Effectiveness of radio waves application in modern general dental procedures: An update

Arslan Qureshi, DDS1/Sergio Varela Kellesarian, DDS2/Michael A. Pikos, DDS3/Fawad Javed, BDS, PhD2/Georgios E. Romanos, DDS, PhD, Prof Dr med dent4

Objective: The purpose of the present study was to review indexed literature and provide an update on the effectiveness of HRW application in modern general dentistry procedures.

Data Sources: Indexed databases were searched to identify articles that assessed the efficacy of radio waves in dental procedures.

Results: Radiosurgery is a refined form of electrosurgery that uses waves of electrons at a radiofrequency ranging between 2 and 4 MHz. Radio waves have also been reported to cause much less thermal damage to peripheral tissues compared with electrosurgery or carbon dioxide laser-assisted surgery. Formation of reparative dentin in direct pulp capping procedures is also significantly higher when high-frequency radio waves are used to achieve hemostasis in teeth with minimally exposed dental pulps compared with traditional techniques for achieving hemostasis. A few case reports have reported that radiosurgery is useful for procedures such as gingivectomy and gingivoplasty, stage-two surgery for implant exposure, opereculectomy, oral biopsy, and frenectomy. Radiosurgery is a relatively modern therapeutic methodology for the treatment of trigeminal neuralgia; however, its long-term efficacy is unclear. Radio waves can also be used for periodontal procedures, such as gingivectomies, coronal flap advancement, harvesting palatal grafts for periodontal soft tissue grafting, and crown lengthening.

Conclusion: Although there are a limited number of studies in indexed literature regarding the efficacy of radio waves in modern dentistry, the available evidence shows that use of radio waves is a modernization in clinical dentistry that might be a contemporary substitute for traditional clinical dental procedures. (Quintessence Int 201##;##:1–6; doi:##.####/j.qi.a#####)

Key words: dentistry, electrosurgery, radiofrequency, radiosurgery, radio waves

Radio waves are high frequency electromagnetic radiations that produce heat by electromagnetic movement of charged particles.1,2 Radio wave units operate on a 60-cycle alternating current, which is converted to a direct current (DC) by a rectifier (Fig 1). The DC current passes through a rectifier that generates radio waves.3 These waves are then passed through a waveform adapter that helps alter the intensity and characteristics of the radio waves generated. This helps to attain the required waveform. Radio waves are transferred from the tip of an electrode and are returned to the unit by a neutral antenna plate. Resistance to the passage of radio waves through the tissues generates heat that result in tissue cutting or coagulation.4,5 This frequency delivers the energy to the targeted area without heating the electrode itself. In contrast, in conventional
electrocautery, a direct or alternating current is passed through a resistant metal wire electrode, generating heat; the heated electrode is applied to living tissue to achieve hemostasis and/or varying degrees of tissue destruction (Table 1).

A number of studies have assessed the role of radio waves in the treatment of oral inflammatory conditions. For example, results from an experimental study on rats showed that use of high-frequency radio waves (HRW) in direct pulp capping induces faster hemostasis and forms high-quality reparative dentin compared with traditional pulp-capping techniques that used 10% sodium hypochlorite (NaOCl) and 3% hydrogen peroxide (H₂O₂). Likewise, in the case-report by Sherman, radio wave surgery was reported to be an alternate procedure for cosmetic gingivectomy compared with traditional surgical protocols. Furthermore, HRW have been used for the treatment of gingival melanin hyperpigmentation, trigeminal neuralgia, and sleep apnea. Results from these studies indicate that HRW have a potential role in the treatment of various oral inflammatory conditions, and can be used in various disciplines of clinical dentistry such as endodontics, periodontology, oral surgery, and respiratory disturbances.

To the authors’ knowledge, from indexed literature a limited number of studies have evaluated the role of HRW in dental procedures. Therefore, the purpose of the present study was to review indexed literature and provide an update on the effectiveness of HRW application in modern general dentistry procedures.

