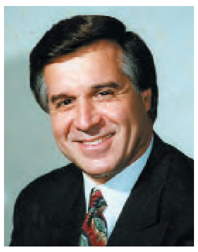
RADIOSURGERY: THE CUTTING EDGE



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Radiosurgery is a common and now well-respected word in the field of dentistry. This form of surgery evolved from electrosurgery and before that electrocoagulation. The common use of radiosurgery is in part a result of the advancement of the technology as well as the increased research in the field over the years. The original electrosurgical equipment developed by Coles, Martin, and Ellman[1] has been downsized with the development of more sophisticated waveforms and cutting tips. Dr. Irving Ellman developed the fully filtered waveform combined with a frequency of 3.8 MHz. Dr. Maurice Oringer wrote ject.[2,3] Dr. John Flocken of the University of California at Los Angeles was one of the original educators that brought electrosurgery in the form of participation courses to dental schools and the dental profession.

Advancement in the field of dentistry has progressed rapidly during the past 12 years with the development of high-frequency radiosurgery. What was once thought of as a luxury has quickly turned into a necessity for soft tissue management. Dentists are now equipping every operatory not only with handpieces and bonding lights but with high-frequency radiosurgery instruments as well. With the advent of the CEREC® technology (Sirona Dental Systems), laminate veneers, the increased demand for bonded restorations, and the need for a blood-free environment has increased tremendously (Figures 1 through 3). With proper instruction on the use of the varying waveforms and electrode tips, dentists can now expect to use the instrument on 8 of every 10 patients. It is this increased usage that has opened techniques in the field and justifies an instrument in every treatment room.

Figure 1—Line drawing depicting a gingivectomy or tissue removal to expose subgingival decay. A straight wire electrode is used to perform the procedure.

Figure 2—A Vari-Tip No. 118 electrode is used with a fully rectified waveform to expose the subgingival decay.

Figure 3—A pencil-shaped No. 113F electrode is used with the partially rectified waveform to establish hemostasis.

There are presently four different types of waveforms available in the field of dentistry (Table 1). It should be noted that all instruments do not necessarily include all waveforms and the practitioner should research the differences of waveforms and establish which waveforms will suit the individual dentist's needs. The American Dental Association and Underwriters Laboratories, Inc. Seal of Acceptance should also be strongly considered because all instruments do not necessarily meet the criteria.

TYPES OF WAVEFORMS

FULLY RECTIFIED Waveform

The most commonly used waveform is the fully rectified waveform. The mode of action is one that will easily cut through the tissue as well as establish coagulation. The cut and coagulate feature makes radiosurgery far superior to the scalpel or cure in that it minimizes blood flow and in turn gives a better field of visibility and an enhanced surgical result.

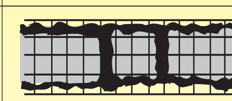
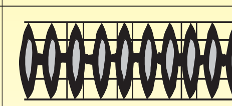
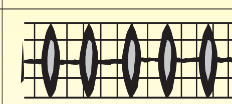
Fully Filtered Waveform

The fully filtered waveform is the least traumatic of the waveforms. This waveform produces rounding tissue and permits a certain amount of bleeding to occur. This is advantageous in periodontal surgery, where a blood supply is necessary for flap closure. This waveform is ideal for working in close proximity to the bone and in removing specimens for biopsy because of its delicate nature. The filtered waveform is also excellent for exposing crown preparation margins on the anterior teeth, where the tissue is thin and frail.

Partially Rectified Waveform

The partially rectified waveform is used only to establish It should be used with the thicker ball Nos. 135 and 136 electrodes (Ellman International, Inc.) and the pencil-shaped Nos. 113F and

TABLE 1 - DIFFERENCES OF THE FOUR WAVEFORMS AVAILABLE IN RADIOSURGERY

WAVEFORM	TISSUE USAGE	SECTIONING	LATERAL COAGULATION	HEAT	WAVEFORM ON OSCILLOSCOPE
Fully rectified filtered	pure cutting	excellent	minimal	least	
Fully rectified	cutting with hemostasis	very good	very good	more	
Partially rectified	coagulation on soft tissue	very poor	excellent	slightly greater	
Fulguration	superficial destruction and coaglation near bone	none	excellent for osseous surgery	greatest	

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117 electrodes (Ellman International, Inc.) only. When performing hemostasis, the blood is wiped from the area with gauze and the electrode is applied directly to the tissue in the area of the bleeding. This will allow for coagulation of the bleeding vessel directly.

