GOCE DELCEV UNIVERSITY, STIP, NORTH MACEDONIA

FACULTY OF ELECTRICAL ENGINEERING

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27-29 SEPTEMBER, 2023

TECHNICAL SCIENCES APPLIED IN ECONOMY, EDUCATION AND INDUSTRY

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GOCE DELCEV UNIVERSITY, STIP, NORTH MACEDONIA

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PREFACE

The Faculty of Electrical Engineering at University Goce Delcev (UGD), has organized the Second International Conference ***Electrical Engineering, Informatics, Machinery and Automation - Technical Sciences applied in Economy, Education and Industry-ETIMA.***
ETIMA has a goal to gather the scientists, professors, experts, and professionals from the field of technical sciences in one place as a forum for exchanging the ideas, strengthening the multidisciplinary research and cooperation, and promoting the achievements of technology and its impact on every aspect of living. We hope that this conference will continue to be a venue for presenting the latest research results and developments on the field of technology.
Conference ETIMA was held as online conference. More than sixty colleagues contributed to this event, from five different countries with more than thirty papers.
We would like to express our gratitude to all the colleagues, who contributed to the success of ETIMA'23 by presenting the results of their current research and by launching the new ideas through many fruitful discussions.
We invite you and your colleague to attend ETIMA Conference in the future as well. One should believe that next time we will have opportunity to meet each other and exchange ideas, scientific knowledge and useful information as well as to involve as much as possible the young researchers into this scientific event.

The Organizing Committee of the Conference

ПРЕДГОВОР

Меѓународната конференција ***Електротехника, Технологија, Информатика, Машинство и Автоматика-технички науки во служба на економија, образование и индустрија-ЕТИМА*** е организирана од страна на Електротехничкиот факултет при Универзитетот „Гоце Делчев".
ЕТИМА има за цел да ги собере на едно место научниците, професорите, експертите и професионалците од полето на техничките науки и да претставува форум за размена на идеи, да го зајканува мултидисциплинарното истражување и соработка и да ги промовира технолошките достигнувања и нивното влијание врз секој аспект од живеењето. Се надеваме дека оваа конференција ќе продолжи да биде настан на кој ќе се презентираат најновите резултати од истражувањата и развојот на полето на технологијата.
Конференцијата ЕТИМА се одржа online и на неа дадоа свој придонес повеќе од шеесет автори од пет различни земји со повеќе од триесет труда.
Сакаме да ја искажеме нашата благодарност до сите колеги кои придонесоа за успехот на ЕТИМА'23 со презентирање на резултати од нивните тековни истражувања и со лансирање на нови идеи преку многу плодни дискусии.

Организационен одбор на конференцијата

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PRINCIPLES AND APPLICATIONS OF ORAL ELECTROSURGERY

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Abstract

Electrosurgery is a good alternative to the scalpel or lasers for soft tissue management and would be the method of choice. Oral electrosurgery is widely accepted throughout the world and has a broad spectrum of clinical applications. Once the clinician understands the nature of the different waveforms and how electrosurgical technology relates to clinical results, a comfort level will be achieved making clinical applications safe, predictable and easy. Electrosurgery can be used instead of the scalpel to cut soft tissues, with the goal of reducing hemorrhage. Electrosurgery alludes to the delivery of thermal energy in the form of an alternating current in the radiofrequency range from an electrical generator to the probe tip and the tissues. The heat generated in the tissue depends on the current intensity, the distance from this tissue to the electrode tip, and the period during which the RF energy is delivered. Electrosurgery is the passage of high frequency radio waves (RF energy) into soft tissue resulting in a variety of clinical effects, including cutting, cutting and coagulation at the same time, coagulation or tissue destruction. Because of the resistance offered by the tissue to the incoming RF energy, the tissue heats up. The electrode tip never gets hot. In actuality, the water in the cells is boiled causing the cells to explode. Radiosurgery has also become an unofficial but accepted term referring to electrosurgery instruments that fall into the higher frequency range of 3-4 mHz (3-4 million cycles per second). Study by Maness et al. in 1978 concluded that higher frequency electrosurgical units produce less tissue alteration than those instruments with frequencies under 2 mHz. Higher frequency units produce less lateral heat and, therefore, less tissue alteration. The optimal frequency appears to be in the 3-4 mHz range. There are numerous indications for oral electrosurgery and some include bleeding control, cosmetic elongation of clinical crowns, soft tissue management during crown and bridge procedures, biopsies, frenectomies, pulpotomies, collecting tissue for gingival grafts, incisions or excisions and tissue contouring. The main goal of this study is to highlight the principles and benefits of electrosurgery application. Electrosurgery can never completely replace the scalpel, but it requires more knowledge, skill and complete understanding of the biophysical aspects of the interaction of electrosurgical energy and tissue. Continued research into the field of tissue interaction is promised and potential development of applications of electrosurgery.