### METHOD AND MATERIALS

#### Focused question
A specific question was developed according to the Participants, Interventions, Control, and Outcomes (PICO) format. The addressed focused question was: “What are the reported uses (O) of radio waves (I/C) in dental patients (P)?”

PubMed (National Library of Medicine), Google Scholar, Scopus, EMBASE, MEDLINE (OVID), and Web of Knowledge databases were searched without language or time restrictions to identify articles that assessed the basic principles of HRW and its efficacy in dental procedures. Different combinations of the following key

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Fig 1 Radio wave device for oral surgical procedures (Ellman).
words were used: “radio waves,” “radiosurgery,” “radiofrequency,” “dental,” “dentistry,” “oral,” “implants,” “endodontics,” “periodontics,” “soft tissues;” “sleep apnea,” and “trigeminal neuralgia.” All levels of available evidence (including in-vitro studies, studies in animal models, case reports, and case series) were included. Review articles, commentaries, and letters to the editor were, however, not sought.

RESULTS

Radio waves and direct pulp capping
In direct pulp capping (DPC) procedures the clinical success depends upon the formation of reparative dentin and achievement of hemostasis. Calcium hydroxide (Ca(OH)₂) and mineral trioxide aggregate (MTA) dressings are most commonly used to induce reparative dentin formation in DPC procedures.11-13

In the study by Handa et al, 6 46 male Wistar rats (aged 8 weeks old) were included. In these animals, pulp chambers in the maxillary first molars were exposed under general sedation and the rats were divided into control and test groups. In the control group hemostasis was achieved by using 10% NaOCl and 3% H₂O₂, following which the pulp was covered with Ca(OH)₂ as a DPC agent; in the test group, hemostasis was performed with HRW, and the pulp was covered with Ca(OH)₂. The authors compared hemostasis times in both groups, and 28 days after surgery the animals were euthanized to evaluate reparative dentin formation. The results showed that HRW-induced hemostasis required significantly less time compared to the control group, and high-quality reparative dentin was seen in the test group compared with the control group.

The mechanism of wound healing for pulp-capped surfaces has been associated with the formation of fibronectin, which enhances cell chemo-attraction, differentiation, and adhesion.14 There is a possibility that HRW treatment enhances the expression of fibronectin in pulp tissues, which increases the formation of reparative dentin. Although studies have shown that MTA induces the formation of high-quality reparative dentin,15,16 in some instances hemostasis might fail, thereby yielding unsatisfactory outcomes.17,18 It is therefore hypothesized that achieving hemostasis by HRW enhances the oral efficacy of MTA in reparative dentin formation. Further studies are needed to test this hypothesis.

Radio waves and trigeminal neuralgia
Trigeminal neuralgia (TN) is a painful neurologic condition that is confined within the areas distributed by the trigeminal nerve. Antiepileptic drugs, such as carbamazepine, have been reported to help in relieving pain associated with TN;19 however, nearly 10% of patients may not respond to this form of treatment.20 In such circumstances, other interventions such as radio waves thermo-coagulation (RFT) might be useful alternatives for the management of TN.

In a recent study by Jin et al,9 90 patients who underwent RFT for the management of TN were evaluated. In this study, nearly 83% reported to have at least a 50% reduction in pain at 6 months following RFT.

It should be noted that in the long term the efficacy of RFT in the treatment of TN is not as effective as other procedures such as microvascular decompression; however, RFT is less invasive, has a lower morbidity, and the procedure can be repeated in the same patient if necessary.21 Moreover, RFT allows selective destruction of trigeminal nerves, which is beneficial for TN patients with single nerve distribution.9

Radio waves and soft tissue management
In periodontology, indications for HRW are limited. Conservative management of mucosa and gingiva during common periodontal and surgical procedures, such as gingivectomy and crown lengthening, is desired to decrease the risk of postoperative complications (pain, bleeding, swelling, scar tissue formation) and to improve functional and esthetic outcomes (Fig 2). A limited number of case reports have reported the efficacy of HRW for the management of soft tissues, such as gingivectomy and frenectomy.7,22-28

In a case report by Sherman,7 a 46-year-old man underwent gingivectomy using HRW for the treatment of inflamed and hyperplastic tissues on maxillary teeth.
Following tissue removal using HRW, a periodontal pack was placed over the surgical site. The author claimed that use of HRW facilitates rapid tissue removal and allows a pressureless incision with adjunct coagulation. Moreover, greater patient comfort (due to the lack of bleeding) and a clear field of visibility to ensure adequate removal of tissue were stated as benefits of using HRW for tissue removal surgeries.