Fulguration

The fulguration current was developed in the medical field as a means of establishing hemostasis in an area where the blood vessel cannot be directly contacted.[4] This waveform is useful in areas of periodontal osseous surgery and when performing apicoectomies where bone contact should be avoided. Fulguration can also be used to eliminate interproximal oozing during crown impression techniques. A bleeding problem during osseous surgery can be quickly eliminated without fear of injury to the underlying osseous structure. Fulguration is accomplished by placing the pencil-shaped No. 113F electrode in close proximity to the bleeding site and placing the instrument in the fulguration mode. A spark is allowed to jump from the electrode tip to the area of bleeding and carbonize and clot the blood cells (Figure 4). This procedure is known as the spark gap technique and is only accomplished with those instruments equipped with this waveform.

Figure 4—The No. 113F electrode is placed in close proximity to the tissue and a spark jumps to the soft tissue, establishing hemostasis.

For proper cutting as well as coagulation it is necessary for the instrument to be tuned for the best possible results. Cutting should be smooth and easy with no or only minimal sparking. The tissue should be incised with no tissue sticking or clinging to the electrode tip. Sparking on cutting is indicative of too much power whereas drag or tissue sticking is indicative of an inadequate power setting. With proper power tuning the electrode will move rapidly through the tissue, making a clean, odorless, microsmooth incision that produces a painless, rapidly healing incision with no or minimal patient discomfort.

Lateral Heat

Lateral heat refers to the heat

Table 2 - Formula for Minimizing Lateral Heat To The Surrounding Tissue

Lateral heat =	Time which electrode contacts	x	Intensity	x	Frequency of power of unit	x	Waveform of the radio signal	x	Electrode size

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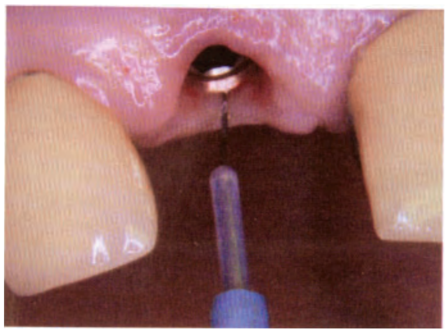

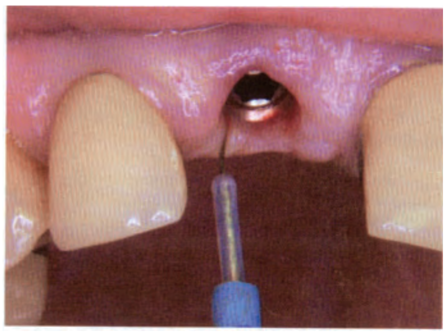

Figures 6 and 7—The margin is exposed using a No. 118 Vari-Tip electrode and a fully filtered waveform.

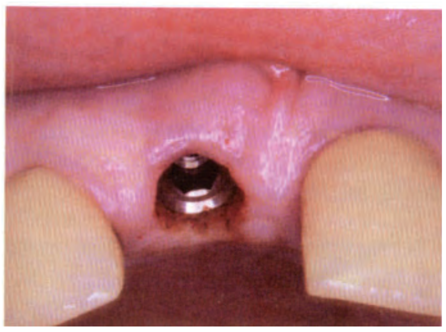

Figure 8—Tissue fully excised, exposing the implant.