Key words:

Electrosurgery, bipolar, incision, hemostasis, coagulation, soft tissue management, wound healing.

Introduction

Electrosurgery is a commonly used technique in oral surgery for various purposes. It involves the use of high-frequency electric current to cut, coagulate, or remove tissue [1] . Here are some applications of oral electrosurgery: 1. Tissue cutting: Electrosurgery can be used to make precise incisions in soft tissues. It is often employed in procedures such as excision of soft tissue lesions, removal of excess gum tissue (gingivectomy), or crown lengthening; 2.

Hemostasis (control of bleeding): One of the significant advantages of electrosurgery is its ability to coagulate blood vessels during surgical procedures. The electric current can effectively seal blood vessels, minimizing bleeding and facilitating a bloodless surgical field; 3. Soft tissue ablation: Electrosurgery can be used to remove or ablate unwanted or diseased soft tissues. It is commonly used for procedures such as removal of oral mucosal lesions, including benign tumors or precancerous lesions; 4. Tissue contouring: In certain cases, electrosurgery is utilized for tissue sculpting or reshaping. It can help in reshaping gingival tissues, removing excess tissue, or creating esthetic gingival margins; 5. Frenectomy: A frenectomy involves the removal or alteration of a frenulum, which is a small fold of tissue that connects the lips, tongue, or cheeks to the underlying structures. Electrosurgery is often to perform frenectomies, allowing for precise tissue removal and minimal bleeding; 6. Biopsies: Electrosurgery can be used to perform incisional or excisional biopsies of oral lesions [2] , [3]. The technique enables the surgeon to obtain a tissue sample for diagnostic purposes while providing hemostasis during the procedure[4].

Electrosurgery offers several advantages in oral surgery, including precise cutting, simultaneous coagulation, and the ability to control bleeding. However, it's important to use the appropriate power settings and techniques to minimize thermal damage to surrounding tissues. The specific application of electrosurgery will depend on the surgical procedure and the surgeon's preference and experience [5]. Electrosurgery is an excellent alternative to the scalpel or lasers for soft tissue management, and in most instances, would be the instrument of choice. Oral electrosurgery is widely accepted throughout the world and has a broad range of clinical applications. For those practitioners that want to incorporate electrosurgery into their routine patient treatment protocols, there is a learning curve that is critical to its implementation. Once the clinician understands the nature of the various waveforms and how electrosurgical technology relates to clinical results, a comfort level will be reached making clinical applications safe, easy and predictable[6]. Electrosurgery is the passage of high frequency radio waves (RF energy) into soft tissue resulting in a variety of clinical effects, including cutting, cutting and coagulation at the same time, coagulation or tissue destruction. Because of the resistance offered by the tissue to the incoming RF energy, the tissue heats up. The electrode tip never gets hot. In actuality, the water in the cells is boiled causing the cells to explode. Dorland’s Medical Dictionary defines radiosurgery as, “surgery in which tissue destruction is performed by means of ionizing radiation rather than surgical incision.” It usually involves implanted radioactive material. However, radiosurgery has also become an unofficial but accepted term referring to electrosurgery instruments that fall into the higher frequency range of 3-4 mHz (3-4 million cycles per second) [7]. Study by Maness et al. in 1978 concluded that higher frequency electrosurgical units produce less tissue alteration than those instruments with frequencies under 2 mHz. To reach a level of confidence and competence, the clinician needs to understand how to control lateral heat. Lateral heat is the build up of heat in the tissue adjacent to the active electrode. The practitioner must learn to guide and control the RF energy entering the tissue so that enough heat is produced to accomplish the task at hand without creating additional heat that will cause tissue alteration or destruction [8]. The control of lateral heat depends on various factors that are depicted in the following formula. As long as the formula is kept in balance and the clinician stays within acceptable parameters, electrosurgery will be safe and effective.