In another case report, a lingual frenectomy was performed using HRW on a 46-year-old man with developmental ankyloglossia. The procedure was performed in two steps. In the first step, an incision was made using a HRW-based ball-shaped electrode. The incision was widened to expose the underlying muscle, which was then resected with ease, and the simultaneous coagulative effect of HRW eased visibility. As a postoperative dressing, tinctures of myrrh and benzoin were placed over the surgical site. In the second step, the surgical site was clinically evaluated after 3 weeks and additional muscle tissues were resected using HRW to facilitate further extension of the tongue; again, a dressing of tinctures of myrrh and benzoin was placed over the surgical site to promote postoperative healing.

In the same study, the author reported a case of a 41-year-old man with subgingival delay on a mandibular canine. The author used HRW to perform a gingivectomy and expose the decay, which was excavated and restored with a light-cured resin-based restoration. The author concluded that use of radio waves is a valuable modality for surgical procedures such as frenectomy and gingivectomy.

In another case report, a 52-year-old woman was seen for prosthetic restoration of three mandibular implants that had been in place for 3 months. Upon clinical and radiographic evaluation, it was decided that the prosthetic phase could be started. On removal of the healing caps, soft tissue overgrowth was observed. In order to expose the implants completely, radiosurgery was performed. Healing was uneventful following radiosurgery and the prosthetic phase was completed without any complications.

Likewise, HRW has also been reported to be effective in the esthetic treatment of gingival melanin
Clinical experience shows that HRW can be used beneficially for soft tissue incisions, periosteal releasing incisions for coronal flap advancement after bone grafting of the alveolar ridge (Figs 3a and 3b), stage-two surgery for implant exposure (Fig 3c), as well as apically positioned flaps (Fig 3d) for increase of the keratinized attached gingiva (mucosa) around teeth (implants).

Although radiosurgery therapy has been shown to have beneficial effects in soft tissue management, these findings are mainly based on uncontrolled studies (case reports) and have to be confirmed by well-designed randomized control clinical trials with objective and subjective outcome measurement.

Radio waves in sleep apnea and snoring

Sleep apnea is an involuntary cessation of breathing during sleep. There are three types of sleep apnea: obstructive (the most common), central, and mixed. In contrast, the partial obstruction and the vibration of the oropharynx results in a noisy respiratory sound termed snoring.

HRW ablation (RA) consists of generating a precise submucosal lesion in the soft palate, to promote a coagulative necrotic lesion followed by scar tissue. This results in stiffening of the soft palate.

Gerek et al. assessed apnea index and daytime sleepiness among 88 patients to evaluate the efficacy of RA of the soft palate in patients with mild sleep apnea and snoring. The results showed that approximately 90% of the patients referred an improvement of at least 50% in snoring symptom level, snoring noise level, and apnea index after 2 months follow-up.

Likewise, Sonsuwan et al. treated with RA 51 men diagnosed with mild to moderate obstructive sleep apnea. The results after 3 months follow-up showed increased minimal oxygenation levels and significant decrease in snoring score and apnea index.

CONCLUSION

Although there are a limited number of studies in the indexed literature regarding the efficacy of HRW in modern dentistry, the available evidence shows that use of HRW is a modernization in clinical dentistry that might be a contemporary substitute for traditional clinical dental procedures. The clinician is encouraged to use this technology in order to develop knowledge about the clinical advantages, and to control complications in clinical practice.

REFERENCES