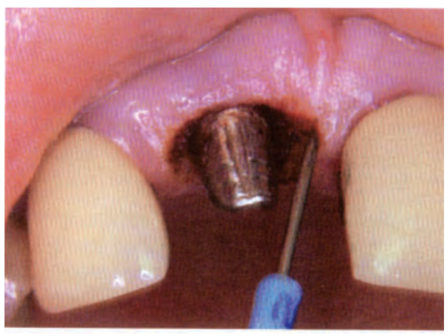

Figure 9—Hemostasis is established using a partially rectified waveform and a pencil-shaped No. 113F electrode.

produced to the tissue on either side of the electrode tip. This heat is produced by the resistance of the tissue to the radio wave being transmitted through it. The control of lateral heat to the tissue surrounding the electrode tip is a must. When making an incision, the radio signal should be applied to any one point for a period of 1 to 2 seconds followed by a waiting or cool-down period of 5 to 10 seconds. The tissue can also be cooled using the air-water syringe or central suction, thereby eliminating the waiting period. Lateral heat can also be minimized by using the fully filtered waveform for making the most delicate incisions in close proximity to the osseous tissue. Research has shown that this waveform produces the least lateral heat of the four available waveforms.[5]

Lateral heat can be minimized by proper instrument power tuning, proper waveform selection, and by using a high-frequency radiosurgical instrument operating between 3.8 and 4 MHz in comparison with the old 1-to 2.9-MHz low-frequency electrosurgical instruments (Table 2). The high-frequency radio signal has shown through research and testing to produce the least possible tissue alteration.[5] Published research studies confirm adjacent nontarget tissue alteration at 15 to 30 µ with the 4-MHz device.[6] The patient experiences a pressureless incision with a minimal amount of bleeding, which often requires no suturing, and reduces bacteria, healing time, and discomfort. The radio wave produces a finer, less traumatic incision and therefore has seen increased usage in all forms of delicate periodontal, oral, and cosmetic surgery.

Case Example

A 39-year-old woman presented with the need for restoration of an implant on tooth No. 8 that was placed 6 months previous (Figure 5). Radiosurgery was used with a filtered waveform to fully expose the implant. A trough was created using a fine wire No. 118 Vari-Tip electrode

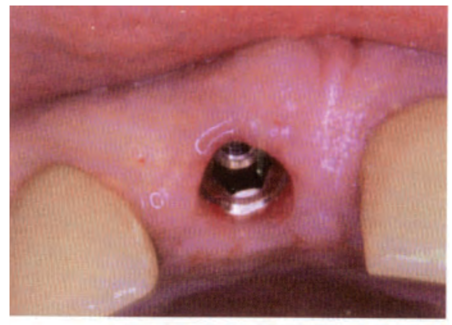

Figure 5—A preoperative photo shows the implant healed with some tissue covering the margins.

(Ellman International, Inc.) (Figures 6 through 9). An impression was then taken and a precious metal coping was then constructed. The patient returned 3 weeks later and the coping and crown were inserted (Figure 10). Radiosurgery was once again performed to widen the sulcus area to allow proper seating of the crown without impingement on the soft tissue. Figure 11 shows the postoperative view of the crown cemented in position.

Bipolar Surgery

Bipolar surgery has made a brief appearance in the dental literature.[7] There is some confusion among practitioners as to the difference of monopolar and bipolar surgery. Radiosurgery offers the ability to perform as both a monopolar and bipolar instrument. In the monopolar mode, the incision is made with a microfine, single-frequency matched surgical wire. This mode is used to delicately and precisely remove or recontour soft tissue. The bipolar mode is used for precise, pinpoint coagulation during microsurgery (Figure 12). Bipolar coagulation uses an electrode with two wider tip wires parallel to each other. The signal travels between the wires, establishing coagulation.

Bipolar surgery is the method used to incise and recontour the soft tissue. In dentistry it is difficult to produce a fine precise incision with two tips, one actually cutting and the other acting as an antenna and making constant contact with the tissue. Tactile sense, especially around teeth, is considerably reduced (Figure 13). Bipolar surgery is used frequently in medicine where bleeding is prevalent, rather than in dentistry where practitioners work in a relatively blood-free environment. In dentistry bipolar surgery can be used for its hemostatic ability in a wet field.