Critical to successful electrosurgery is working with a “tuned” unit. To tune your electrosurgical unit, set it up in the room where it will be routinely used [9].

The appropriate waveform must be chosen and preset by the practitioner depending on the clinical procedure. For some procedures, a combination of waveforms may be utilized. The coagulation wave (partially rectified) produces the most amount of lateral heat. The cut + coag wave (fully rectified) produces less lateral heat, and the cut (filtered) wave produces the least

amount of lateral heat. So, the cut setting would be the waveform of choice when working near bone or implants, when performing biopsies or when tissue shrinkage is of concern.
Frequency is the one factor in the lateral heat formula that is controlled o
nly once by the clinician–when he/she purchases an electrosurgery instrument. The lower frequency electrosurgical units usually seen in a hospital OR (.5 mHz) require that the antenna (passive electrode) contacts the patient's skin with an applied jelly for better conduction. The higher frequency dental units require no skin contact. Higher frequency units produce less lateral heat and, therefore, less tissue alteration. The optimal frequency appears to be in the 3-4 mHz range. Once the practitioner understands radiosurgical instrument and how to control its radio frequency energy, a comfort zone will be reached, and both the patient and dentist will benefit[10].

1.Materials and Methods

Research strategy

For this narrative article review on the use of electrosurgery in oral surgery, a comprehensive search of relevant literature was conducted using electronic databases, including PubMed and Google Scholar. Keywords such as electrosurgery, bipolar, incision, hemostasis, coagulation, soft tissue management, wound healing , were used to identify relevant articles published in peer-reviewed journals. The inclusion criteria encompassed studies, clinical trials, and reviews published in the English language from the past 10 years. Articles focusing on the materials, methods, techniques, and advancements in electrosurgery in the context of oral surgery were prioritized. The retrieved articles were meticulously analyzed, and relevant information was extracted and synthesized to provide a comprehensive overview of the topic. Additionally, textbooks, surgical guidelines, and manufacturer's literature were consulted to supplement the literature findings. The narrative review aims to present a balanced and informative discussion on the methods, advancements, clinical outcomes, and patient benefits associated with the use of electrosurgery in oral surgery.

2.Evaluation and results

The reviewed articles consistently highlighted the widespread usage of electrosurgery in various oral surgery procedures, such as soft tissue surgeries, gingivectomy, frenectomy, and periapical surgery. Electrosurgical system contain electrosurgical unit as a generator with active electrodes (Fig.1) At it's frequency, muscles and nerves are not affected, and heat is created at the cellular level. The heat created is responsible for the cutting and coagulation effect that is experienced.

