight pressure should be avoided. The movement can't be too slow, because the heat will propagate deep into the tissue and may cause burning resulting in necrosis. In order to cool down tissue during surgery in electrosurgery is that the pressure applied when using a scalpel is not necessary in electrosurgery. Turn off the power, and practice the operation with power off. Determine the length, depth and direction of the electrode movement.A smooth cutting technique allows the operator to maximize the advantages of electrosurgery.

Instrument can be used to coagulate capillaries. Switch the current dial to partially rectified current. Usually the electrode ball is chosen to expand the range of the covered muscle tissue. Before coagulation, wipe the blood off to see the wound more clearly. Pressing the wound indirectly helpful to find the source of the bleeding. Touch the tissue with electrode intermittently and gently until the bleeding stops.

Control of blood shed:

Abnormal bleeding is not a problem for electrosurgery. With partially rectified current and different skill, the range of coagulation can be extended, and bleeding can be controlled. Coagulation can prevent the bleeding at the beginning of entering the tissue. Once the bleeding begins, it can't be stopped. Direct pressing is necessary, such as air, pressure, and styptics. When the bleeding is stopped, COAG2 can be used to repair the capillary or blood vessel.[22]

Conclusion:

- Careful, controlled use of the electrosurgery within accepted clinical guidelines for time of exposure and energy production may elicit minor cellular changes but not clinically significant changes at the end of healing.
- Electrosurgery can be used an alternative to conventional surgery provided the operator follows the clinical guide lines based upon research reports.

The application of electrosurgery in the field of dentistry will depend directly on the dentist's skills, his knowledge on the new concepts of the technique and on the structure and quality of the tissues. The most important advantages of electrosurgery are that this procedure is fast and secure with a field free of hemorrhage and with an easy access to hard to reach zones. Electrosurgery has to be seen only as an auxiliary technique, not as a method that will solve all the problems in soft tissue management.

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