This author has worked with a bipolar instrument to become familiar with its differences from radiosurgery and prefers using monopolar surgery with a single wire for the precision and control (Figure 14); it is much easier and safer to control one wire instead of two. One wire gives a more predictable and consistent

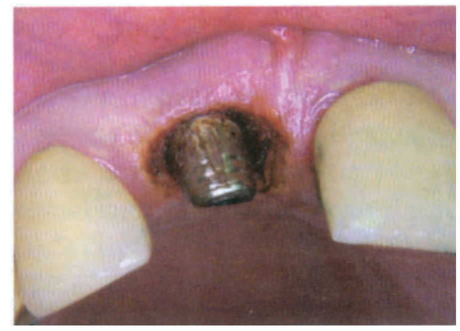

Figure 10—Implant coping is placed with total hemostasis to allow the crown to be cemented without tissue or blood impeding its cementation.

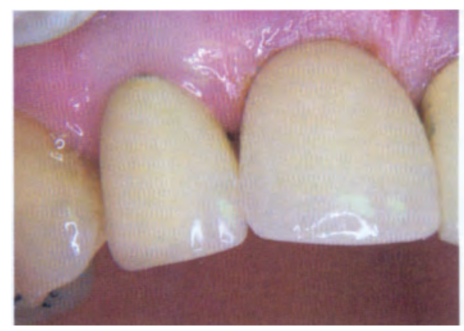

Figure 11—Postoperative view of the crown cemented in position.

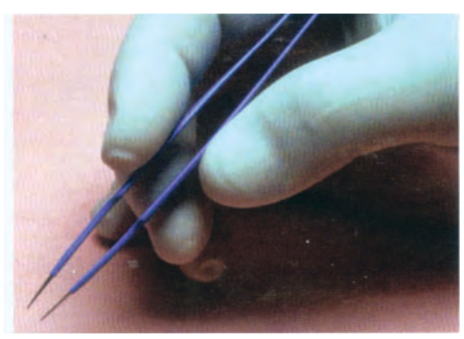

Figure 12—Bipolar forceps used for pinpoint coagulation during microsurgery.

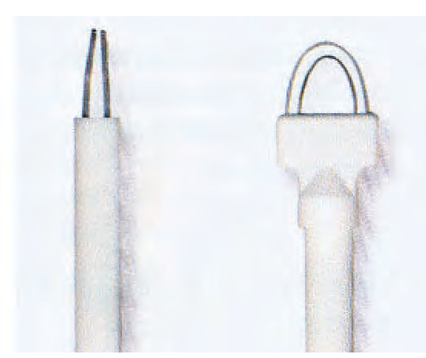

Figure 13—Bipolar electrodes have two wires, the first to contact the tissue acts as the antenna whereas the second wire makes the incision.

Figure 14—Monopolar surgery uses one wire to incise tissue. A separate antenna is placed behind the patient. This gives more precision and control to the incision.

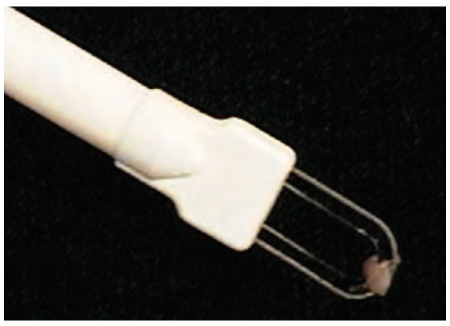

Figure 15—Char tissue gets caught between the wires, causing the signal to short out.

result, especially in the anterior of the mouth, where the area of visibility is limited. One serious disadvantage of bipolar cutting during all soft tissue procedures is that char tissue collects between the double wires. This causes the radio signal to short out, and the energy flow to stall (Figure 15). The dentist must then stop the procedure and spend time cleaning the burnt tissue fragments from the bipolar electrode wires. This author prefers to use and teach monopolar radiosurgery at 3.8 to 4 MHz because of its safety, precision, control, ease of use, and consistent, predictable results. In addition, research in dental and medical literature support the efficacy of 4-MHz radiofrequency radiosurgery.[5,8-10]