Fig.1 Electrosurgical unit
Source:www.praxisdienst.com

Electrosurgery was reported to be effective in achieving hemostasis, precise tissue cutting, and coagulation during these procedures. The use of electrosurgery was particularly beneficial in reducing intraoperative bleeding, postoperative edema, and operative time when compared to traditional surgical techniques. The safety of electrosurgery in oral surgery was a major focus in the reviewed studies. Although electrosurgery was generally considered safe, the articles emphasized the importance of proper technique, appropriate power settings, and good clinical judgment to minimize potential complications. The most commonly reported complications included thermal damage to adjacent tissues, delayed wound healing, and postoperative pain. However, these complications were generally mild and manageable with proper postoperative care. Several studies assessed patient satisfaction and postoperative outcomes following oral surgery procedures involving electrosurgery. Overall, patients expressed high levels of satisfaction with the outcomes, reporting minimal postoperative pain, improved healing, and reduced complications compared to conventional techniques. The use of electrosurgery was associated with improved esthetic outcomes, reduced scar formation, and enhanced wound healing. Based on the reviewed literature, electrosurgery is a valuable tool in oral surgery, providing effective hemostasis, precise tissue cutting, and coagulation. Despite potential complications, when used with proper technique and settings, electrosurgery offers advantages in terms of reduced bleeding, shorter operative time, and improved postoperative outcomes. Future research should focus on optimizing electrosurgical techniques, exploring new advancements in technology, and conducting long-term follow-up studies to evaluate the safety and efficacy of electrosurgery in oral surgery procedures.

The authors of the reviewed articles provided valuable insights and discussions regarding the usage of oral electrosurgery. Here are some key points raised by the authors: 1. Effectiveness and Advantages: The authors consistently acknowledged the effectiveness of electrosurgery in achieving hemostasis, precise tissue cutting, and coagulation during various oral surgery procedures. They highlighted the advantages of electrosurgery, such as reduced intraoperative bleeding, improved visibility, shorter operative time, and enhanced postoperative outcomes. The ability to control bleeding and achieve accurate tissue cutting were considered significant benefits of electrosurgery; 2. Safety Measures and Complications: The authors emphasized the importance of adhering to safety measures and proper techniques when using electrosurgery in oral surgery. They highlighted the need for appropriate power settings, good clinical judgment, and adequate training to minimize potential complications. While thermal damage to adjacent tissues, delayed wound healing, and postoperative pain were reported as possible complications, the authors indicated that these complications were generally mild and manageable with proper postoperative care; 3. Patient Satisfaction and Outcomes: The authors discussed patient satisfaction and postoperative outcomes following oral surgery procedures involving electrosurgery. They reported high levels of patient satisfaction, citing minimal postoperative pain, improved healing, reduced complications, and enhanced esthetic outcomes compared to conventional techniques. The authors emphasized the positive impact of electrosurgery on wound healing, scar formation, and overall patient experience; 4. Optimization and Future Research: The authors acknowledged the need for further research to optimize electrosurgical techniques in oral surgery. They called for studies focusing on refining the power settings, exploring new advancements in technology, and conducting long-term follow-up evaluations to assess the safety and efficacy of electrosurgery. The authors highlighted the importance of ongoing research to improve outcomes and address any potential concerns or limitations associated with electrosurgery.

3.Discussion

Although in the scientific literature review there are some articles on oral electrosurgery, its clinical applications are numerous. Electrosurgery is used in many fields of dentistry, and we believe it is appropriate to study in deep its in clinical field. The benefits and better control of intraoperative complications and risks can lead clinicians to increasingly use electrosurgery in everyday clinical practice[11], [12].

In Nixon et al. gingival incisions were performed on 25 adult male guinea pigs. For every animal, an electrosurgical scalpel was used on one side and a conventional scalpel was used on the other side. However, in this study, only one surgical method was applied to each rat in order not to affect wound healing.

Rathofer et al. compared electrosurgery with scalpel for the excision of inflammatory papillary hyperplasia using questionnaires to assess pain and patients' perception of the postoperative period. Most patients did not feel pain during either technique, but the pain and discomfort after the application of electrosurgery lasted longer than with the conventional scalpel.

Sinha et al. reported that limited hemostasis was obtained with the use of conventional scalpel, but buffering with gauze was needed. They also suggested that use of an electrosurgical device provided better hemostasis compared to CO2 laser and conventional scalpel[13].