Tissue Removal with Lasers

Light amplification by stimulated emission of radiation (LASER) technology is another method of tissue removal that is commonly seen in the dental literature.[11,12] The laser can create a precise incision by varying the power level delivered to the surgical site. The laser can achieve coagulation of blood vessels smaller than 0.5 mm in diameter, providing a bloodless field of operation. The lasers are able to perform many of the procedures accomplished with radiosurgery, but at a much greater expense. Lasers vary in type including argon, CO2, Nd:YAG, Er:YAG, Ho:YAG, diode, and excimer, to mention a few (Table 3). These lasers vary in tissue contact and noncontact modes, to create incisions with and without coagulation. The lasers vary in which soft and hard tissue procedures they are able to perform, although no one laser can accomplish all procedures. The size and cost of the lasers make it difficult to decide whether the investment is truly worth incorporating lasers into the dental practice. Parts and maintenance of lasers are still another cost consideration. The radiosurgery units are very small and compact in comparison with the larger laser units. This author's experience is that radiosurgery produces excellent results with a short learning curve, at a fraction of the cost (Figure 16).

Table 3 - Various Types of Lasers

Laser	Action	Procedure
Argon	Light Cure	Resins Bases
CO2 (Noncontact)	Cut with Coagulation	Gingivectomies Gingivoplasties Frenectomies
Er:YAG (Contact)	Cut	Mucogingival surgery Vaporizing large benign lesions
Nd:YAG (Contact)	Cut with coagulation	Gingivectomies Gingivoplasties Frenectomies Soft tissue contouring
Diode	Cut with coagulation	Gingivectomies Gingivoplasties Frenectomies Soft tissue contouring
Ho:YAG (Contact and noncontact)	Cut with Coagulation	Rapid tssue removal and hemostasis Frenectomies Implant exposure Procedures near floor of the mouth or tongue
Excimer	Cut	Very precise tissue removal Delicate periodontal procedures Delicate endodontic procedures

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Postoperative Dressing

Patient comfort during the postoperative period is an important concern in all phases of dentistry. A postoperative dressing is indicated for all areas of radiosurgery. Areas of minimal tissue removal such as exposing subgingival decay, establishing hemostasis during bonding, or tough crown preparations can be protected by irrigating the surgical area with 0.12% chlorhexidene gluconate or Peridex® (Zila Pharmaceuticals) or with a Listerine® rinse (Pfizer). A coating of Iso-Dent (Ellman International, Inc.), isobutyl cyanoacrylate (tissue adhesive), can also be applied to areas of minor surgery. In areas of moderate surgery, tincture of myrrh and benzoin is liberally applied to the surgical site in several layers, air-drying between each layer. A periodontal pack such as COE-PAK™ (GC America, Inc.), Zone (Cadco), or Barricaid® (Dentsply Caulk) should be placed on all areas where extensive surgery has been performed. It is important to give the patient a prescription to minimize postoperative discomfort. The patient should be cautioned about eating spicy food or citrus fruits that may irritate the surgical site and be made aware that surgery was performed although there was no or minimal bleeding. Frequently the patient who undergoes radiosurgery sees no bleeding and tends to minimize postoperative care.

Conclusion

Radiosurgery is a modality that belongs in every general dental office. It is safe, easy, predictable, and cost effective. This author strongly recommends taking a participation course to become fully versed in the use of radiosurgery. ○

Figure 16—The Dento-Surg 90 F.F.P.™ (Ellman International, Inc.) offers four waveforms and is approved by the American Dental Association and Underwriters Laboratories, Inc.

Disclosure

Dr. Sherman receives honoraria from Ellman International, Inc. and Patterson Dental Supply, Inc.

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