Kalkwarf et al. 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 three successive incisions into the same site dramatically increased the amount of lateral heat production (8.0 - 48.0oC) at a distance of 1 mm from the electrode. The authors demonstrated that a cooling period of at least 8 seconds 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, 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 seconds was necessary to properly dissipate heat between successive entries into the same area of tissue with a loop electrode. Size and type of active electrodes the thicker the electrode, the greater the amount of lateral heat. In a study of electrosurgical wounds, it was reported that the needle-type electrode, which is used for incisions, creates a 0,12-mm-wide necrosis, and the loop electrode, used for tissue planing, makes a 0.31- mm-wide necrosis. The same report also concluded that large electrodes cause more tissue damage than small ones. Wave form the choice of waveform depends on (1) the required Surgical effect, i.e., whether tissue separation or hemostasis is required, and (2) the proximity of bone to the surgical site. The fully rectified waveform produces excellent tissue separation with the least amount of lateral heat, but it also produces very little hemostasis (Fig.2). The fully rectified, unfiltered waveform produces good tissue separation with effective hemostasis.

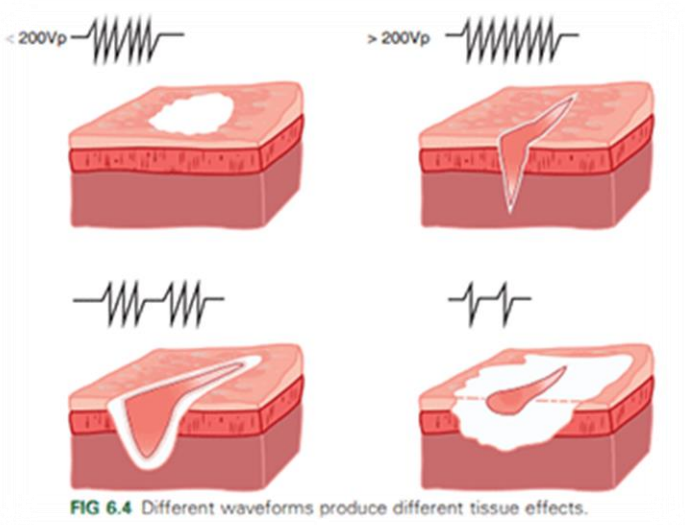

Fig.2 Different waveforms produce different tissue effects
Source://www.steris.com/

The partially rectified waveform produces much more lateral heat than the fully rectified, unfiltered waveform: therefore, it can be used only for the control of hemorrhage in soft tissue ecutting time, The quicker the active electrode is passed over the tissue, the lesser the lateral heat. It has been estimated that to generate an effective incision, while keeping the lateral heat at a minimum level, the electrode must be guided over the tissue at a speed of 7 mm/s. The active electrode must not remain in contact with tissue for more than 1 to 2 seconds at a time and successive applications of the electrode on the same spot must have a 10 to15 seconds interval. This interval allows the heat produced on the wound to dissipate and prevents overheating of the tissue surface before the next application of the electrode. Surface tissue condition. The surface of the tissue must be moist to allow heat dispersal. A dehydrated tissue surface causes sparking, tissue drag, and delayed healing. Therefore, it is desirable for the tissue surface to be wetted with the patient's own saliva or water or saline. Irrigation of the surgical site immediately after ES will also help to minimize lateral heat[14], [15].

Conclusion

Electrosurgery can never completely replace the scalpel, but it requires more knowledge, skill and complete understanding of the biophysical aspects of the interaction of electrosurgical energy and tissue. Continued research into the field of tissue interaction is promised and potential development of applications of electrosurgery. Overall, the authors expressed positive views on the usage of oral electrosurgery, recognizing its effectiveness, advantages, and patient satisfaction. They also emphasized the need for proper techniques, safety measures, and further research to optimize the use of electrosurgery in oral surgery procedures.

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